

**DELAWARE MEDICAID PARTICIPANTS WITH TYPE II DIABETES:
TRENDS IN CARE UTILIZATION, AND IMPLICATIONS FOR MEDICAID
POLICY**

by

Seth Chizeck

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Public Policy

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ABSTRACT

The Medicaid program plays an important role in facilitating and financing the treatment of type 2 diabetes in America. This thesis uses Medicaid claims data from the state of Delaware to investigate three specific concerns regarding type 2 diabetes and Medicaid: the prevalence of diabetes among Medicaid participants, the quality of care received by Medicaid patients with diabetes, and disparities in diabetes prevalence and treatment quality across Medicaid participant subgroups. The results are discussed in the context of existing research, followed by a review of promising Medicaid strategies to better prevent and treat type 2 diabetes. The findings in this thesis offer a preliminary glimpse into the health needs and experiences of Delaware's Medicaid participants with type 2 diabetes. This can help inform Delaware's ongoing efforts to transform its health care system and improve the health of underserved populations.

Chapter 1

INTRODUCTION

Type 2 diabetes mellitus (henceforth referred to as *diabetes*) is a pressing public health issue in both the United States and the state of Delaware.¹ As the country's seventh leading cause of death, diabetes afflicted an estimated 9.1 percent of adult Americans and 9.7 percent of adult Delawareans in 2014 (CDC, 2016a), and its prevalence has nearly quadrupled nationwide since 1980 (CDC, 2014a). Moreover, a full 37 percent of U.S. adults have prediabetes (CDC, 2014a), meaning they exhibit strong warning signs of developing the disease. Diabetes carries the risk of many severe health complications. It represents the nation's leading cause of kidney failure, lower limb amputation, and adult-onset blindness. It also heightens the chance of heart disease and stroke, and increases one's overall risk of premature death by 50 percent (CDC, 2014a).

Diabetes stems in large part from lifestyle factors related to obesity, such as excessive caloric intake and lack of physical activity. However, these risk factors are linked to deeper social trends, such as the limited availability of unprocessed food in

¹ There are also several other types of diabetes besides type 2 diabetes mellitus. These include type 1, gestational, monogenic, and cystic fibrosis-related diabetes (ADA, 2012b). These types of diabetes are not discussed in this report, because they comprise only five to 10 percent of all cases of the disease, and are not understood to result from socially determined risk factors. Thus, they have public health implications distinct from those of type 2 diabetes mellitus.

local retail environments (Auchincloss, Diez Roux, Brown, Erdmann, & Bertoni, 2008), and the sedentary nature of modern work and leisure activities (Hu, 2011). The prevalence of diabetes also falls along socioeconomic lines. Racial/ethnic minorities in America are two to six times more likely than Whites to have diabetes (Carter, Pugh, & Monterrosa, 1996), and the disease is more prevalent among people with lower incomes and educational attainment (Clark & Utz, 2014). These socioeconomic factors also affect how well diabetes is treated. The adequate management of diabetes requires continuous self-monitoring and preventive care; yet for many reasons, low-income and minority individuals tend to maintain poorer control of their diabetes (Berkowitz et al., 2015). Similar socioeconomic disparities in diabetes have been documented in Delaware, where Black adults have rates of diabetes more than four percentage points higher than Whites, and Blacks with diabetes are twice as likely to die from their condition as Whites with diabetes (DHSS, 2014; DHSS, 2015).

Diabetes further constitutes a public health problem because it produces consequences for the whole of society that concern economic productivity, community health, and even basic human rights. Diabetes imposes a large burden on the economy. In 2012, the disease accounted for \$176 billion in U.S. health care spending, and cost the country another \$69 billion in reduced productivity and workforce participation. In Delaware alone, the 2012 health care and productivity costs amounted to \$860 million (ADA, 2013). Diabetes weakens communities by debilitating people who play vital social roles, and inhibiting participation in civic activities (Gannon & Nolan, 2006). The public health response to diabetes has even been framed as a matter of ensuring

the basic human right to achieving the highest attainable standard of health (Gruskin, Ferguson, Tarantola, & Beaglehole, 2014; United Nations, 1948).

The Medicaid program plays an important role in facilitating and financing the treatment of diabetes in America. Medicaid is a joint state-federal public health insurance program that covers low-income individuals and families. The program covers nearly one fifth of all U.S. adults with diabetes (Casagrande & Cowie, 2012), increasing their access to care and paying for the majority of their treatment costs (Garfield & Damico, 2012).

The purpose of this report is to investigate three specific concerns regarding diabetes and the Medicaid program. The first concern is the prevalence of diabetes among Medicaid participants. Due to its correlation with poverty, diabetes occurs more frequently among Medicaid participants than among individuals with private insurance. Over 11 percent of nonelderly adult Medicaid participants in the U.S. have diabetes, which is more than twice the percentage among those with private insurance (CDC, 2015).

The second concern is that Medicaid faces challenges in delivering high quality care to participants with diabetes. The treatment of diabetes strains Medicaid's budget and challenges the coordination of care. In 2009, state Medicaid programs spent an average of \$13,490 on each participant with diabetes, compared to just \$5,133 per participant without diabetes (KFF, 2012a). Medicaid's higher spending on patients with diabetes is driven in large part by hospitalizations for acute complications (GAO, 2015). Diabetes care for Medicaid patients also tends to be

fragmented or uncoordinated in ways that do not optimally address their complex health needs (Frandsen, Joynt, Rebitzer, & Jha, 2015). The treatment of diabetes thus poses a financial and operational challenge for the Medicaid program, which in turn affects the quality of care and health outcomes for many of the country's low-income people with diabetes.

The third concern is that disparities in diabetes prevalence and care quality exist across subgroups of Medicaid participants. Ethnic minority participants, just as in the wider population, have shown higher rates of diabetes and worse diabetes outcomes than White participants (Buescher, Whitmire, & Pullen-Smith, 2010; Stewart et al., 2011). These disparities challenge the government's health equity goal of eliminating avoidable differences in health care quality and health outcomes between social groups.

These three concerns can be investigated by examining participants' utilization of care, using administrative claims data. Researchers have made use of claims data to gauge the prevalence of diabetes among Medicaid participants, as well as differences in prevalence across subgroups (Guo, Gibson, Gropper, Oswald, & Barker, 1998; Buescher et al., 2010). Studies have also used Medicaid claims data to examine differences in care utilization between participant subgroups, such as between participants with and without diabetes (Hilltop Institute, 2016), rural and urban participants with diabetes (Center for Health Workforce Studies, 2015), and White and minority participants with diabetes (Priest, Cantrell, Fincham, Cook, & Burch, 2011). These data allow the tracking of the delivery of preventive screenings and more costly

acute care, making them a rich source of information on the health status of Medicaid participants with diabetes and the quality of care they receive.

The state of Delaware stands to benefit from a claims-based examination of its Medicaid participants with diabetes. Evidence from the Medicaid program would help Delaware officials better understand the health status and needs of the state's most vulnerable residents with diabetes. This evidence would also shed light on how these residents are faring under the state's current landscape of policies regarding both diabetes and Medicaid. Findings from a Delaware Medicaid claims analysis would also add a new local context to the overall body of knowledge on the prevalence and treatment of diabetes within Medicaid. In light of this research need, this report draws upon Delaware's Medicaid claims data to answer the following questions:

1. *Prevalence:* What was the overall prevalence of diabetes among Delaware nonelderly adult Medicaid participants between fiscal years 2009 and 2015? How did this prevalence compare to the general nonelderly adult population in Delaware, and to nonelderly adult Medicaid participants in other states? How did it vary by year, and by participant age, sex, race/ethnicity, county, and zip code of residence?
2. *Care quality:* Between fiscal years 2009 and 2015, what percentage of Delaware nonelderly adult Medicaid participants with diabetes received care that satisfied the National Committee for Quality Assurance's Healthcare Effectiveness Data and Information Set (HEDIS) performance measures for Comprehensive Diabetes Care (annual HbA1c test, eye exam, and nephropathy screening)? How

did these percentages vary by year, and by participant age, sex, and race/ethnicity?

3. *Care utilization:* What was the mean number of ED (emergency department) and inpatient hospitalization claims for nonelderly adult Medicaid participants with diabetes in Delaware between fiscal years 2009 and 2015? How did these amounts vary by year, and by participant age, sex, race/ethnicity, zip code of residence, and whether the person received care that met all three HEDIS care quality measures?
4. *High-need participants:* Among the population of nonelderly adult Medicaid participants with diabetes in Delaware that comprised the top 10 percent of mean annual number of diabetes-related inpatient hospitalization claims between fiscal years 2009 and 2015: How did the demographic composition of this group compare to the full nonelderly adult participant population in terms of age, sex, race/ethnicity, and county. How did this group compare in its receipt of care that met HEDIS performance measures?

The rest of this report proceeds as follows.² Chapter 2 describes the individual-level causes and consequences of diabetes. Chapter 3 details the dimensions of diabetes as a public health issue, and Chapter 4 examines the role of Medicaid in facilitating the treatment of the disease. Chapter 5 presents the results of the Delaware

² Chapters 2, 3, 4, and 7 are based on a review of existing literature. See Appendix A for a description of the methodology used to carry out this literature review.

Medicaid claims data analysis, and Chapter 6 discusses the findings from this analysis. Chapter 7 reviews the implications of the findings for Medicaid policy. Chapter 8 offers recommendations for the state of Delaware, reflects on the strengths and limitations of the claims data analysis, and concludes.

Chapter 2

INDIVIDUAL-LEVEL DIMENSIONS OF DIABETES

Diabetes originates from both modifiable and non-modifiable risk factors, and its severe consequences require diligent lifestyle management to avoid. The disease puts enormous burdens on afflicted individuals, and demonstrates the complexity of the forces that shape an individual's health.

What is Diabetes?

Diabetes is a chronic, progressive condition that affects the body's metabolism, or its ability to derive energy from food. When humans digest food, the food is broken down into glucose, which passes into the bloodstream. The pancreas secretes a hormone called insulin that allows this glucose to absorb into the body's cells, which use glucose for growth and energy. The path towards diabetes begins when cells in the muscles, liver and fatty tissues become resistant to the function of insulin, and the pancreas gradually loses the ability to produce enough insulin to compensate for the body's increased demand. This combination of insulin resistance and defective insulin production causes glucose to build up in the blood (CDC, 2014b).

The diagnosis of diabetes involves measuring the level of glucose in a person's blood. This can be done through any of three blood tests: the hemoglobin A1c (HbA1c) test, the fasting plasma glucose test, and the oral glucose tolerance test. These tests assess blood sugar levels against thresholds that indicate the presence of

diabetes or its precursor condition, prediabetes. For example, the HbA1c test measures the average percentage of hemoglobin that has had glucose attached to it over the past two to three months. An HbA1c reading of between 5.7 and 6.4 percent indicates that a person has prediabetes. Approximately 70 percent of people with prediabetes go on to develop full-fledged diabetes, in which HbA1c levels are above 6.4 percent (Tabak et al., 2012).

Diabetes produces many severe health difficulties, and while the disease's initial symptoms are subtle and gradual, complications can often become grave and fatal. The beginning symptoms of diabetes include increased urination, increased thirst, unexplained weight loss, fatigue, blurred vision, increased hunger, and sores that do not heal (NIH, 2014). Because these symptoms often begin imperceptibly, diabetes frequently goes undiagnosed until more severe complications arise (Zgibor, Dorman, & Orchard, 2008). In fact, an estimated 30 percent of people with diabetes do not know that they have the condition (Ali, Bullard, Gregg, & del Rio, 2014). In light of the high prevalence of undiagnosed diabetes and the benefits of early detection (Herman et al., 2015), the American Diabetes Association (ADA) recommends that adults of all ages be tested for diabetes if they display certain risk factors, discussed below (ADA, 2012b).

In the long run, diabetes heightens the risk of several debilitating complications, including kidney failure, tissue damage in the lower limbs that can require amputation, retinal degeneration with loss of vision, nerve damage, and most of all, cardiovascular disease, which accounts for 70 percent of all deaths among

people with diabetes (ADA, 2012b; Laakso, 1999). People with diabetes also run the risk of developing a host of other ailments, from skin infections, to hearing loss, to sexual dysfunction, to Alzheimer's disease ("Complications", n.d.). These complications serve to reduce the median lifespan of 55 to 64 year-old adults with diabetes by eight years compared to their peers without the disease (Gu, Cowie, & Harris, 1998). In summary, diabetes is a complex disease that can lead to a number of degenerative health problems and serious complications.

Risk Factors

Diabetes stems most directly from unhealthy behaviors related to obesity, but the interplay between these behaviors and less preventable risk factors means that the origins of the disease are complicated, and makes the prevention of the disease particularly challenging.

The most proximal causes of diabetes involve deviations from a healthy lifestyle that are considered to be modifiable risk factors, meaning that they can be controlled or avoided to some extent. Obesity has long been established as the most important risk factor for diabetes (Holbrook, Barrett-Connor, & Wingard, 1989). Obesity itself results from a confluence of excessive caloric intake, poor nutrition, and lack of physical activity (Wright & Aronne, 2012), all of which represent behaviors and habits that are theoretically possible to alter through personal effort. The potential mutability of these behaviors was demonstrated in landmark diabetes prevention experiments in the late 1990's and early 2000's, in which high-risk individuals reduced their incidence of diabetes by up to 58 percent through intensive regimens of

weight loss and exercise (Diabetes Prevention Program Research Group, 2002; Pan et al., 1997; Tuomilehto et al., 2001). Other behavioral risk factors for diabetes are similarly modifiable. Smoking has been found to increase the risk of diabetes by 30 to 40 percent (CDC, 2014c), and not getting enough sleep also elevates one's risk of developing the disease (Touma & Pannain, 2011).

While these unhealthy behaviors can all lead to diabetes, they are also mutually reinforcing and can even result from diabetes itself. This complicates the causal sequence that leads a person to develop the disease. For example, sleeping poorly may make a person too tired to exercise and also increase their appetite, both of which contribute to obesity (Willie, Chemelli, Sinton, & Yanagisawa, 2001). Obesity then often leads to sleep apnea, which further reduces the quality of one's sleep (Vgontzas et al., 1994). But then diabetes itself may *further* increase one's likelihood of having sleep apnea through neural damage to the upper airway (Aurora & Punjabi, 2013). As another circular example, overeating increases the risk of obesity and diabetes, yet diabetes can also produce a feeling of insatiable hunger called polyphagia, which further leads to overeating and weight gain (NIH, 2014). Even smoking stems in part from the same emotional impulses that fuel excessive eating and obesity, such as feelings of stress (Childs & de Wit, 2010; Dallman, et al., 2003), which are then compounded by the physical and emotional toll of diabetes. With these multi-directional relationships, the behaviors that lead to diabetes are better characterized as a complex web rather than a strict sequence of events, especially since diabetes is often already present yet undiagnosed as these risk factors occur.

Many studies have sought to parse out the independent causal effects of these entangled behaviors, often testing the hypothesis that these behaviors cause diabetes solely through their relationship with obesity. But in fact, many of the behaviors associated with obesity have shown evidence of causing diabetes even when controlling for weight gain. The consumption of sugar-sweetened beverages not only contributes to obesity, but also fuels the risk of diabetes in its own right by spiking blood glucose levels (Imamura et al., 2015). Neglecting physical activity not only leads to weight gain, but also reduces muscle tissue sensitivity to insulin (Manson et al., 1992). Eating too few fruits and vegetables and too much saturated fat also increases the risk of diabetes through other physiological channels besides obesity (Hu, van Dam, & Liu, 2001; Carter, Gray, Troughton, Khunti, & Davies, 2010). Even lack of sleep appears to independently cause insulin resistance by interrupting the elaborate metabolic regulation that takes place during quality slumber (Touma & Pannain, 2011). Whether these unhealthy behaviors lead to diabetes independently or through the pathway of obesity, or more likely through a complex interaction of factors, they nonetheless represent a well-established set of risk factors that may be considered modifiable.

However, the risk of diabetes also depends on factors considered to be non-modifiable, such as one's age, sex, unavoidable physical and mental health problems, and heredity. The process of aging itself is arguably the most universal risk factor for diabetes (Morley, 2008). The body's metabolism naturally slows down as it reaches middle age. This causes fat to accrue in the abdominal area, and tissues to become

more resistant to insulin, both central facets of diabetes (Barzilai, Huffman, Muzumdar, & Bartke, 2012). Aging also gradually diminishes the body's aerobic fitness, which often causes physical activity to decrease with advancing age (Caspersen, Pereira, & Curran, 2000). These age-related bodily changes pose additional challenges to preventing diabetes through healthy behavior, and explain why diabetes typically develops between ages 45 and 64 (CDC, 2014e). Diabetes is also slightly more prevalent among men than women, and studies attribute this, in part, to gender-related differences. Men's bodies tend to be naturally more resistant to insulin than women's bodies, and tend to develop diabetes at lower body mass indices (Logue et al., 2011).

Diabetes is also correlated with other physical and mental risk factors that are less modifiable. For instance, a child has a higher chance of developing diabetes later in life if they are born prematurely, have very high or low birth weight, or are born to a mother who had poor nutrition during pregnancy (Harder, Rodekamp, Schellong, Dudenhausen, & Plagemann, 2007; Kajantie, Osmond, Barker, & Eriksson, 2010; Bartz & Freemark, 2012). Infants who are fed by bottle have a greater risk of diabetes in adulthood than those who were breastfed (Owen, Martin, Whincup, Smith, & Cook, 2006). Diabetes can also be brought on by physical traumas such as spinal cord injury, which more than doubles the odds of the disease as paralyzed muscle tissue shrinks and becomes resistant to insulin (Cragg et al., 2013). Studies have even found preliminary evidence that diabetes is associated with viral infections such as herpes simplex and hepatitis C, or bacterial infections such as *Staphylococcus*, although the

pathways of these relationships are poorly understood (Vu et al., 2015; Mehta et al., 2003; Sun et al., 2005). Mental health disorders comprise another well-known set of diabetes risk factors. Chronic psychological and emotional stress increases the risk of diabetes, as do clinical conditions such as depression and post-traumatic stress disorder. These same conditions can also *result* from the burden of having diabetes (Roberts et al., 2015; Pan et al., 2010; Lloyd, Smith, & Weinger, 2005; Ali et al., 2006). People born with intellectual disabilities are also more likely to develop the disease (McVilly et al., 2014). All of these maladies add layers of complexity to the causal path towards diabetes, complicating efforts aimed at prevention.

Genetic predisposition is the most complex of all diabetes risk factors, because it can potentially influence all of the above behaviors and conditions. It has long been known that the risk of diabetes has a strong hereditary component. First-degree relatives of individuals with diabetes are three times more likely to also develop diabetes than those without a family history of the disease (Florez, Hirschhorn, & Altshuler, 2003). When one identical twin develops diabetes, studies have found that the other twin will develop it as often as 95 percent of the time (Willemsen, et al., 2015). There is also marked variation in rates of diabetes across racial/ethnic groups that live in the same general environment. In Europe, people of South Asian descent have a risk of diabetes three to five times higher than native Europeans (Meeks et al., 2016). Genetic ancestry also partly explains African Americans' higher risk of diabetes compared to Caucasians (Cheng et al., 2012), as well as the extreme prevalence of diabetes among Native American tribes such as the Pima, where 38

percent of people have the disease (Baier & Hanson, 2004). But the exact mechanisms behind these genetic associations remain unclear. Studies of the human genome have to date identified over 40 specific gene variations that are linked to diabetes, but these variations only account for a small fraction of the disease's overall heritability (Imamura & Maeda, 2011). For now, an individual's risk of diabetes can still be better predicted from their age and body mass index than from their gene sequence (Lango et al., 2008).

Family members may also owe their similar risk of diabetes to shared surroundings rather than shared genes. Siblings have the same parents, who can imbue their children with shared health behaviors that lead to diabetes. Identical twins may both develop diabetes because they gestated in the same intrauterine environment, where they were exposed to the same maternal risk factors (Poulsen et al., 2009). The burgeoning field of epigenetics may also account for some of the correlation of diabetes between family members, as external influences can change how genes are expressed, and this expression can be passed down over multiple generations (Ali, 2013). The links between genes and behavior run even deeper. The fat and sugar-seeking eating habits that can lead to obesity likely reflect an ancient evolutionary necessity, suggesting that obesity and diabetes have common genetic roots (Neel, Weder, & Julius, 1998). However, a person's behavior can also affect how their genes translate into physical traits. In genetic terms, this is known as the genotype interacting with environmental factors to produce the phenotype (Murea, Ma, & Freedman, 2012). This interplay between genes and behavior lends a circular quality to the comparison

of modifiable and non-modifiable risk factors. The development of diabetes can best be characterized as a dynamic interaction between inborn predispositions, behaviors, and environmental influences on the body.

Treatment

Diabetes is treated through a combination of medication, preventive care, and lifestyle changes. The central task of diabetes management is to control the level of glucose in the blood. For a newly diagnosed patient, this initially involves changing one's diet and adopting an exercise regimen (Vijan, 2010). If these measures by themselves fail to bring blood glucose down to target levels within six weeks, then the patient usually begins taking a supplemental medication such as Metformin, which chemically increases tissue sensitivity to insulin (Stumvoll, Haering, & Matthaei, 2007). Patients who still do not achieve adequate glycemic control will often need to self-administer insulin on a daily basis, which also requires them to closely monitor their blood sugar at home (Vijan, 2010). In addition to this regimen of self-care, the ADA recommends that patients with diabetes receive a set of preventive health screenings every year, including at least two HbA1c tests, a dilated eye exam, a cholesterol screening, and a foot exam (ADA, 2017).

A person's success in avoiding severe diabetes complications largely depends on adherence to lifestyle modifications, preventive care, and medication. Tightly controlling one's blood glucose reduces the risk of many complications, such as kidney failure, retinopathy, and cardiovascular disease (Holman, Paul, Bethel, Matthews, & Neal, 2008; ACCORDION Study Group, 2016). On the other hand,

failing to adhere to one's treatment plan leads to worse long-term health outcomes. It also raises the risk of acute life-threatening conditions such as hyperglycemic hyperosmolar syndrome, in which high blood glucose causes severe dehydration (Currie et al., 2012; Umpierrez, Murphy, & Kitabchi, 2002).

The progress made in recent decades in understanding how to effectively treat diabetes has improved the overall health and quality of life of those with the disease (Gregg et al., 2014). Best practices in self-care have been adopted into a nationally standardized curriculum known as diabetes self-management education (DSME), now received by over half of all people with diabetes (Haas et al., 2014; CDC, 2014b). The advent of DSME, together with better clinical care and innovative medications, has served to reduce diabetes-related complications over time, though evidence is mixed on whether these improvements are due to better glycemic control (Gregg et al., 2014; Hoerger, Segel, Gregg, & Saaddine, 2008; Lipska et al., 2016).

Despite these improvements in knowledge and education, many people with diabetes still struggle to adhere to a self-care regimen and healthy lifestyle. The same behaviors and predispositions that make diabetes so difficult to avoid make it similarly difficult to control once diagnosed. Studies have found that as few as 25 percent of people with diabetes meet the ADA's recommended levels of physical activity, and only 64 percent tend to monitor their blood glucose on a daily basis (Zhao, Ford, Li, & Balluz, 2011; CDC, 2014b). People with diabetes also miss up to 33 percent of their oral medication doses, and up to 38 percent of their insulin doses (Cramer, 2004). These less than ideal adherence rates result from complex psychosocial and

environmental factors. The stress of constantly managing diabetes and dealing with its complications often leads to mental health issues such as depression and anxiety (Ducat, Philipson, & Anderson, 2014). The unique emotional burdens that come with the disease even comprise a distinct mental condition known as diabetes distress (Fisher Hessler, Polonsky, & Mullan, 2012). These mental health difficulties can prevent people from maintaining proper self-care and increase the chances of complications, leading to further mental and physical decline.

The existing paradigm for treating diabetes is challenged by emerging evidence that the disease may actually be reversible. Physicians have long considered diabetes to be a permanent condition. This established wisdom underpins the message to patients that their management of diabetes will be a lifelong, unceasing endeavor. The disease's supposed permanency also informs physicians' treatment approach of engaging patients in a long-term decision-making process based on the patient's life goals and priorities (Anderson & Funnell, 2000). However, recent studies have found that diabetes may be more surmountable than previously thought. In one study, nearly a quarter of patients with diabetes achieved complete remission after having their stomach size surgically reduced, and this remission persisted six years later (Brethauer et al., 2013). In another study, certain patients saw their diabetes largely disappear after eating an extremely low-calorie diet for eight weeks (Lim et al., 2011). Many clinicians caution that these drastic measures are not suitable for everyone, and must be weighed against the risk of complications from surgery or sharp reductions in food intake. But others, in response to this evidence, now argue that the reversal of diabetes

should be presented to patients as a realistic treatment goal (Steven, Lim, & Taylor, 2016). Ongoing research into how patients can best self-manage chronic conditions, coupled with forthcoming results from new clinical trials testing the reversal of diabetes (Leslie et al., 2016), will ensure that the paradigm for treating the disease continues to evolve.

The causes and implications of diabetes have many dimensions, but they are not confined to the physical makeup of a single individual. Chapter 3 discusses how the disease's causes are also shaped by wider social, cultural, and economic forces, while its consequences also extend beyond the afflicted individual.

Chapter 3

DIMENSIONS OF DIABETES AS A PUBLIC HEALTH PROBLEM

The causes of diabetes are rooted in societal trends, and its burden falls disproportionately on individuals who experience low socioeconomic status. The disease's consequences also deplete shared economic resources and degrade community wellness. For these reasons, diabetes represents a public health problem for Delaware and the nation at large.

Prevalence

Diabetes first qualifies as a public health issue because of its high prevalence, meaning the proportion of the total population that has diabetes in a given time period. An estimated 29.1 million Americans had diabetes as of 2014, which represents 9.1 percent of the entire adult population (CDC, 2016a). Another 37 percent of U.S. adults, or 86 million people, now register as having prediabetes, and 70 percent of these individuals will likely go on to develop diabetes (CDC, 2016b). And these numbers have risen over time, as the nationwide prevalence of diabetes has nearly quadrupled since 1980 (CDC, 2016a). If this trend continues, then one out of every three U.S. adults could have the disease by 2050 (Boyle, Thompson, Gregg, Barker, & Williamson, 2010). The increase in diabetes seen in the U.S. has also occurred throughout the entire world. Nearly every global region has witnessed a dramatic rise in the disease, but the U.S. has the highest prevalence of all developed countries (NCD

Risk Factor Collaboration, 2016; International Diabetes Federation, 2015). In Delaware, 9.7 percent of adults had diabetes as of 2014, up from 5.8 percent in 1994. Delaware's rate of diabetes thus exceeds the national average and ranks 17th among all states (CDC, 2016a).

The high prevalence of diabetes leaves an indelible footprint on the health of Americans. Diabetes ranks as the seventh leading cause of death in America (CDC, 2014b). It represents the country's leading cause of kidney failure, lower limb amputation, and adult-onset blindness, and constitutes a major risk factor for developing heart disease, which is the country's number one cause of mortality (CDC, 2014b). Diabetes can also cause many other conditions that plague Americans, such as nerve damage, dental problems, skin infections, urologic and sexual dysfunctions, hearing loss and mental health disorders ("Complications", n.d.) Overall, the disease afflicts a vast number of people and underlies many commonly occurring health conditions.

Diabetes has become more prevalent over time because the individual risk of developing the disease has increased, and because people are living longer with the condition. As with any disease, the proportion of the total population that has diabetes in a given time period (i.e. *prevalence*) depends on two factors: the rate at which people newly acquire diabetes, called the incidence, and how long people live with the disease. The national incidence of diabetes climbed from 4.9 new cases per 1,000 adults per year in 1996, to a high of 8.7 per 1,000 adults in 2010, before declining to 7.8 per 1,000 in 2014 (CDC, 2016a). In other words, today's U.S. adults have a 40

percent chance of developing diabetes over their lifetime (CDC, 2014b). The recent decline in incidence is encouraging, but several factors will likely keep the incidence of diabetes high in the overall population. First, America's age distribution is skewing older, meaning that an increasing proportion of the population will occupy the late middle age range where diabetes typically develops (Geiss et al., 2014). Second, minority populations such as Hispanics and African Americans are growing in size, and these groups have a relatively higher risk of diabetes (Boyle et al., 2010). The incidence of diabetes may also continue rising simply because more undiagnosed cases will be discovered through improved screening practices and diagnostic criteria (Gregg et al., 2004).

However, incidence alone does not explain the total proportion of people who have a disease. For example, many people contract influenza each winter, but the total proportion of the population with influenza does not remain high for very long, because the illness passes quickly. But diabetes almost always persists for a person's entire life after onset, so cases of the disease tend to build up in the total population as more individuals develop it. And as described in Chapter 2, improvements in treatment have allowed people to live longer with diabetes. The average life expectancy after onset for a person with diabetes has increased by almost two years since 1990 (Gregg et al., 2014). People are also spending more life-years with diabetes because they are developing it at younger ages. In fact, there has been an alarming rise in diabetes among children and young adults in recent decades, concurrent with the rise in childhood obesity (Fryar, Carroll, & Ogden, 2014). Pediatric cases of diabetes

typically involve the type 1 variety, which is an autoimmune disease that destroys the ability of the pancreas to produce insulin. But type 2 diabetes now accounts for a third of all new cases of diabetes in people under age 18 (Pinhas-Hamiel & Zeitler, 2007). All of these factors help explain why diabetes has become increasingly prevalent in the U.S. population over time.

The large health burden of diabetes fulfills the first theoretical criterion for the disease to be considered a public health issue. Diabetes is certainly a problem for an afflicted individual. But why should it be considered a matter that merits wider social concern? Public health studies often assert that a health condition first of all deserves to be considered a public problem if it imposes a large burden on the general populace (Vinicor, 1994; Schoolwerth et al., 2006). The burden of a disease is a function of how many people are affected, and how strongly they are affected. For instance, nearly everyone suffers from a common cold at some point, but the condition is not severe enough to be publicly burdensome. On the other hand, some deadly inborn diseases afflict only a handful of people in the world, and thus also have a low aggregate burden. This concept of disease burden is mirrored in the literature on public policy analysis, which distinguishes between social problems that are widespread but not serious, and vice versa (Patton, Sawicki, & Clark, 2012, p. 141). Diabetes affects a significant proportion of the population, and inflicts considerable damage on those who have the disease. This makes diabetes socially burdensome enough to qualify as a public health issue.

Upstream Factors

Diabetes further constitutes a public health problem because its individual-level risk factors are rooted in deeper social and ecological trends, such as changes in patterns of food consumption and physical activity, and the features of modern built environments.

Rates of obesity and diabetes have increased significantly since the mid-20th century (Ogden & Carroll, 2010). Yet human physiology has not changed over this short evolutionary time span. This suggests that changes have instead occurred in social and environmental forces beyond the individual. The most notable of these changes has been an increase in food consumption, led by rising intake of processed food. In 1970, Americans consumed an average of 2,039 calories per day, but by 2010, this had risen to 2,536 calories per day. Eighty-six percent of these additional calories came from refined grains, as well as fats, oils, sugars, and sweeteners that are artificially added to foods during processing (“Summary Findings”, 2017). This rising intake is due in part to the growing portion sizes of meals and beverages, and to people eating more often at restaurants and other places outside the home (Nielsen & Popkin, 2003; Variyam, 2005). Many studies have drawn connections between the high energy density of the contemporary American diet and rates of obesity and diabetes (Hill, et al., 2013).

At the same time, overall levels of physical activity in the U.S. have declined as part of wider cultural trends. Work has become less physically demanding over time, as more people are employed in occupations that require long periods of sitting

(Church, 2011). Other domains of daily life have also become increasingly sedentary. Labor-saving technologies have resulted in less time spent doing household chores that require moderate levels of physical activity, such as cooking, cleaning, and repairs (Robinson & Godbey, 2010). Active forms of commuting have also declined in recent decades. The practice of walking to work has dropped sharply since 1960, with a rise in the amount of time Americans spend sitting in the car (Federal Highway Administration, 2011; Jarosz & Cortes, 2014). Encouragingly, the amount of leisure time that Americans spend exercising has modestly increased over the years. But overall levels are still low, as only one in five adults currently meets the federal government's guidelines for aerobic and muscle-strengthening exercise (CDC, 2014e). The low physical demands of modern life appear to be an important contributor to the prevalence of diabetes (Hill et al., 2013).

These trends in diet and physical activity are heavily influenced by the features of the built environments in which people live, work, and play. The modern urban landscape offers an overabundance of cheap, fast, and processed food. And humans must navigate this environment with a brain that naturally craves fatty and sugary foods, an evolutionary holdover from a time when such foods were scarce and valuable (Power & Schulkin, 2009). Studies of the developing world demonstrate how cities enable excessive eating. From China to sub-Saharan Africa, research has found that as communities urbanize, inhabitants' lifestyles tend to shift towards greater food intake, with an ensuing rise in diabetes (Assah, Ekelund, Brage, Mbanya, & Wareham, 2011; Attard et al., 2012). The abundance of high-calorie processed food also extends

into the suburbs, where commercial corridors are lined with fast food chains. Even rural areas often have few healthy eating options beyond fast food (Casey et al., 2008).

The planned layout of communities also plays a role in rates of physical activity, obesity, and diabetes. In the decades after World War II, American towns and cities became increasingly designed for car travel. Distances grew between the home, work, and commercial areas. Public transit options decreased, and neighborhoods were carved apart by high-speed roads unsuitable for pedestrians. Areas that exhibit these features of sprawl are associated with less self-powered transportation and greater obesity (Sallis, Floyd, Rodriguez, & Saelens, 2012). The patterns of development that discourage physical activity exist not only in rural and suburban areas, but even within cities, where living far from services and amenities can inhibit active mobility and promote obesity (Lopez, 2004). On the other hand, pedestrian-friendly neighborhood features such as sidewalks, well-lit streets, and walking trails have been linked to increased rates of physical activity and lower obesity rates (Bassett, Pucher, Buehler, Thompson, & Crouter, 2008). Land use decisions may especially affect children, whose rates of obesity depend significantly on access to parks, playgrounds, recreation centers, and other safe places to play (Sallis & Glanz, 2006).

The modern environment exposes humans to man-made chemicals that may be linked to diabetes. A relationship has been identified between traffic-related air pollution and diabetes, even when controlling for individual-level risk factors (Pearson, Bachireddy, Shyamprasad, Goldfine, & Brownstein, 2010). Chronic exposure to certain pesticides and herbicides has also been found to disturb glucose

metabolism and induce insulin resistance (Murea, Ma, & Freedman, 2012). Having higher bodily concentrations of phthalate compounds, which are used in manufactured products from cosmetics to paints, also appears to heighten one's risk of diabetes (Stahlhut, van Wijngaarden, Dye, Cook, & Swan, 2007). Causal relationships have not been firmly established between these substances and diabetes, but plausible biological mechanisms have been observed in laboratory settings. Such links between these chemicals and diabetes would only add to the evidence that diabetes is a consequence of the modern built environment.

All of these societal and ecological factors apply to the context of Delaware as well. Regarding physical activity, Delaware exceeds the national average in the percentage of adults who report no leisure time exercise (CDC, 2014e). Delaware also contains the above aspects of the built environment that engender obesity. The state has the typical concentrations of fast food restaurants, such as along the Route 13 and Route 40 corridors, while 61 percent of the population lives in census tracts that lack a grocery store (Jacobson et al., 2015). Delaware also has many automobile-centric rural and suburban areas that do not promote active forms of transportation. Only 2.6 percent of Delawareans reported walking or biking to work in 2014, which was below the nationwide average of 3.4 percent (CDC, 2014e). And the state's latest Comprehensive Outdoor Recreation Plan notes that "there are insufficient, safe bicycle and pedestrian facilities like trails and pathways that advance biking or walking to schools, businesses, and community centers" (DNREC, 2013, pg. 4D.11). All of the above upstream factors give diabetes further hallmarks of a public health problem.

Inequities

The field of public health was originally concerned with establishing basic conditions of sanitation and hygiene to prevent the spread of communicable diseases. But as basic health conditions have improved over time, the scope of the discipline has widened to include, among other things, a commitment to reducing systematic health differences between social groups and communities (Schneider, 2017). Today, the notion of social inequality is considered a central dimension of public health (Graham, 2004). If a disease falls more heavily on certain groups for socially determined reasons outside of their control, then this creates avoidable and unfair differences in the chance to live a healthy life.

Diabetes indeed exhibits these inequities, because it disproportionately afflicts groups that rank lower on several indicators of socioeconomic status. Only 8.1 percent of White U.S. adults had diabetes as of 2015. This contrasts with 12.2 percent of Hispanics, 13.1 percent of Blacks, 14.1 percent of Mexican Americans, and 20.9 percent of Native Americans (CDC, 2015b). Rates of diabetes also differ markedly by educational attainment. Nearly 15 percent of adults without a high school diploma have diabetes, compared to just 7.1 percent among those with a bachelor's degree or higher (CDC, 2015b). Diabetes is also more than twice as prevalent among adults with annual family incomes of less than \$35,000 than it is among those with incomes over \$100,000 (CDC, 2015b). And these gaps have been widening over time. The disparity in diabetes prevalence between the highest and lowest income quartiles grew by almost four percentage points between 1971 and 2002 (Kanjilal et al., 2006), and then

grew by another 1.8 percentage points between 2002 and 2014 (Beckles & Chou, 2016).

Lower socioeconomic status increases the risk of diabetes through many channels, including the physiological and psychosocial effects of poverty, the role of education in understanding lifestyle risks, and cultural norms unique to certain racial/ethnic groups. Living in a state of material deprivation has direct physiological effects that can cause diabetes. These effects begin at the earliest stages of life, when malnourishment in utero or as a young child can lead to obesity, and can impair the development of the muscles and pancreas in ways that lead to diabetes (Chaufan & Weitz, 2009). Other common difficulties of living in poverty, such as poor housing conditions and food insecurity, have also been observed to affect one's risk of diabetes (Schootman et al., 2007; Seligman, Bindman, Vittinghoff, Kanaya, & Kushel, 2007). Having low income often relegates a person to living in neighborhoods that have fewer recreational facilities and opportunities for active transportation, and lower access to fresh and healthy food, all of which further promote diabetes (Gordon-Larsen, Nelson, Page, & Popkin, 2006; Hipp & Chalise, 2015; California Center for Public Health Advocacy, 2008). Lower-income individuals are also more likely to lack health insurance or access to primary health care (Garfield, Licata, & Young, 2014). This keeps them from receiving the health services that can help prevent diabetes (Brown & McBride, 2015).

Living in poverty also comes with psychological and social burdens that are associated with diabetes. Impoverishment brings a harrowing uncertainty to the daily

task of meeting one's basic needs, which wracks the mind and body with stress. This stress can be compounded by living in a neighborhood that has concentrated poverty. The chronic stress of poverty has been linked to many adverse health conditions, including diabetes (Purnell, 2015). Behavioral science research has found that the juggling act of living in poverty serves to constrain one's cognitive capacity. This can make mundane tasks such as healthy meal planning become an overwhelming burden (Mullainathan & Shafir, 2013; Devine et al., 2006). Poverty can also lower a person's sense of self-efficacy, which is the belief that they are able to control their own circumstances. Self-efficacy is a primary component of the Health Belief Model, which has demonstrated that people at risk of diabetes will likely fail to avoid the disease if they do not believe in their own ability to change their behavior (Glasgow, Toobert, & Gillette, 2001). Poverty is also often accompanied by social isolation and low levels of community support (Tigges, Browne, & Green, 1998). These social deficits are correlated with health problems such as diabetes, and make it even more difficult for an individual to cope with the stresses of economic hardship (House, Landis, & Umberson, 1988; Moskowitz, Vittinghoff, & Schmidt, 2013).

A person's race/ethnicity and level of education may also influence their risk of diabetes independently of income. For example, people with higher educational attainment are generally more aware of obesity risk factors and more knowledgeable about healthy behaviors (Mirowsky & Ross, 2003). This may partly explain why they tend to eat healthier foods, exercise more often, and smoke less often than people with lower education (Pampel, Krueger, & Denney, 2010: "Current cigarette smoking",

n.d.). One literature review estimates that these three health behaviors together account for one quarter of socioeconomic disparities in health (Pampel et al., 2010). The role of culture-specific norms and customs has also been explored as a potential factor in the higher rates of diabetes among racial/ethnic minority groups. Certain cultures, including Latino, Native American and Pacific Islander, traditionally consider being overweight to be a sign of physical robustness and well-being (Kumanyika, 1993). This may influence a person's opinion of their own health, and lessen social pressure to lose weight and avoid diabetes.

However, all of these socioeconomic factors are deeply interrelated, which makes it difficult to parse out unique causal links to diabetes. On one hand, racial/ethnic minorities still have lower average incomes and higher rates of diabetes than Whites when holding levels of education constant (Beckles & Chou, 2016). But access to higher education is also heavily mediated by family income, and people with lower educational attainment are then even more likely to remain in poverty (Pampel et al., 2010). Some studies have even explored the reverse possibility that diabetes causes low socioeconomic status, since the disease can bring high medical costs and make it difficult to maintain employment (Kraut, Walld, Tate, & Mustard, 2001; Smith, 1999). But the factors that primarily dictate one's socioeconomic status, such as family wealth, race/ethnicity, and education, are all established early in life, well before the onset of diabetes. The literature on the social determinants of health indicates that the direction of causation runs mostly from socioeconomic status to health, rather than vice versa (Brown et al., 2004).

The unequal burden of diabetes is compounded by the fact that these same socially determined factors also shape a person's quality of diabetes treatment and health outcomes. Numerous studies have documented socioeconomic differences in diabetes management. Black and Hispanic individuals with diabetes have significantly higher average HbA1c levels than Whites with diabetes, indicating poorer glycemic control (Bonds et al., 2003; Ali, Bullard, Imperatore, Barker, & Gregg, 2012). Blacks with diabetes also show lower rates of preventive screenings than their White counterparts (Brown et al., 2005). They are also less likely to adhere to dietary and exercise regimens (Oster et al., 2006). Lower levels of income and education are similarly correlated with worse glycemic control (Houle et al., 2016; Brown et al., 2004). These disparities in diabetes management lead to differences in health outcomes. Blacks are twice as likely to die from diabetes than Whites, and two to four times more likely to experience complications such as foot amputation, kidney failure or blindness (Carter et al., 1996; Peek, Cargill, & Huang, 2007). Among adults ages 40 to 64, diabetes mortality rates are over three times higher for those with only a high school diploma than for college graduates (Miech, Kim, McConnell, & Hamman, 2009).

These disparities in treatment quality and health outcomes are attributable to the same social factors that shape the risk of developing diabetes in the first place. Living in poverty can hinder diabetes management in several ways. Most importantly, it can mean not having enough money to afford vital medications. Many low-income individuals with diabetes report underusing their medication for cost-related reasons,

and they consequently have poorer glucose control (Ngo-Metzger, Sorkin, Billimek, Greenfield, & Kaplan, 2012). People with diabetes who are food insecure also show poorer glucose control, and sometimes must decide between buying food or medication (Berkowitz et al., 2015; Gucciardi, Vahabi, Norris, Del Monte, & Farnum, 2014). The lack of social support that often accompanies poverty is also correlated with worse glycemic control, poorer lifestyle management, and greater diabetes-related distress (Tang, Brown, Funnell, & Anderson, 2008). Having low income also reduces access to health insurance, and uninsured individuals with diabetes show poorer glucose control and lower rates of preventive screenings (Carter et al., 1996; Oladele & Barnett, 2006). However, disparities in diabetes complications exist even in countries that have universal health coverage (Booth & Hux, 2003). Research has also found that racial bias in the health care system creates differences in the quality of treatment received by race/ethnic minorities (Smedley, Stith, & Nelson, 2003). This may also help to explain disparities in the receipt of diabetes preventive care.

Levels of education and cultural norms also play important roles in diabetes management. People with higher educational attainment may have better diabetes control because they adhere to physician guidance more closely and adopt new treatment technologies more quickly (Glied & Lleras-Muney, 2008; Lutfey & Freese, 2005), in addition to the previously discussed correlations between education and healthy behavior. Cultural factors unique to certain racial/ethnic groups can also influence diabetes care. Hispanic culture traditionally considers diseases to be a matter of destiny that cannot be overcome, a belief known as *fatalismo* (Caballero, 2005).

This may reduce the level of effort that Hispanics put forth in diabetes self-care. Language barriers may also impede proper diabetes care among Hispanic Americans, some of whom report not comprehending prescriptions or physician instructions (Dagogo-Jack, Funnell, & Davidson, 2006). Research has described the role of many other culture-specific concepts in diabetes care, such as strong reliance on family members for support and guidance, adherence to traditional dietary customs, and distrust of Western medicines (Zeh, Sandhu, Cannaby, & Sturt, 2014). However, these factors have not yet been shown to account for systematic disparities in diabetes outcomes across racial/ethnic groups.

The state of Delaware contains similar social inequalities in the prevalence and outcomes of diabetes. As of 2012, the most recent year for which data are publicly available, 13.3 percent of Delawareans who earn less than \$15,000 per year had diabetes, compared to only 7.9 percent of those with earnings over \$50,000 per year (DHSS, 2014). More recent data are available regarding educational disparities. As of 2014, 12.3 percent of Delaware adults without a high school diploma had diabetes, compared to nine percent of adults with some higher education. Among people with diabetes who do not have a high school diploma, over 67 percent reported being physically inactive, compared to only 19.3 percent of those with some higher education. Similarly large educational disparities exist in certain preventive care practices, such as attending a diabetes management class or receiving an annual eye exam (CDC, 2016a). Even more recent data exist regarding racial/ethnic disparities. As of 2015, 15.1 percent of Black Delawareans had diabetes, compared to 11 percent

of Whites, and this gap has grown by 1.8 percentage points since 2007 (DHSS, 2015; DHSS, 2009). In Delaware, Blacks with diabetes are also twice as likely to die from their condition as Whites with diabetes (DHSS, 2014).

In summary, the burden of diabetes falls more heavily on the most economically vulnerable segments of the population. This exacerbates existing social inequalities and erodes the chance for all citizens to live a healthy life. Diabetes thus offends the important societal principle of fairness and equality of opportunity, which further makes the disease a matter of public concern.

Public Consequences

Diabetes becomes even more of a public health concern when considering its communal consequences. The disease drives up health insurance costs, reduces economic productivity, diminishes community wellness, and can even harm the health and safety of those who do not have the disease.

Diabetes imposes monetary costs on all citizens by fueling higher health care spending and slowing economic growth. The United States spends enormous amounts of money on the medical treatment of diabetes. In 2012, the country spent an estimated \$176 billion on health care goods and services related to diagnosed diabetes, and another \$23.4 billion related to undiagnosed diabetes (ADA, 2013; Dall et al., 2014). Diabetes currently tops all health conditions in terms of spending, and accounts for nearly five percent of the country's total health care expenditures (Dieleman et al., 2016). Annual per capita spending for a person with diabetes is more than twice that of a person without diabetes (ADA, 2013). And over the course of a lifetime, a person

diagnosed with diabetes at age 40 will spend \$211,000 more on health care than a person without the disease, despite living eight to 10 fewer years (Zhuo et al., 2014). This sets diabetes apart from other health burdens such as smoking and obesity, which may actually reduce lifetime per capita health expenditures when factoring in shorter lifespans (Barendregt, Bonneux, & van der Maas, 1997; van Baal et al., 2008). The state of Delaware alone spent \$818 million on medical costs related to diabetes in 2012, which ranked fifth among all states in per capita spending on the disease (Author's calculation based on data from Dall et al., 2014 and U.S. Census Bureau 2013 American Community Survey Table B01003).

The medical costs of diabetes fall predominantly on those who have the disease. But these costs also impact the wider public in several ways. First and foremost, the disease inflates health insurance costs, as insurers compensate for the health risks of beneficiaries who have diabetes by raising premiums for all plan holders (Bipartisan Policy Center, 2012). Second, the government spends taxpayer dollars on diabetes care for beneficiaries of Medicare, America's public health insurance program for people aged 65 and older. Nearly 27 percent of Medicare beneficiaries have diabetes, and one in three Medicare dollars is spent on beneficiaries with diabetes (CDC, 2014a; Ashkenazy & Abrahamson, 2006). The higher taxes required to finance these Medicare costs can suppress economic growth and reduce the after-tax incomes of households (Pauly, 2003). Third, companies' payroll costs are driven up by rising employee health insurance premiums. This may cause firms to hire fewer workers, pay lower wages, reduce investments, and raise the price of their

products (Sood, Ghosh, & Escarse, 2007; Baicker & Chandra, 2005), all of which can dampen economic output. Fourth, people with diabetes often cannot afford the large sums that they are forced to spend on treatment. Even with health insurance, diabetes can plunge a person into medical debt (Hamel et al., 2016). Excessive household debt lowers consumer spending and savings, further dragging down economic growth.

Diabetes takes a further shared economic toll in the form of health-related productivity losses. Individuals with diabetes miss up to seven percent more workdays than other workers, and are less productive when on the job (ADA, 2013). They also have a 2.4 percentage point higher rate of being out of the workforce altogether due to disability (ADA, 2013). Overall, these productivity losses cost the U.S. an estimated \$69 billion in 2012, on top of the \$176 billion in medical spending (ADA, 2013; Dall et al., 2014). In Delaware alone, this lost productivity totaled \$293 million in 2012 (Dall et al., 2014). Some of these productivity losses are directly paid for by those with diabetes, such as when the wages of an employee with diabetes are reduced because the employee is underperforming at work (Anomaly, 2012). But the burden of lost productivity inevitably flows through the entire economy. The interdependencies between consumers, producers, and savers ensure that one person's dollar lost to diabetes will eventually impact another person's pocketbook or a firm's revenues. Indeed, after appraising all of the collective costs of diabetes, Dall et al. (2014) conclude that the disease amounts to an annual tax of over \$1,000 on each American citizen.

Diabetes also affects several aspects of shared community wellness. An important political debate exists in contemporary public health over the degree to which noncommunicable diseases such as diabetes should merit collective action. Some argue that the purview of public health should be restricted to diseases that spread biologically between people, which does not include diabetes (Epstein, 2004; Snowden, 2015). But this view ignores other ways in which diabetes can be transmitted. Chapter 2 mentioned preliminary evidence that certain contagious germs and viruses may heighten the risk of diabetes. Even obesity, the foremost risk factor for diabetes, may be caused in part by gut bacteria that can spread from person to person (Fei & Zhao, 2012; Turnbaugh et al., 2006). Obesity may also be socially contagious, by becoming more acceptable and normalized as it proliferates. This theory has been supported by a social network analysis study that found that having a friend become obese can triple one's own chance of becoming obese (Christakis & Fowler, 2007).

Even if diabetes is not contagious in the strict epidemiological sense, it still degrades many other aspects of shared health. Diabetes can take an emotional toll on families by debilitating or killing a family member (Fisher, 2006). It can weaken communities by afflicting people who play important social roles, and on whom others rely for friendship and support. Sociological studies of chronic diseases such as diabetes have found that they can strain relationships with friends and family due to feelings of shame and guilt (Rapaport, Cohen, & Riddle, 2000; Funnell, Bootle, & Stuckey, 2015), and can inhibit participation in social and civic activities (Mars,

Kempen, Mesters, Proot, & Van Eijk, 2008; Gannon & Nolan, 2006). Native Americans, among whom diabetes is highly prevalent, have reported a collective sense of fear and hopelessness about the inevitability of the disease (Cavanaugh, Taylor, Keim, & Geraghty, 2008), although surveys also show that Americans on the whole have surprisingly little fear of diabetes, given how prevalent the disease is (“Americans are afraid of that?”, 2008). All of these aspects of diabetes can diminish a community’s collective wellness.

Diabetes can also harm the health and safety of other people. Motorists with diabetes have a slightly elevated risk of causing accidents compared to those without the disease. This is because they can experience sudden bouts of low blood sugar while driving, which can cause blurred vision and disorientation (ADA, 2012a). Obesity and diabetes have also been cited as a potential threat to national security. One in four military recruits are unable to join the armed forces due to being too overweight (Cawley & Maclean, 2010). This reduces the country’s military readiness, and thus can be said to harm the safety and security of all Americans. Finally, as discussed in Chapter 2, women with poor nutrition or diabetes during pregnancy can bequeath to their child a higher risk of eventually developing diabetes. This harms members of the future public, who have no way of avoiding this maternal risk factor.

Diabetes has even been framed as a matter of various rights and liberties, depending on one’s social perspective. Framing diabetes as a rights issue implies that the disease deprives a person of something that all members of society are legally entitled to enjoy, or even morally entitled to by higher laws and principles. This

characterization elevates the problem of diabetes to a profoundly communal level, because if one person's rights are unfairly usurped, then an important shared social expectation is harmed (Stone, 2012). Some observers consider the prevention and treatment of diabetes to be a human rights imperative (Gruskin et al., 2014), because by debilitating an individual for reasons outside of their control, the disease deprives them of the basic health conditions required to fully exercise their liberty, or in the words of Isaiah Berlin, to conceive of their own goals and realize them (Berlin, 1968). The idea that poor health diminishes one's liberty is enshrined in the Universal Declaration of Human Rights, which includes the right of every human being to achieve the highest attainable standard of health (United Nations, 1948).

But skeptics argue that diabetes poses no such threat to human rights, since the disease is largely self-inflicted through conscious choices (Anomaly, 2012). This view emphasizes the avoidable lifestyle aspects of diabetes, and speaks to the consensus in the health ethics literature that a health outcome is not unfair if it stems from damaging behavior that is freely chosen (Whitehead, 1992). Viewing health as a matter of personal responsibility can lead to the counter-claim that diabetes infringes on the right to not be harmed by the bad decisions of other people, such as through higher insurance premiums or through the community health and safety effects mentioned above (Wikler, 2002). The friends and family of a person with diabetes may even claim that they have the right not to lose their loved one to diabetes. This envisions a person's maintenance of good health as an ethical duty to those who depend on their existence. But as discussed earlier, diabetes stems in large part from

risk factors that lie outside the realm of conscious choice. Public health theorists have raised numerous objections to the general idea of holding people morally responsible for their health (Resnik, 2007). Nonetheless, the question of which rights and liberties are most relevant to the issue of diabetes depends on one's beliefs regarding social obligations and the avoidability of the disease.

The public significance of diabetes takes on yet another dimension when considering the disease's intersection with America's largest government health insurance program by number of enrollees: Medicaid. Chapter 4 discusses this important intersection.

Chapter 4

DIABETES AND THE MEDICAID PROGRAM

Medicaid plays an important role in the treatment of diabetes by financing health care for the many people with diabetes who otherwise could not afford it. But the treatment of diabetes also poses several challenges for Medicaid by requiring costly medical services and well-coordinated care delivery. These challenges have been empirically investigated through the Medicaid program's administrative claims data.

Medicaid Overview

Established in 1965 by Title XIX of the Social Security Act, Medicaid is a public health insurance program that covers eligible low-income adults, children, pregnant women, elderly adults and people with disabilities. The program is administered by states under federal guidelines, and although states' participation in the program is optional, all 50 states choose to participate. The federal government requires states to offer Medicaid to certain core populations, such as children up to age 19 in families with incomes below 138 percent of the federal poverty level (FPL), and pregnant women with incomes below this threshold. States are also required to cover the cost of many essential medical services for participants, including physician visits, inpatient and outpatient hospital care, laboratory and x-ray services, and nursing home

care. Beyond these basic requirements, states can dictate their own additional Medicaid eligibility rules and benefits (CBPP, 2016).

Medicaid is jointly funded by the states and the federal government, with the federal government historically covering about 57 percent of total costs (KFF, 2012c). Medicaid had an enrollment of 68.6 million people (over 21 percent of all Americans) in December 2016, including more than 32 million children, 20 million low-income adults, nearly 7 million seniors, and 10 million people with disabilities (“U.S. and world population clock”, 2017; CMS, 2017a; CMS, 2017b). This coverage comes at an annual program cost of more than \$545 billion, which makes Medicaid not only the nation’s single largest source of health insurance, but also its largest means-tested transfer program by total costs and number of beneficiaries (Buchmueller, Ham, & Shore-Sheppard, 2016).

The 2010 Patient Protection and Affordable Care Act (ACA) brought significant changes to Medicaid. The ACA originally required states to extend Medicaid coverage to all people under age 65 with family incomes below 138 percent of the FPL. States that chose not to expand their coverage would lose all of their federal Medicaid funding. However, in 2012 the Supreme Court ruled that Congress could not revoke a state’s Medicaid funding for not expanding coverage (*NFIB v. Sebelius*, 2012). This ruling effectively made the expansion of Medicaid voluntary for states, but the federal government currently incentivizes this expansion by reimbursing states at a higher rate for the costs of expansion-based participants. For states that expanded Medicaid in 2014, this enhanced reimbursement rate stands at 95 percent as

of January 2017, and will phase down to 90 percent by 2020 (Rudowitz, Valentine, & Smith, 2016). States that already covered this expansion population prior to 2014, such as Delaware, receive a lower enhanced reimbursement rate that will phase up to 90 percent by 2020. Delaware's 2017 enhanced reimbursement rate is 86 percent (Rudowitz, 2014).

State Medicaid programs vary in their eligibility rules and provider payment schemes. As of March 2017, 31 states and Washington, D.C. have chosen to expand Medicaid eligibility as intended by the ACA ("Status of state action", 2017). These states now offer Medicaid to all individuals with incomes up to 138 percent of the FPL. In the 19 states that have not expanded, the eligibility threshold for parents ranges from 100 percent of the FPL in Wisconsin, to 18 percent of the FPL in Alabama and Texas. Except for Wisconsin, these non-expansion states do not offer Medicaid to non-disabled childless adults at all ("Medicaid income eligibility", 2017). States also differ in how they compensate providers. All but two states use a managed care system to cover at least some portion of their Medicaid population ("Total Medicaid managed care enrollment", 2017). In this arrangement, the state contracts with insurance groups such as health maintenance organizations, which deliver comprehensive care to participants. In return, the state pays these organizations a fixed monthly amount per participant, called a capitation. Additionally, every state except Tennessee uses a fee-for-service arrangement for certain categories of Medicaid participants or certain medical services. This involves the state directly reimbursing

providers for each specific service rendered (“Medicaid-to-Medicare fee index”, 2017).

The state of Delaware covered approximately 210,000 residents through its Medicaid program in 2015, the most recent full year for which federally verified data is available (CMS, 2016b). An estimated 40 percent of these participants were children, 42 percent were adults ages 18 to 64, 6 percent were adults older than age 64, and 12 percent were blind or disabled (State of Delaware, 2016).³ In 2015, Delaware covered a greater percentage of its state population under Medicaid (22.3 percent) than regional peers such as Maryland (17.6 percent), New Jersey (18.8 percent), and Pennsylvania (20.9 percent), and nearly matched the nationwide coverage rate of 23 percent (Author’s calculations based on data from CMS (2016b) and U.S. Census Bureau American Community Survey 2015 1-year estimates Table B01003). Total Medicaid costs for the state of Delaware were \$1.86 billion in 2015, 54 percent of which was paid by the federal government (“Total Medicaid spending”, 2017; “Federal medical assistance percentage”, 2017).

In 1996, Delaware became one of the first states to offer Medicaid to childless adults living at or below the FPL (Rudowitz, Artiga, & Arguello, 2013). Then in 2014, the state expanded Medicaid under the provisions of the ACA to cover all residents up to 138 percent of the FPL (CCRS, 2016). The vast majority of Delaware Medicaid

³ Delaware also provided health coverage to another 16,341 children in 2015 through the Children’s Health Insurance Program (CHIP), known in Delaware as the Delaware Healthy Children Program (“FFY 2015 Number of Children”, 2016).

participants are covered through the Diamond State Health Plan, a managed care organization (MCO) that provides comprehensive health services (Smith et al., 2016). Overall, Medicaid is a cornerstone of the American safety net, and a major component of the health care payment and delivery system in Delaware and the nation at large.

Medicaid and Diabetes

Medicaid insurance enables many economically vulnerable Americans to prevent, detect, and effectively treat diabetes, by financing and facilitating access to vital health services.

The Medicaid program plays an important role in the provision of diabetes care in the United States. Diabetes occurs more frequently among Medicaid participants than among the general population, due to its correlation with lower income. In 2015, 11.5 percent of nonelderly adult Medicaid participants reported having diabetes. This was more than two percentage points higher than the general population's rate of diabetes, and more than double the rate among adults with private health insurance (CDC, 2015b). Medicaid covers nearly one fifth of all adults with diabetes. It also covers the majority of adults with diabetes who have incomes below the poverty level, where few people tend to have private health insurance (Casagrande & Cowie, 2012).

Medicaid coverage serves several important functions in addressing diabetes. For one, it has the potential to prevent new cases of diabetes from developing in the first place. Medicaid enables pregnant women to receive prenatal care that promotes child health. As a mother, gaining access to Medicaid reduces the chance of having a low birth weight infant, which in turn lowers the child's future risk of diabetes (Currie

& Gruber, 1996). Miller and Wherry (2015) further identify a relationship between in utero Medicaid coverage and lower rates of obesity and diabetes hospitalizations as an adult. Providing Medicaid to low-income children under age six, a federally mandated coverage population, also lays a crucial foundation for better health in their adult years, including a lower risk of diabetes (Boudreaux, Golberstein, & McAlpine, 2016; Chester & Alker, 2015).

Access to Medicaid may similarly help at-risk adults avoid developing diabetes, although the evidence is mixed. It has been widely observed that Medicaid eligibility increases adults' access to routine sources of primary care (Long, Coughlin, & King, 2005; Paradise & Garfield, 2013). This increased access also leads to greater use of care (DeLeire, Dague, Leininger, Voskuil, & Friedsam, 2013; Clemans-Cope, Long, Coughlin, Yemane, & Resnick, 2013). The Oregon Medicaid lottery provides especially rigorous evidence of this effect by using a randomized experimental design. In this study, individuals who were randomly offered Medicaid eligibility have shown significantly greater use of primary care than the control group (Baicker et al., 2013). However, greater use of primary care may not reduce one's risk of diabetes (Green, Brancati, Albright, & PPDWG, 2012), and primary care is only one of many complex factors that influence how well an at-risk adult avoids diabetes. Further, gaining access to health care through Medicaid has been found to have a negligible effect on key diabetes risk factors such as exercise and obesity (Simon, Soni, & Cawley, 2017). Alternatively, Medicaid may prevent cases of diabetes by keeping an estimated 2.1

million Americans out of poverty through reduced medical spending (Sommers & Oellerich, 2013), keeping in mind the disease's association with indigence.

Medicaid plays a second important role in relation to diabetes by allowing people to detect their condition. Recall that 30 percent of people with diabetes do not know that they have the disease, yet early detection is crucial for staving off complications. Zhang et al. (2008) find that gaining any form of health insurance leads to reduced rates of undetected diabetes. Other studies have found that Medicaid in particular improves the rate of diagnosis of diabetes (Kaufman, Chen, Fonseca, & McPhaul, 2015; Wherry & Miller, 2016). In the Oregon Medicaid lottery, rates of diabetes detection increased by nearly four percentage points with Medicaid eligibility (Baicker et al., 2013).

For people with diagnosed diabetes, access to Medicaid improves the quality of their treatment by paying for comprehensive care. People with diabetes make frequent use of inpatient and outpatient health services. They must also routinely purchase prescription drugs and medical supplies such as blood glucose meters and insulin syringes (Burge & Schade, 2014). These necessities make diabetes prohibitively expensive to treat without insurance, but Medicaid covers the majority of costs for all elements of diabetes care. Medicaid participants with diabetes consequently report much greater access to care and lower cost burdens than those without health insurance (KFF, 2012a; Garfield and Damico, 2012). This enhanced access to low-cost care leads to better treatment quality. Studies show that Medicaid participants with diabetes have more primary care visits, fill more prescriptions, and

receive the core preventive screenings at higher rates than their noninsured counterparts, including HbA1c tests, cholesterol checks, and eye and foot exams (Hu, Shi, Rane, Zhu, & Chen, 2014; Brown & McBride, 2015; KFF, 2012a; Baicker, 2013). Medicaid participants with diabetes are also more likely to perform blood glucose self-monitoring, and to have received diabetes self-management education (Nelson, Chapko, Reiber, & Boyko, 2005), which is covered by Medicaid in many states but not in Delaware (Cauchi, Chung, Mason, & Thangasamy, 2016).

Challenges that Diabetes Poses for Medicaid

Diabetes poses challenges for the Medicaid program by driving large program expenditures, requiring intricate coordination of care, and resulting in health disparities across participant subgroups.

Diabetes first challenges Medicaid through its heightened prevalence among participants. As previously mentioned, Medicaid participants have a disproportionately high rate of diabetes compared to those with private health insurance. This is not surprising, because Medicaid's eligibility rules include diabetes-prone individuals by design. Medicaid not only covers lower-income people who have an inherently greater risk of diabetes, but also explicitly extends coverage to certain people in poor health whose incomes are above the eligibility limit, through what is called the Medically Needy Program. This program is offered by 34 states, not including Delaware (KFF, 2012b). It allows certain chronically ill individuals who have exhausted their assets to qualify for Medicaid, and these individuals are at especially high risk of diabetes. The toll of having diabetes itself may cause a person

to qualify for Medicaid, by reducing their employment opportunities and lowering their earnings down to the eligibility threshold.

Certain trends in diabetes, along with state policy choices, may further increase Medicaid's coverage of individuals with diabetes. For instance, children are Medicaid's single largest age demographic, comprising 43 percent of all participants (CBPP, 2016). The rising incidence of diabetes among children will therefore be strongly reflected among Medicaid participants. State decisions about Medicaid expansion may also affect the program's coverage of individuals with diabetes. The new participants covered by the ACA Medicaid expansion are mostly younger, non-disabled, childless adults who are healthier on average than existing participants (Garfield & Damico, 2016). They also appear to use fewer medical services, after an initial spike due to pent up demand from prior lack of insurance (Chang & Davis, 2013; Fertig, Carlin, Ode, & Long, 2016). But in the 19 states that have not chosen to expand Medicaid, there are currently 2.5 million low-income adults without health insurance. Twenty-one percent of these uninsured adults report having poor health, and many likely have untreated diabetes (Garfield & Damico, 2016). Such untreated cases of diabetes will prove especially costly for Medicaid if this population is ever brought into the program.

Medicaid participants with diabetes have higher costs of care that strain the program's budget. In 2009, state Medicaid programs spent an average of \$13,490 on each participant with diabetes, compared to just \$5,133 per participant without diabetes (KFF, 2012a). In fact, Medicaid spends more per capita on diabetes than any

other chronic condition (KFF, 2012d). The 50 states' Medicaid programs spent a combined \$65.5 billion on diabetes care in 2015. This amounted to over 12 percent of states' total Medicaid spending in that year. It is estimated that Delaware alone devoted \$186.8 million in Medicaid funds to treating people with diabetes in 2015.⁴ Medicaid's high spending on diabetes comes out of public coffers, putting a fiscal burden on all taxpayers. Diabetes-related expenditures also pressure Medicaid to enact cost-containing measures that make coverage more austere, such as higher participant copayments and lower provider reimbursement rates (Smith et al., 2005). Medicaid cost growth, driven in part by diabetes, has also dissuaded several states from expanding the program under the ACA (Galewitz, 2016).

Medicaid's most complex challenge regarding diabetes is that the program appears to produce only minor improvements in the health outcomes of participants with diabetes, compared to people with diabetes who lack health insurance. In the Oregon Medicaid lottery, people with diabetes who gained access to Medicaid have so far shown no statistically significant improvement in blood glucose levels compared to those who did not gain access (Baicker et al., 2013). Two other studies have found that people with diabetes who have any form of health insurance do have fewer instances of highly uncontrolled blood glucose than their uninsured counterparts (Casagrande & Cowie, 2016; Wilper et al., 2009). However, those with insurance show no better

⁴ Author's calculations based on data from several different sources. See Appendix B for the details of these national and Delaware-specific Medicaid spending calculations.

achievement of HbA1c levels below seven percent, which is the ADA's recommended glucose target. Beyond these three studies, the literature is scarce on this important matter.

How can it be that Medicaid increases access to and utilization of treatment for people with diabetes, yet some studies indicate that this improved access and utilization does not translate into improved health outcomes? The answer may lie in the coordination and quality of care, and the broader limits of insurance in improving a person's health. Medicaid participants with diabetes have complex health needs that challenge any health care delivery system. Over 80 percent of Medicaid participants with diabetes have one or more physical comorbidities, and over a third have a mental comorbidity (KFF, 2012a). These multiple health issues require patients with diabetes to visit several doctors across primary, specialty, and inpatient care settings.

Optimizing this care requires patients to seek out the proper venues for their various needs, which can be confusing and difficult. It also requires clinicians to work together and guide patients towards appropriate treatments, but this does not always happen (Joy, 2008). The many doctors involved in a patient's diabetes care can have communication lapses and role conflicts (MacPhail, Neuwirth, & Bellows, 2009), and patients are sometimes directed to the emergency department (ED) when their complication can actually be addressed through ambulatory care (Finkelstein, Taubman, Allen, Wright, & Baicker, 2016).

Such uncoordinated diabetes care can lead to inefficiency and rising costs, with little health benefit for the patient. The inappropriate utilization of primary care can

put patients at higher risk of acute diabetes complications. These complications can often lead to avoidable ED visits and hospitalizations. Nearly 10 percent of all Medicaid nonelderly adult ED visits are related to diabetes (Capp et al., 2015). And Medicaid participants with diabetes exhibit the same rates of avoidable diabetes-related hospitalizations as those without any health insurance (Fisher & Ma, 2015). The relatively frequent use of hospital care among participants with diabetes is a key reason behind their higher per capita Medicaid costs (GAO, 2015). These hospitalizations then further fragment the coordination of care by involving more doctors and unplanned services, which can lead to yet worse diabetes control and even more ED utilization (Frandsen, Joynt, Rebitzer, & Jha, 2015; Liu, Einstadter, & Cebul, 2010).

There are several factors unique to Medicaid that create further challenges for the delivery of high quality care to patients with diabetes. First, Medicaid participants with diabetes tend to have economically unstable lives (Garfield, Xenakis, Bastian, & McBride, 2015). This can impede them from accessing preventive care, which involves scheduling and keeping appointments weeks in advance, taking time off from work, and navigating public transit to get to the clinic. Individuals with diabetes on Medicaid, compared to those with other types of insurance, also have lower levels of education and reduced access to information on health resources, which can prevent them from receiving proper care (Garfield et al., 2015). Further, many Medicaid participants were previously uninsured, and had no option but to rely on the ED for acute care services. This practice may persist as newly insured individuals may not

have the level of health literacy to effectively utilize primary care (Decker, Doshi, Knaup, & Polsky, 2012).

Medicaid participants with diabetes also experience other, more substantial barriers to care. Participants often experience coverage interruptions, as they must go through an eligibility re-determination process on an annual basis (Ku, MacTaggart, Pervez, & Rosenbaum, 2009). These gaps in coverage hurt the continuity of care and lead to increased hospitalizations for ambulatory care-treatable conditions (Kasper, Giovannini, & Hoffman, 2000; Bindman, Chattopadhyay, & Auerback, 2008).

Medicaid participants also face out-of-pocket expenses. Medicaid does not always pay for the entire cost of care, charging copayments for many services and medications (Li et al., 2014).⁵ These small costs can add up to a financial burden for low-income individuals with diabetes who are being treated for multiple health problems. Surveys have found that nearly 30 percent of Medicaid participants with diabetes have at some point lacked the money to pay for care, or have underused their medication for cost reasons (Mendes, 2013; Piette, Wagner, Potter, & Schillinger, 2004). Additionally, Medicaid participants in general may have trouble finding care because many doctors do not serve them. Medicaid reimburses care providers at significantly lower rates than private insurers. These lower reimbursement rates are associated with lower physician acceptance of new Medicaid patients, particularly in specialty and surgical

⁵ Delaware Medicaid charges no copayments for medical care, and charges \$0.50 to \$3.00 for prescription drugs. Participants' out-of-pocket expenses are capped at \$15 per month (Brooks, Wagnerman, Artiga, Cornachione, & Ubri, 2017).

medicine (Decker, 2007). One recent national survey found acceptance rates to drop by 26 percentage points when a prospective patient is revealed to have Medicaid insurance (Hing, Decker, & Jamoom, 2015). All of these factors can challenge the coordination and quality of diabetes care for those insured by Medicaid, and may help to explain the slim health improvement reported in studies of people with diabetes upon joining Medicaid.

The limitations of health insurance in improving population health also help explain Medicaid's small estimated effect on diabetes outcomes. Medicaid's chief purpose is to cover the cost of medical care. Yet medical care has been found to account for only 10 percent of the overall forces that shape a person's health status (McGinnis, Williams-Russo, & Knickman, 2002). The evidence is also mixed on the question of whether health insurance improves health at all. Health insurance does appear to improve certain measures of health for certain subgroups, but it may not improve average population health (Levy & Meltzer, 2008). This finding is supported by the results of the Oregon experiment, where Medicaid participants have so far shown no improvement in any physical health outcomes relative to the control group (Baicker et al., 2013). Health economists have even theorized that low-cost health insurance such as Medicaid may create the moral hazard of discouraging people from properly treating their health conditions, because they pay little of the financial cost of complications (Ehrlich & Becker, 1972). This perverse incentive of Medicaid has not been empirically proven (Simon et al., 2017; Kelly & Markowitz, 2009). Nonetheless, the optimal management of lifestyle-based chronic diseases involves many complex

factors, and demands an intensity of support that goes beyond access to care. Medicaid enables many low-income people with diabetes to afford treatment, and this alone makes the program important for this population's well-being. But Medicaid, as an insurer, is ultimately limited in how well it can improve a participant's overall health.

Finally, a third problem for Medicaid is that its participants exhibit many of the same demographic disparities in diabetes that exist in the general public, with specific examples presented in the next section of this chapter. Just as in the wider population, Medicaid participants show relatively higher rates of diabetes and worse health outcomes when they are older, non-White, and have multiple comorbidities. Many of the socioeconomic inequities in diabetes described in Chapter 3 are confounded by the fact that some demographic groups are more likely than others to have health insurance, which determines access to care. But Medicaid largely eliminates this confound by offering all participants access to affordable care. The disparities in the prevalence of diabetes among subgroups within Medicaid are therefore especially meaningful, because they likely illuminate other nonfinancial factors at play in treating the disease, or differences in care quality that depend on participant demographics. These disparities challenge the health equity goal that is targeted by the Centers for Medicare and Medicaid Services (CMS), the federal agency that oversees Medicaid. In its 2016 Quality Strategy, CMS states that “the gaps among racial and ethnic groups in the quality, experience, outcomes, [and] costs of health...must close at a faster pace” (CMS, 2016, p. 5). For all of the above reasons, diabetes presents a deep and costly challenge for the Medicaid program.

Medicaid Claims

The aforementioned challenges that diabetes poses for Medicaid can be empirically investigated by looking at participants' patterns of health care utilization, through the use of administrative claims data. Claims data are electronic records of the transactions that occur between participants and health care providers. While these claims data are not maintained for research purposes, they offer a direct glimpse into the health care utilization of participants. This makes them a rich source of information for health researchers on a wide range of topics, such as disease prevalence, medical expenditures, and care quality (Ferver, Burton, & Jesilow, 2009).

Numerous studies have used claims data to explore the care utilization and health status of Medicaid participants with diabetes. For example, claims data have been used to estimate the prevalence of diabetes among Medicaid participants, and across participant subgroups. Buescher, Whitmire, and Pullen-Smith (2010) use claims data to discover that diabetes is more prevalent among North Carolina Medicaid participants than among the state's general population, and more prevalent among Medicaid participants of color. Stewart et al. (2011) find similar racial/ethnic disparities in South Carolina's Medicaid program, along with higher rates of diabetes among rural participants compared to urban participants. See Chapter 8 for a discussion of the methodological strengths and limitations of using claims data to estimate the prevalence of diabetes.

Researchers have also used Medicaid claims data to study diabetes treatment quality. Dailey, Kim, and Lian (2001) assess participant adherence to medications,

while Bailey, de Brantes, and Wilson (2016) contrast the receipt of preventive screenings between Medicaid participants and the privately insured. Other studies have identified disparities in care utilization across Medicaid subgroups, such as between participants with and without diabetes (Hilltop Institute, 2016), between urban and rural participants with diabetes (Center for Health Workforce Studies, 2015), and between White versus minority participants with diabetes (Priest, Cantrell, Fincham, Cook, & Burch, 2011). Claims data have revealed that only four percent of New York Medicaid participants with diabetes attended a self-management class in 2013 (New York State Department of Health, 2015), and that Black Medicaid participants with diabetes in North Carolina showed lower drug adherence than Whites (Shenolikar, Balkrishnan, Camacho, Whitemire, & Anderson, 2006). Claims data have also shown that Medicaid participants with diabetes and comorbid mental illness visit the ED more often than other participants with diabetes, and also receive fewer preventive screenings (Shim et al., 2014; Druss et al., 2012). Claims data provide strong insight into Medicaid's diabetes care quality, because they document every encounter between participants and covered providers.

The billed dollar amounts in Medicaid claims have also been used to quantify the medical expenses of participants with diabetes, thus capturing their cost to Medicaid. Ramsey et al. (1999) find that participants with diabetes who have cardiovascular complications exhibit higher costs of care than those without such complications. Wagner et al. (2001) report that a participant's costs of diabetes care decrease when they have better blood glucose control. For Medicaid participants with

diabetes who have high cholesterol, Wu et al. (2011) find that health care costs decline by 15 percent when the participant adheres to statin medication. The billed amounts in Medicaid claims, however, are often far from the price that Medicaid ends up paying for services. In managed care plans where vendors are paid a fixed capitation, these billed amounts have even less relation to Medicaid's true incurred costs (Reck & Yalowich, 2016). Nevertheless, billed prices can sometimes provide a useful representation of relative costs, and can illuminate the drivers of the higher costs of care for participants with diabetes. Overall, claims data can shed light on the key challenges that diabetes poses for Medicaid.

Research Need

An examination of diabetes within the state of Delaware's Medicaid program serves two valuable purposes. First, it adds new local evidence to the overall knowledge base on how the treatment of diabetes may be challenging within the Medicaid program. The decentralized nature of the Medicaid program puts the onus on states to conduct their own research and analysis into important program issues. Because Medicaid is administered by the states, CMS provides little centralized reporting on specific Medicaid topics, such as the prevalence of chronic diseases among participants. Interested states must therefore take it upon themselves to explore the status of participants with diabetes in their respective Medicaid programs. Several states have done this in recent years, using Medicaid claims and other data sources to describe the burden of diabetes for their participants (Michigan DHHS, 2016; State of New York Comptroller, 2015; Commonwealth of Kentucky, 2015). Adding new

evidence from Delaware to this knowledge base creates greater variation in demographic and policy context. This allows more comparisons to be made between states, and enhances the national picture of how Medicaid is responding to the needs of participants with diabetes. Empirical evidence from Delaware also offers the chance to test existing knowledge in a new time and place. For instance, it is known that diabetes has been growing among younger adults, but is this the case for Medicaid participants in Delaware as well? Minority Medicaid participants appear to have relatively poorer diabetes control, but does this finding hold true in the First State? Evidence from new local contexts refines the prevailing knowledge on the disease.

Second, information on Delaware Medicaid participants who have diabetes would support the state's current efforts to address the disease. The state's most recent Health Care Innovation Plan cites chronic conditions like diabetes as key challenges to its *Triple Aim* of improving population health, enhancing care quality, and reducing health care costs (Choose Health Delaware, 2013). The Delaware Department of Health and Social Services (DHSS) periodically publishes a report on the state's burden of diabetes, and also operates a Diabetes and Heart Disease Prevention and Control Program that conducts an array of initiatives related to diabetes (DHSS, 2014; "Diabetes and heart disease", n.d.). The Delaware Diabetes Coalition, a statewide nonprofit organization, has created a comprehensive five-year plan to prevent and control diabetes in Delaware (Delaware Diabetes Coalition, 2013).

Evidence on diabetes that is specific to the state's Medicaid population would augment these existing efforts by helping Delaware's Medicaid agency and health

providers better understand the health needs of the state's most economically vulnerable residents with diabetes. This information can help Delaware policymakers assess how this population is faring under the state's current policies regarding Medicaid and diabetes. It can also provide the basis for additional research and analysis, and inform state efforts to better serve low-income residents with diabetes. Moreover, this information can enable Delaware to compare itself to regional peers such as Maryland, and to other states that operate Medicaid programs similar to Delaware's, such as Tennessee. Both of these states have conducted claims-based analyses of their residents on Medicaid who have diabetes, to explore issues of prevalence and care quality (Hilltop Institute, 2016; Tennessee Department of Health, 2017).

The present report fulfills this research need by using Delaware's Medicaid claims data to conduct a preliminary investigation of the prevalence of diabetes among the state's Medicaid participants, their receipt of preventive care, and their utilization of hospital care.

Chapter 5

DELAWARE MEDICAID CLAIMS DATA ANALYSIS

In this chapter, Medicaid claims data from the state of Delaware are drawn upon to answer four sets of research questions:

1. *Prevalence:* What was the overall prevalence of diabetes among Delaware nonelderly adult Medicaid participants between fiscal years 2009 and 2015? How did this prevalence compare to the general nonelderly adult population in Delaware, and to nonelderly adult Medicaid participants in other states? How did it vary by year, and by participant age, sex, race/ethnicity, county, and zip code of residence?
2. *Care quality:* Between fiscal years 2009 and 2015, what percentage of Delaware nonelderly adult Medicaid participants with diabetes received care that satisfied the National Committee for Quality Assurance's Healthcare Effectiveness Data and Information Set (HEDIS) performance measures for Comprehensive Diabetes Care (annual HbA1c test, eye exam, and nephropathy screening)? How did these percentages vary by year, and by participant age, sex, and race/ethnicity?
3. *Care utilization:* What was the mean number of ED (emergency department) and inpatient hospitalization claims for nonelderly adult Medicaid participants with diabetes in Delaware between fiscal years 2009 and 2015? How did these

amounts vary by year, and by participant age, sex, race/ethnicity, zip code of residence, and whether the person received care that met all three HEDIS care quality measures?

4. *High-need participants:* Among the population of nonelderly adult Medicaid participants with diabetes in Delaware that comprised the top 10 percent of mean annual number of diabetes-related inpatient hospitalization claims between fiscal years 2009 and 2015: How did the demographic composition of this group compare to the full nonelderly adult participant population in terms of age, sex, race/ethnicity, and county. How did this group compare in its receipt of care that met HEDIS performance measures?

Data and Methods

The source data in this chapter were made available to the author by the Center for Community Research and Service under an agreement between the University of Delaware and the Delaware Division of Medicaid and Medical Assistance (DMMA). The data are based on information extracted from four separate Delaware Medicaid administrative files. The first file, the medical claims file, contains all paid claims (for fee-for-service care) and service encounters (for managed care) submitted to Delaware Medicaid between July 1st, 2007 and June 30th, 2015. Each of these medical claims includes a numeric code that indicates the medical diagnosis associated with the encounter. These codes are called International Classification of Diseases (ICD-9) codes, and they are internationally standardized and maintained by the World Health Organization (“Classifications”, 2016). Each medical claim also contains a Current

Procedural Technology (CPT) code, which describes the medical procedure that was performed during the encounter (“CPT process”, n.d.). The second file, the prescription drug claims file, contains all drug claims that were paid by Delaware Medicaid between July 1st, 2007 and June 30th, 2015.⁶ The third file, a participant eligibility file, provides the dates for which each participant was enrolled in Medicaid over this time period. Finally, a supplemental participant information file indicates the participant’s sex and race/ethnicity.

Written approval was obtained from DMMA for the author to use data from these administrative files for the present study. The necessary data were then extracted by Medicaid Research Program personnel at the University of Delaware Center for Community Research and Service (CCRS). The data are Protected Health Information (PHI), as defined by the Health Insurance Portability and Accountability Act (HIPAA). Therefore, the data were provided to the author in de-identified form, in accordance with CMS HIPAA guidelines and the University of Delaware’s agreement with DMMA. The data were de-identified in keeping with the ‘safe harbor’ method (HHS, 2012). See Appendix C for a complete listing and description of the variables included in the data that were made available to the author.

All analyses in this report follow cell size suppression guidelines, as required by CMS according to the HIPAA Privacy Rule (“Researchers”, 2015). For all data aggregations, cells of size 10 or less are not presented. The author performed the data

⁶ Prescription drug claims became covered under managed care on January 1, 2015.

analysis using the Statistical Analysis System (SAS) software version 9.4. However, for analyses that involved aggregations by the participant's county or zip code of residence, the author submitted SAS code to other CCRS Medicaid research personnel to be run. This was done because these variables could not be provided to the author under the agreement with DMMA and CMS de-identification rules. The protocol for this study was submitted to the University of Delaware Institutional Review Board (IRB), because the data are Protected Health Information. The protocol was categorized as 'Exempt' (category 4), as the IRB judged that the subjects could not be identified by the researcher in the de-identified data.

The analytic sample was purposively restricted in two ways. First, it was limited to participants who were enrolled in Medicaid for at least one entire fiscal year between fiscal years 2008 and 2015. Several studies have limited their samples in this way when conducting Medicaid-based diabetes analyses similar to this report, such as Druss et al. (2012) and Hatem et al. (2015). This restriction reduces the influence of participant turnover, also called churning, when calculating the prevalence of diabetes on the Medicaid rolls over a given time period. The average adult participant receives Medicaid for only eight months at a time, and many participants shuttle in and out of the program at even shorter intervals (Ku et al., 2009). Counting short-term participants can distort the program's prevalence of diabetes when calculated over periods of a year or longer. Non-full-year participants were also excluded from the sample because this report uses criteria from the National Committee for Quality Assurance (NCQA) Healthcare Effectiveness Data and Information Set (HEDIS) to

identify participants who have diabetes in a given year, and these criteria apply only to participants who were enrolled nearly continuously for the entire year (CMS, 2016c).

Second, the analytic sample was restricted to participants who were between the ages of 18 and 64 at the time of their first claim in the first full fiscal year that they were enrolled. This is the primary age range in which diabetes develops, and several studies of the prevalence of diabetes among Medicaid participants have focused on this age group (Garfield & Damico, 2012; Kaufman et al., 2015; Center for Health Workforce Studies, 2015; Guo et al., 1998). Adults over age 64 become enrolled in the Medicare program, whereupon Medicaid usually ceases to be the primary payer for their health services. This creates gaps in Medicaid claims data for elderly adults, and makes their diabetes less consequential for the Medicaid program (Hennessy, Bilker, Weber, & Strom, 2003; Druss et al., 2012). Additionally, the HEDIS diabetes identification criteria used in this report apply only to adults (CMS, 2016c).

Table 1 presents the characteristics of the resulting analytic sample that is used throughout this chapter. The sample contains a total of 30,693,125 Medicaid claim records for 157,770 nonelderly Delaware adults who were enrolled in Medicaid for at least one full fiscal year between fiscal years 2008 and 2015.

Table 1 - Characteristics of analytic sample

Mean age at time of first claim	34.3
Mean number of fiscal years enrolled	3.9
Age at time of first claim	Percentage of total (N = 157,770)
18 – 30	47.2
31 – 40	19.0
41 – 50	17.9
51 – 60	12.6
61 – 64	3.1
Sex	
Male	38.2
Female	61.8
Race/Ethnicity[†]	
White, non-Hispanic	49.5
Black, non-Hispanic	38.1
Hispanic	9.7
Other	2.7
County	
New Castle	56.5
Kent	19.7
Sussex	23.7
Number of fiscal years enrolled	
One	22.3
Two	16.1
Three	12.8
Four	11.1
Five	9.4
Six	8.5
Seven	7.3
Eight	12.6

Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

[†]The racial/ethnic groupings of *White, non-Hispanic* and *Black, non-Hispanic* will henceforth be referred to as *White* and *Black*, respectively. Among the participants categorized as *Other* race/ethnicity, 80 percent were listed as having a race/ethnicity of *Asian or Pacific Islander*, 9.2 percent were listed as *American Indian or Alaskan*, 0.5 percent were *Subcontinent Asian*, 0.07 percent were *Pacific Islander*, and 10.2 percent were listed as *unknown* or *not provided*.

A modified version of the HEDIS Comprehensive Diabetes Care criteria was employed to identify sample members who have type 2 diabetes. HEDIS criteria are utilized throughout the health care industry to assess care quality for many different medical conditions (“HEDIS data submission”, n.d.). State Medicaid agencies also use HEDIS criteria to monitor the quality of care provided by MCOs (Burwell, 2015). For research purposes, the HEDIS criteria offer a standardized, replicable method of identifying individuals with diabetes through claims data. Numerous prior studies have relied on HEDIS-based criteria to identify Medicaid participants who have diabetes (Hilltop Institute, 2016; Druss et al., 2012; Patric et al., 2006). According to the criteria, a participant has diabetes in a given year if their claims indicate any of the following scenarios in the given year or the year prior to the given year:

1. At least two outpatient visits, observation visits, ED visits, or non-acute inpatient encounters on different dates of service, with a diagnosis of diabetes. Visit type need not be the same for the two visits.
2. At least one acute inpatient encounter with a diagnosis of diabetes.
3. Members who were dispensed insulin or hypoglycemics/antihyperglycemics on an ambulatory basis (CMS, 2016c, p. 123).

Diabetes diagnoses were identified in the medical claims using the ICD-9 code values listed in the 2017 HEDIS Value Set, which is a proprietary codebook that accompanies the information in CMS (2016c).⁷ This codebook contains diagnosis codes for both type 1 and type 2 diabetes. Since this report focuses only on type 2

⁷ This codebook is available for free download from the HEDIS website at <http://store.ncqa.org/index.php/catalog/product/view/id/2479/s/2017-quality-rating-system-qrs-hedis-value-set-directory/>.

diabetes, the diagnosis codes that indicate type 1 diabetes were not used. This follows the method in Wu et al. (2011), who conduct a similar claims-based analysis that focuses on type 2 diabetes. See Table D1 in Appendix D for a complete listing of the ICD-9 code values used to identify diabetes diagnoses.

Diabetes scenario 3 was identified in prescription drug claims using the National Drug Code values listed in Table CDC-A on the HEDIS website.⁸ These drug codes include medications for the treatment of both type 1 and type 2 diabetes. Following the method in Wu et al. (2011), only the National Drug Codes for orally-administered diabetes medications were used. This rules out injectable insulin, in order to minimize the inadvertent inclusion of participants with type 1 diabetes in the analysis. All type 1 diabetes patients are generally treated with injectable insulin, compared to only an estimated 27 percent of type 2 diabetes patients (Koro, Bowlin, Bourgeois, & Fedder, 2004). The 1,565 National Drug Code values used for scenario 3 are too numerous to list in this report, but they can be obtained online through the link in footnote 7.

Diabetes scenarios 1 and 2 were identified in medical claims. For scenario 1, a modification was made to the HEDIS criteria. Instead of counting only outpatient, observation, ED, or non-acute inpatient claims, a participant was considered to meet diabetes scenario 1 if they had at least two of *any* type of medical visit with a diabetes

⁸ Available at <http://www.ncqa.org/hedis-quality-measurement/hedis-measures/hedis-2016/hedis-2016-ndc-license/hedis-2016-final-ndc-lists>.

diagnosis on different dates of service in the given year or the year prior. This modification was done for two reasons. First, the HEDIS Value Set provides specific procedure codes to identify outpatient, observation, ED, and non-acute inpatient claims, but 28,447 claims in the study data had missing procedure codes. These missing values resulted in a one percent lower overall calculated rate of diabetes when using only the HEDIS Value Set codes. Second, research has found little difference in the detective accuracy of various claims-based diabetes algorithms, as long as they use two years' worth of data to identify cases, and require at least two separate diagnoses for non-acute claims (Hebert et al., 1999). See Chapter 8 for further discussion of the tradeoffs and limitations of this report's method of identifying cases of diabetes. For scenario 2, the CPT codes in the HEDIS value set were used to identify acute inpatient claims, because there was no other way to identify these types of claims in the study data. These CPT code values are listed in Table D2 in Appendix D. All analyses in this chapter cover fiscal years 2009 to 2015, with data from fiscal year 2008 used to identify participants who had diabetes in fiscal year 2009.

The quality of care received by participants with diabetes was operationalized based on the 2017 HEDIS clinical performance measures for Comprehensive Diabetes Care. These performance measures include three process-of-care measures and one health outcome measure:

Process-of-care measures

1. Patient had a hemoglobin A1c (HbA1c) test performed in the given year
2. Patient had a retinal eye exam performed in the given year

3. Patient had medical attention for nephropathy in the given year (CMS, 2016c, p. 123).

Health outcome measure

4. The patient's most recent HbA1c test in the given year had a result of less than 8.0% (CMS, 2016c, p. 125).

Measures 1 and 2 were identified in medical claims using the CPT procedure codes listed in the HEDIS Value Set. Measure 3 was identified in medical claims using CPT procedure codes and ICD-9 diagnosis codes, as well as in prescription drug claims using the National Drug Code values listed in Table CDC-L on the HEDIS website. See Table D3 in Appendix D for a complete listing of the diagnosis and procedure codes used to assess these three process-of-care measures. The 3,899 National Drug Code values used for Measure 3 can be obtained through the link in footnote 8.

The lone health outcome measure, Measure 4, could not be ascertained based on the data available to the author. This is because all HbA1c test results between 7 percent and 9 percent are assigned the same CPT code (3045F) in medical claims. HEDIS explains that this CPT code “is not specific enough to denote...compliance for this indicator. For members with this code, the organization must use other sources (laboratory data, hybrid reporting method) to...determine if the HbA1c result was < 8.0%” (CMS, 2016c, p. 125). Measure 4 was therefore excluded from the operationalization of diabetes care quality. Several prior studies have either excluded this measure (Druss et al., 2012; Hu et al., 2014; Patric et al., 2006), or used alternative HbA1c thresholds that align with CPT codes (Berkowitz et al., 2015).

The volume of care utilized by participants was quantified in terms of their number of individual claims. These claims quantities should not be interpreted as numbers of separate visits or encounters. The author did not attempt to determine which claims corresponded to the same visit, appointment, or hospital stay. ED visits and inpatient hospitalizations in particular can often yield multiple claims. The numbers of claims nonetheless capture relative differences in utilization of care across participant groups, since more claims per visit likely indicate that more procedures were done. The estimated prevalence of diabetes does not change whether quantifying care in terms of claims or visits.

Finally, the statistical significance of differences across sample subgroups was tested. The Chi-Square test of association was used to test the respective null hypotheses that the prevalence of diabetes did not differ by age group, by sex, by race/ethnicity, or by county. These same Chi-Square tests were conducted for rates of diabetes care measure receipt. The one-way analysis of variance (ANOVA) test was used to test the respective null hypotheses that the mean annual number of ED and inpatient claims did not differ by age group, by sex, by race/ethnicity, or by county. All tests used a significance level of .05.

Prevalence of Diabetes

Table 2 presents the prevalence of diabetes among the study sample. These sample members met the above criteria for having diabetes in at least one of the fiscal years in which they were enrolled in Medicaid between 2009 and 2015.

Table 2 - Prevalence of type 2 diabetes

	Percent with type 2 diabetes
Total sample (N = 157,770)	9.6
Age at time of first claim*	
18 – 30	2.4
31 – 40	8.4
41 – 50	17.1
51 – 60	24.6
61 – 64	24.2
Sex*	
Male	10.2
Female	9.3
Race/Ethnicity*	
White	9.2
Black	10.2
Hispanic	8.8
Other	12.8
County*	
New Castle	9.4
Kent	10.2
Sussex	9.9

Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

*Grouping shows a statistically significant relationship with diabetes with a significant Chi-Square test at $p \leq .05$ level

The total sample of Medicaid participants had a 9.6 percent prevalence of diabetes over the study period. The prevalence was higher in older age cohorts up to ages 51 to 60. The null hypothesis was rejected that all age cohorts have the same prevalence of diabetes, based on the Chi-Square test of association. Males had a one percentage point greater prevalence than females, which was statistically significant. New Castle County had the lowest prevalence of the three counties at 9.4 percent, while Kent County had the highest at 10.2 percent. This variation across counties was statistically significant. The prevalence also showed statistically significant variation

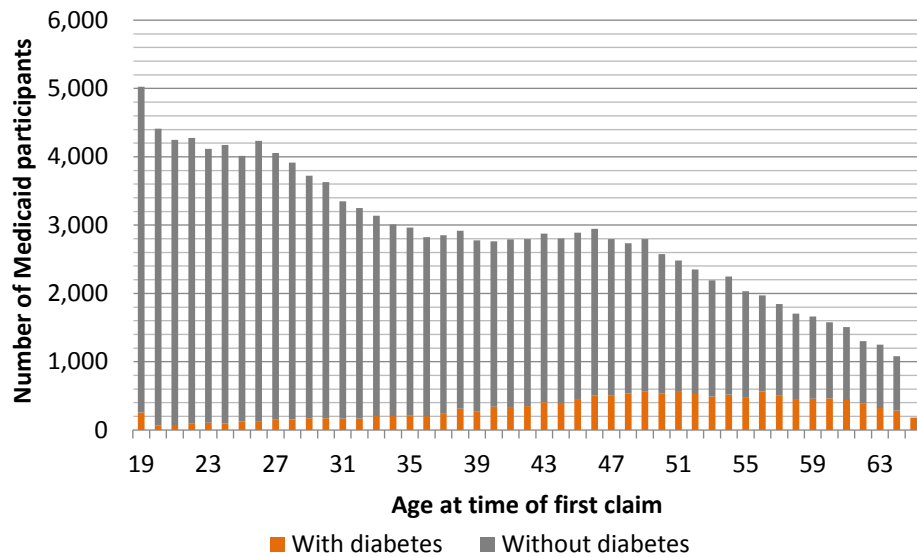
by racial/ethnic group. Hispanic participants had the lowest prevalence, followed by White and Black participants.

Figure 1a displays the number of individuals in the study sample by their age at the time of their first claim, as well as the proportion that met the criteria for having diabetes in at least one year during the study period. The number of individuals in the sample generally declined as entrance age increased, while rates of diabetes increased with entrance age. Individuals who were 60 years old at the time of their first claim had the highest rate of diabetes of any single age cohort, at over 40 percent.

Eighteen year-olds are not depicted in Figure 1a in order to make the graphical scale more readable. As shown in Figure 1b, a very disproportionate number of sample members were 18 years old at the time of their first claim in the study, a full 15.7 percent of the entire sample.⁹ Eighteen is generally the most common adult age at which to enter Medicaid, as a person's childhood eligibility simply continues into their adult years ("Medicaid enrollment by age", n.d.). The 18 year-old age cohort also had the lowest rate of diabetes, at only one percent. When this cohort is not included, the overall prevalence of diabetes in the study sample increases to 11.2 percent.

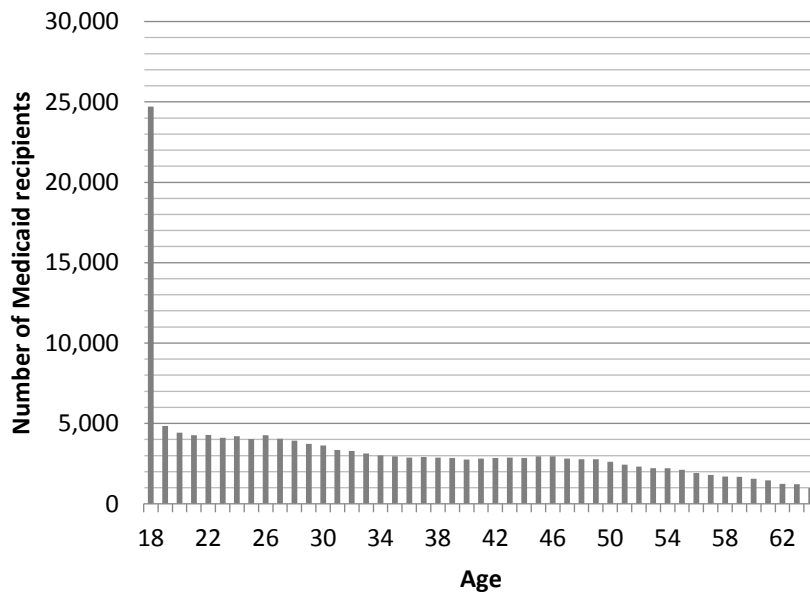
⁹ The age distribution of the sample is more even when looking at each individual fiscal year. Eighteen year-olds still comprise the largest single age group in each year, ranging from a low of 5.7 percent of the sample in FY 2015 to a high of 7.2 percent of the sample in FY 2009.

Figure 1a - Number of participants with and without type 2 diabetes, by age at time of first claim, excluding age 18



Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

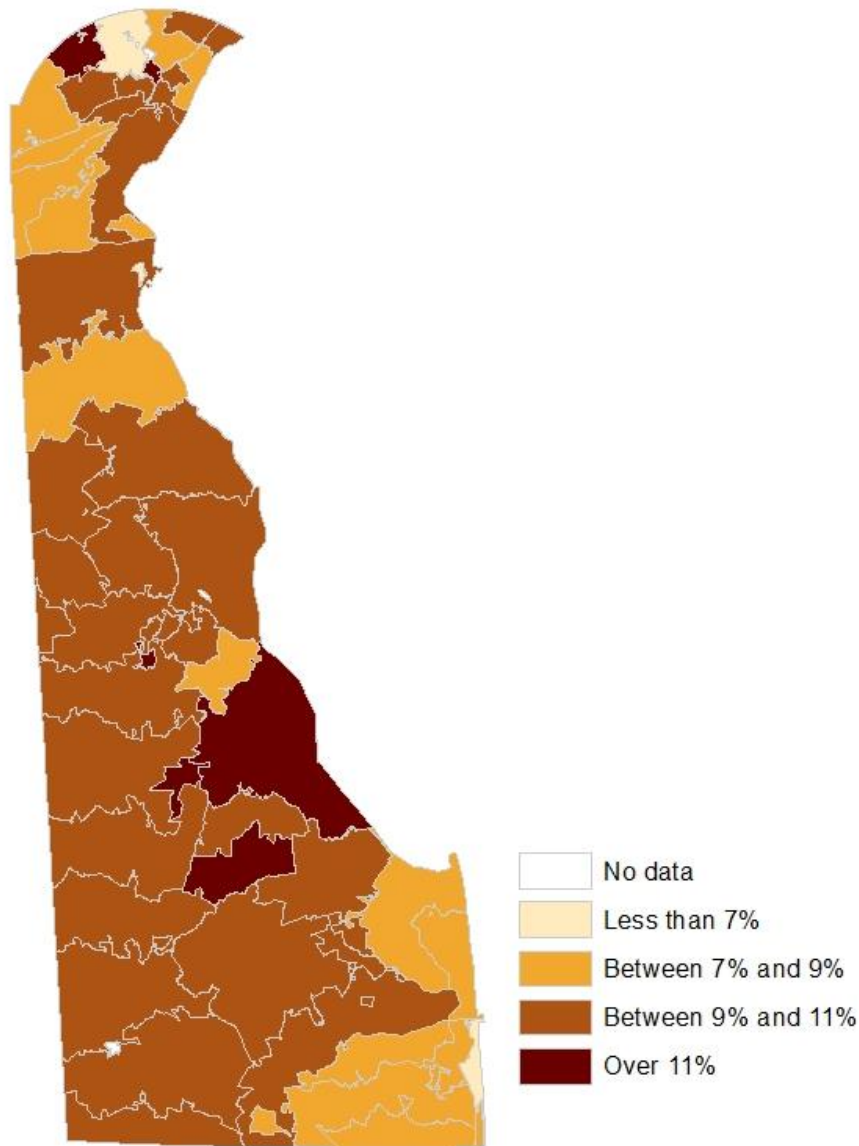
Figure 1b - Distribution of study sample, by age at time of first claim



Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

The prevalence of diabetes also varied by Medicaid participant zip code of residence, although the statistical significance could not be calculated due to small cell sizes in the Chi-Square test of association. As shown in Figure 2, the majority of zip codes in Delaware had diabetes rates of between nine and 11 percent. Four zip codes had rates of diabetes of less than seven percent, including the Bethany Beach area and the area to the northwest of Wilmington. Six zip codes had rates of diabetes of more than 11 percent. Zip code 19941 had the highest rate of diabetes in the state, at 14 percent. This rural zip code lies in northern Sussex County and contains the town of Ellendale.

Figure 2 - Prevalence of type 2 diabetes among study sample, by zip code

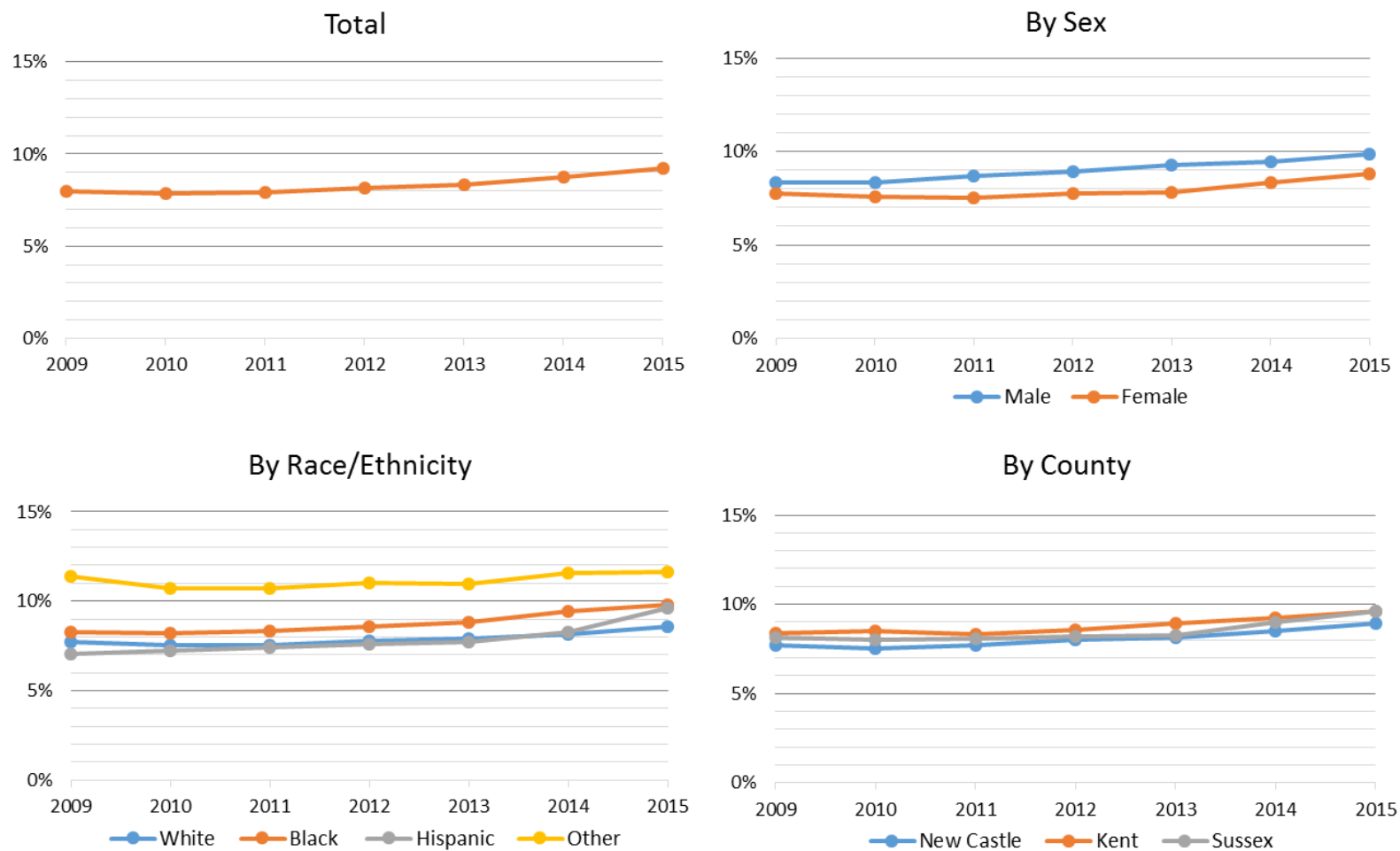


Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, and U.S. Census Bureau TIGER/Line Shapefile, 2017

Figure 3 depicts the trends in the prevalence of diabetes over time among the total sample and various subgroups. The total sample prevalence of diabetes fell

slightly between 2009 and 2010, before rising to a high of 9.2 percent in 2015. Male participants had a consistently higher rate of diabetes than females throughout the study period. The differences between racial/ethnic groups also remained steady over the study period, except for an uptick among Hispanic participants between 2014 and 2015. Note that these rates of diabetes are annual snapshots of the participants who were enrolled for the entire given fiscal year. The same sample members are not enrolled in each year. Participant turnover partly explains why the single-year rates of diabetes are lower than the 9.6 percent rate of *ever* having diabetes. See Chapter 8 for more details.

Figure 3 - Prevalence of type 2 diabetes among study sample, by fiscal year



Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

Diabetes Care Quality

Table 3 presents the rates of receipt of care that met the HEDIS care quality performance measures, among sample members with diabetes.¹⁰ Approximately 62 percent of participants with diabetes in a given year received an HbA1c test in that year. Participants with diabetes showed a 74.5 percent receipt rate for nephropathy attention, which means they received at least one of many different screenings or medications that concern the functioning of the kidneys. Rates of receiving a retinal eye exam were even higher, at almost 94 percent. However, only 54.8 percent of participants with diabetes in a given year received care that met all three performance measures in that year.

Male and female sample members with diabetes showed small differences in their care receipt rates. These differences were statistically significant for each measure, but not for receiving all three measures in the same year. Differences between the three counties were also small yet statistically significant for all measures. Participant age showed a statistically significant relationship with care receipt, with participants in the 61 to 64 year-old age group exhibiting lower receipt rates than the other age groups on all measures. Participant race/ethnicity also had a statistically

¹⁰ The HEDIS measures as defined in CMS (2016c) are calculated for one year at a time. Therefore, the overall study period rates in Table 3 are calculated as:

$$\sum_{t=2009}^{2015} \left(\frac{\text{Number of enrollees with diabetes who received HEDIS measure}}{\text{Number of enrollees with diabetes}} \right)_t$$

significant relationship with the receipt of each care measure and all three in the same year. Black participants showed the lowest rate of receiving all three measures (53.9 percent), while participants in the catch-all *Other* category showed the highest rate (64.9 percent).

Table 3 - HEDIS comprehensive diabetes care receipt among sample members with type 2 diabetes

	HbA1c test (%)	Retinal eye exam (%)	Nephropathy attention (%)	Received all three in same year (%)
Total (N = 157,770)	61.7	93.9	74.5	54.8
Age*				
18 – 30	61.2	96.5	76.6	52.6
31 – 40	64.1	97.7	76.5	56.2
41 – 50	66.6	97.4	78.1	59.6
51 – 60	62.7	95.9	76.2	56.2
61 – 64	56.6	92.1	72.0	49.9
Sex*				
Male	62.3	92.9	73.8	55.1
Female	61.3	94.5	74.9	54.6
Race/Ethnicity*				
White	62.0	94.1	72.4	54.4
Black	59.9	93.9	76.2	53.9
Hispanic	64.2	93.4	75.6	57.5
Other	72.6	91.9	79.3	64.9
County				
New Castle	60.2	93.4	74.0	53.8
Kent	61.3	95.0	75.7	55.5
Sussex	65.4	94.0	74.6	56.6

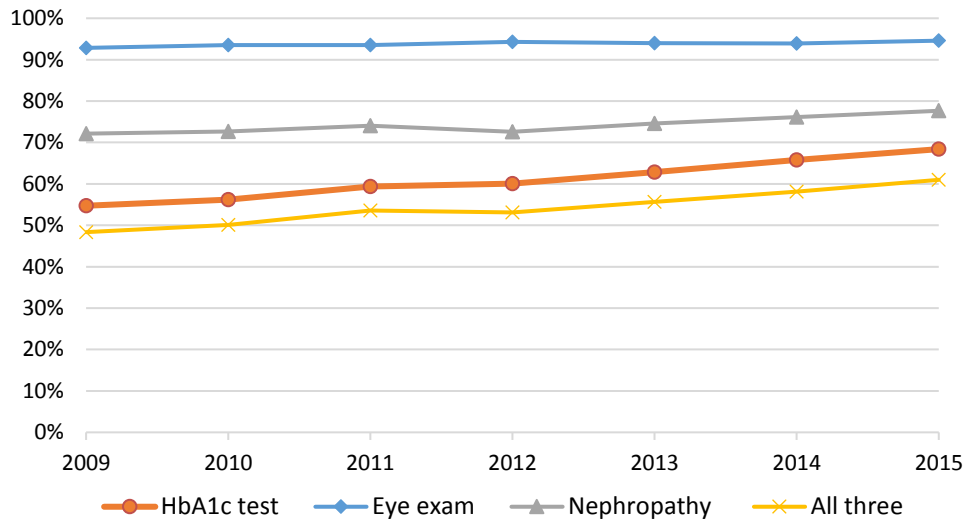
Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

*Grouping shows a statistically significant relationship with care receipt with a significant Chi-Square test at $p \leq .05$ level

Figure 4 depicts the trends over time in the receipt of the diabetes care measures. Rates of receipt increased over the study period for each measure, and for

the receipt of all three together. For all measures, the difference between the 2009 rate and the 2015 rate was statistically significant.

Figure 4 - Receipt of HEDIS comprehensive diabetes care among sample members with type 2 diabetes, by fiscal year



Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

Care Utilization

Inpatient hospitalizations and ED visits are known to be significant drivers of Medicaid spending (GAO, 2015). Medicaid participants with diabetes have been found to use these types of care more frequently than those without diabetes (Capp et al., 2015; Frazee, Jiang, & Burgess, 2010). With this in mind, Table 4 presents the rates of ED and inpatient hospital claims across sample member subgroups with and without diabetes.

Table 4 - Mean annual number of ED and inpatient hospitalization claims per participant, by type 2 diabetes status

	ED		Inpatient hospitalization	
	With diabetes	Without diabetes	With diabetes	Without diabetes
Total (N = 157,770)	7.25	3.95	6.23	1.38
Age*				
18 – 30	10.04	4.64	5.99	1.18
31 – 40	8.00	4.74	5.44	1.41
41 – 50	8.12	5.28	6.01	2.03
51 – 60	6.96	5.20	7.18	3.02
61 – 64	5.04	4.12	6.13	2.86
Sex*				
Male	6.59	3.24	6.83	1.46
Female	7.65	4.33	5.86	1.34
Race/Ethnicity*				
White	7.21	3.98	6.61	1.51
Black	7.68	4.25	6.51	1.36
Hispanic	6.64	2.92	4.15	0.94
Other	3.79	2.21	2.93	0.76
County				
New Castle	7.10	3.90	6.65	1.49
Kent	6.98	3.93	6.72	1.40
Sussex	7.82	4.07	4.90	1.12

Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

*Grouping shows statistically significant relationship with ED and inpatient claims, with a significant one-way ANOVA test at .05 level

Over the study period, participants with diabetes had a greater per capita volume of ED and inpatient claims than their counterparts without diabetes.¹¹ These differences were statistically significant. The differences also showed statistically significant variation across age groups, and were more pronounced among participants in the 18 to 30 year-old age group. Rates of ED and inpatient claims showed statistically significant variation across racial/ethnic groups, regardless of diabetes status. Black participants in general had the largest average number of ED claims, while Whites had the largest average number of inpatient claims. The three counties showed no statistically significant differences in their rates of ED or inpatient claims. Male and female participants had statistically significant differences in both of these rates.

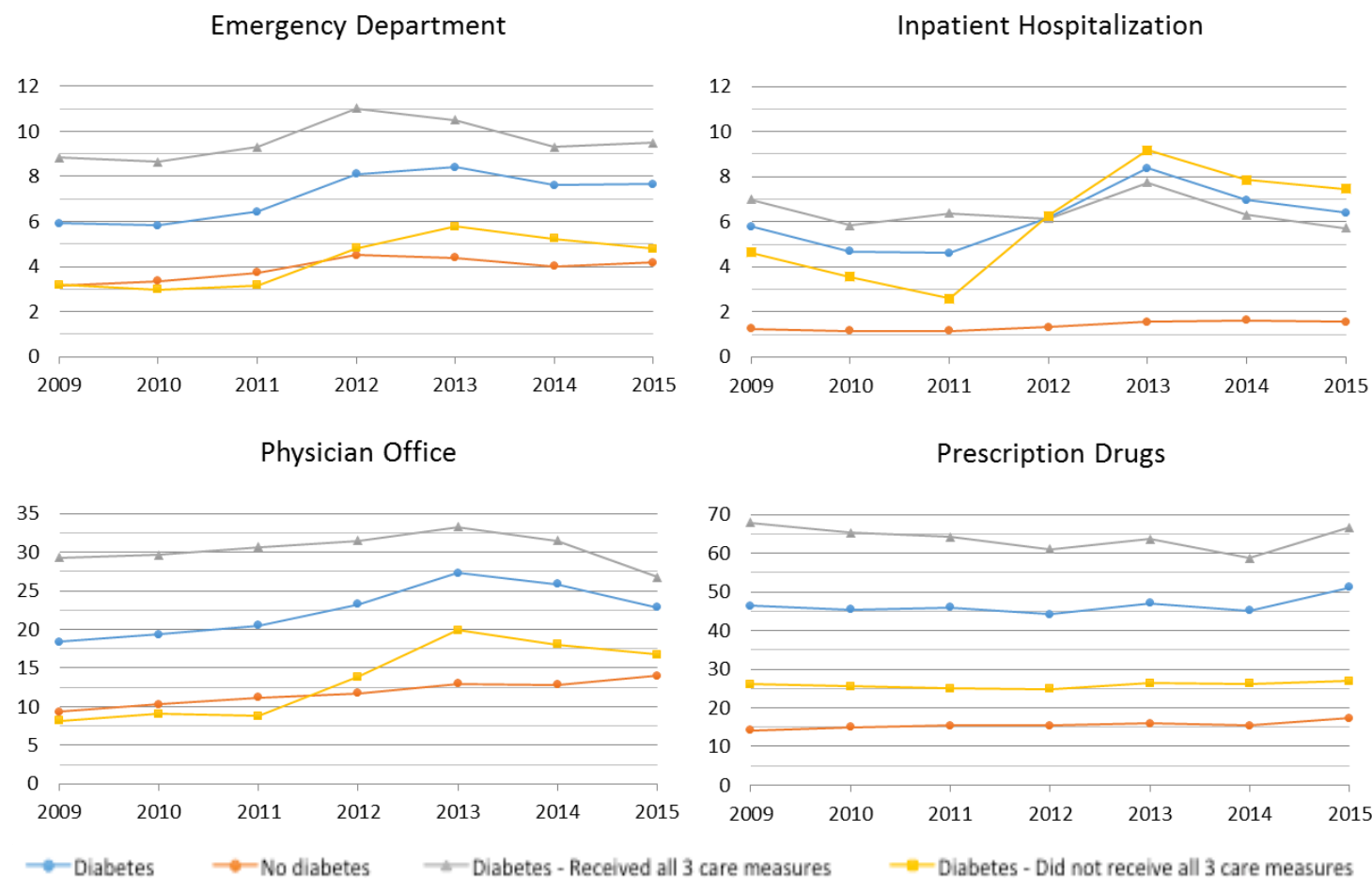
¹¹ The claim counts should not be interpreted as numbers of visits or hospital stays. Assuming that claims that occurred on the same date represent the same visit, the numbers presented in Table 4, Figure 5, and Figure 6 can be converted as follows:

1 ED visit \approx 2.44 claims

1 office visit \approx 1.61 claims

1 inpatient hospitalization \approx 33.33 claims

Figure 5 - Mean annual number of claims per participant, by type of claim, type 2 diabetes status, and fiscal year

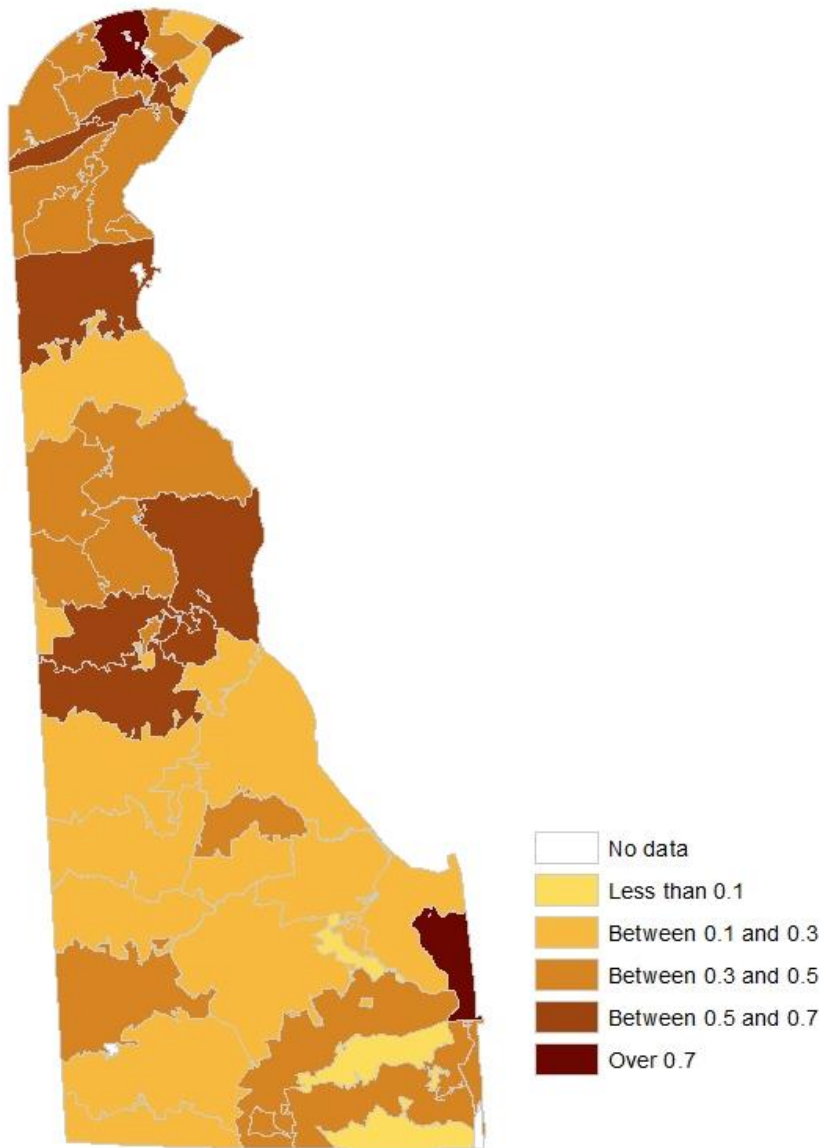


Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

Figure 5 displays the trends over time in the utilization of ED and inpatient hospital care, as well as office care and prescription drugs. Over the study period, participants with diabetes consistently utilized more ED, inpatient, and office care than those without diabetes. They also incurred a much greater number of claims for prescription drugs. Participants with diabetes who received all three care measures in a given year had consistently greater ED, office, and prescription drug claims than those who did not receive all three. They also had greater inpatient claims until 2012, when they were overtaken by those who did not receive all three measures. All four types of claims exhibit a slight trend towards greater utilization over time.

Focusing only on participants with diabetes, Figure 6 shows the variation in the average number of diabetes-related inpatient claims across Delaware zip codes. Interestingly, the zip code with the highest average number of diabetes-related inpatient claims also has the fourth lowest prevalence of diabetes in the state. This zip code, 19807, lies to the northwest of Wilmington. The top 10 diagnoses for ED and inpatient claims among all participants with diabetes are listed in Table 5. ED claims for participants with diabetes most often had a diagnosis of unspecified chest pain, followed by type 2 diabetes mellitus. Acute kidney failure was the most common diagnosis for inpatient claims.

Figure 6 - Mean annual number of claims for type 2 diabetes-related inpatient hospitalization per participant with diabetes, by zip code



Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, and U.S. Census Bureau TIGER/Line Shapefile, 2017

Table 5 – Top 10 diagnoses for ED and inpatient hospitalization claims for sample members with type 2 diabetes

ED		Inpatient hospitalization	
Rank	Diagnosis	Rank	Diagnosis
1	Unspecified chest pain	1	Acute kidney failure
2	Type 2 diabetes mellitus	2	Type 2 diabetes mellitus
3	Abdominal pain, unspecified site	3	Acute respiratory failure
4	Headache	4	Unspecified chest pain
5	Shortness of breath	5	Pneumonia
6	Chest pain, other	6	End stage renal disease
7	Pain in limb	7	Congestive heart failure
8	Lower back pain	8	Uncontrolled type 2 diabetes mellitus
9	Breast cancer screening	9	Obstructive chronic bronchitis
10	Abdominal pain, other specified site	10	Abdominal pain

Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

High-Need Participants

Table 6 - Characteristics of sample members who were in the top 10 percent of annual number of type 2 diabetes-related inpatient hospitalization claims

	Percentage of total (N = 1,515)
Age at time of first claim	
18 – 30	16.9
31 – 40	18.5
41 – 50	32.6
51 – 60	28.5
61 – 64	3.5
Sex	
Male	47.1
Female	52.8
Race/Ethnicity	
White	45.4
Black	45.4
Hispanic	7.3
Other	1.9
County	
New Castle	61.8
Kent	19.7
Sussex	18.3
Care quality	
Rate of receiving all 3 HEDIS measures	59.4

Source: Compiled with data provided by the Delaware Division of Medicaid & Medical Assistance through a partnership between the University of Delaware and the Delaware Department of Health and Social Services, 2017

Table 6 presents the demographic breakdown of the 1,515 Delaware Medicaid participants who ranked in the top 10 percent of annual diabetes-related inpatient hospitalization claims. This group of participants can be considered to face especially severe diabetes-related health challenges. The group is comprised of equal numbers of White and Black patients, and there are over five percentage points more women than men. Over 60 percent of the participants live in New Castle County, which is close to the percentage among the entire study sample. The group has a 59.4 percent rate of

receiving all three care quality measures in a given year. This rate is higher than the rate for all participants with diabetes.

Chapter 6

DISCUSSION OF CLAIMS DATA ANALYSIS RESULTS

The results of the Delaware Medicaid claims data analysis mostly conform to expectations based on existing theory and findings from other settings. They also highlight certain groups of participants that exhibit diabetes treatment challenges, as well as other groups with mixed results that suggest the need for additional research.

Prevalence of Diabetes

The claims data indicate that Delaware's nonelderly adult Medicaid participants are more likely to have diabetes than the state's general nonelderly adult population. This may not be apparent at first glance, as the 9.6 percent overall study period prevalence of diabetes among nonelderly adult Medicaid participants is nearly identical to the CDC's 2014 Delaware statewide estimate of 9.7 percent (CDC, 2016a). However, the CDC's estimate comes from the Behavioral Risk Factor Surveillance System (BRFSS), which includes elderly adults in its survey estimate. Among 18 to 44 year-old Delaware residents, the 2014 BRFSS diabetes estimate was 3.5 percent. Among this age group in the Medicaid sample, the 2014 prevalence was 4.3 percent. The 2014 difference was even larger among residents ages 45 to 64: 13.2 percent in the general population versus 20.8 percent among the Medicaid sample (CDC, 2016a).

The true difference in diabetes prevalence between Delaware Medicaid participants and the Delaware general population is likely even larger than what is reported above, for two reasons. First, the statewide BRFSS estimate includes both type 1 and type 2 diabetes, whereas this report's Medicaid calculations concern only type 2 diabetes. The prevalence of type 2 diabetes in Delaware is likely five to 10 percent lower than the BRFSS estimate, based on the known breakdown of type 1 versus type 2 cases (ADA, 2012b). Second, the methodology that was used to identify cases of diabetes in the Medicaid claims likely undercounts the true number of cases. The reasons for this are discussed in Chapter 8. Overall, this finding supports the existing knowledge that Medicaid participants have elevated rates of diabetes compared to the general public (CDC, 2015b). The change in total prevalence between 2009 and 2015, as shown in Figure 3, exhibits the expected upward trend and reflects the rising prevalence that has been widely observed in the literature.

The differences in rates of diabetes across Medicaid subgroups echo the disparities in Delaware at large. Just as in the state's wider population, Black Medicaid participants were found to have a higher prevalence of diabetes than Whites. The lower prevalence among Hispanic participants compared to Whites also resembles the 2015 statewide rates (DHSS, 2015). The nearly one percentage point higher prevalence among male participants compared to females reflects the existing knowledge that men have a higher risk of diabetes than women (Logue et al., 2011). This difference matches the findings in the Delaware general population (DHSS, 2014). The results in Figure 1a show that rates of diabetes among the study sample rose with age until age

60, before leveling off and then slightly declining. Existing research attributes the decrease in diabetes prevalence among the elderly to falling rates of onset (i.e. *incidence*) and rising diabetes-related mortality rates as individuals advance in age (Kirkman et al., 2012). Forty percent of 60 year-old Delaware Medicaid participants had diabetes over the study period. This group sits at the peak of life-course diabetes onset, and therefore merits particular attention in any Medicaid efforts to mitigate diabetes.

Medicaid diabetes rates are distributed fairly uniformly across Delaware zip codes. Zip codes with higher rates of Medicaid diabetes can be found in urban parts of the state, such as zip code 19806 in Wilmington, as well as in rural areas, such as zip code 19941 in Sussex County. This may illustrate that environmental determinants of diabetes can be present in a wide range of communities. The specific zip codes with especially high and low rates of diabetes defy easy explanation. Diabetes rates are known to rise with age, yet the zip codes show no correlation between their mean Medicaid participant ages and their rates of diabetes. The sample members in this study all have some degree of financial difficulty by virtue of being on Medicaid. Among the 10 zip codes with the highest rates of diabetes, four also rank in the top 10 highest poverty rates in Delaware (U.S. Census Bureau 2015 ACS 5-year estimates Table DP03). These zip codes may indicate areas where Medicaid participants are facing particularly deep poverty or hardship. The environmental characteristics of these standout zip codes warrant further analysis.

Finally, the rates of diabetes among Delaware Medicaid participants cannot easily be compared to the rates found among other states' Medicaid participants. The estimates from other states vary substantially due to the use of different methodologies and population definitions. For example, Michigan Medicaid reported a 9.6 percent prevalence of diabetes among nonelderly adults in 2012, but this rate included types 1 and 2 diabetes (Michigan DHHS, 2016). Kentucky Medicaid reported an 18 percent prevalence in 2013, but this included elderly adults and used a case detection method that is less stringent than this report's (Commonwealth of Kentucky, 2015). Using the HEDIS detection method, Maryland Medicaid reported a 13 percent prevalence in 2013 among participants ages 35 to 64 (Hilltop Institute, 2016). The lack of standardized reporting across states makes it difficult to tell where exactly Delaware ranks in its prevalence of diabetes among the Medicaid population.

Diabetes Care Quality

Annual rates of receipt increased for all three diabetes care measures over the study period. This positive finding shows that in recent years, Delaware Medicaid participants with diabetes have been improving in their rates of receiving these important elements of diabetes care. For all three measures, there was a drop in receipt rates between the 51 to 60 and 61 to 64 year-old age groups. This may indicate that the 61 to 64 year-old participants with diabetes are facing unique age-related barriers to receiving these elements of care.

Delaware Medicaid's care receipt rates can also be compared to the national average Medicaid rates that are published annually by the National Committee for

Quality Assurance (NCQA). In 2015, the national average rate of retinal eye exams for Medicaid participants with diabetes was 52.7 percent. Rates of HbA1c screening were 86 percent, and rates of nephropathy attention were 90 percent (NCQA, 2016). Delaware Medicaid thus fell below the national average in its 2015 rates of HbA1c testing and nephropathy attention, yet exceeded the national average for retinal eye exams. The NCQA report does not list the national average rate of receiving all measures in the same year.

Delaware Medicaid's diabetes care receipt rates also paint a mixed picture when compared to the rates among the state's general population. The BRFSS tracks some of the same diabetes care measures as the HEDIS criteria. In 2015, the BRFSS found that 94.4 percent of adult Delawareans with either type 1 or type 2 diabetes received an HbA1c test (DHSS, 2015), which is greater than the 68.4 percent of Medicaid participants. On the other hand, the 2015 BRFSS also found that only 71.3 percent of adult Delawareans with diabetes received a retinal eye exam (DHSS, 2015), compared to 94.6 percent of those on Medicaid. A deeper investigation is needed to understand these disparities, which may reflect complex factors related to the socioeconomic status of Medicaid participants. The disparities may also reflect that the BRFSS estimates are based on self-reported survey responses, while the Medicaid estimates are based on claims data.

Care Utilization

The care utilization findings appear to support the existing knowledge that individuals with diabetes tend to use a greater volume of health services than those

without the disease. Across all demographic groupings, participants with diabetes had nearly twice as many ED claims per year, and over four times as many inpatient hospital claims, as those without diabetes. These results align with other measures of care utilization from other states' Medicaid populations. For instance, based on hospital records, Kentucky has reported that Medicaid participants with diabetes are more likely to visit the ED (Commonwealth of Kentucky, 2015). Maryland has reported per-capita expenditures to be more than twice as high among its Medicaid participants with diabetes than among those without diabetes (Hilltop Institute, 2016).

The 18 to 30 year-old age group showed more pronounced differences in volume of care utilization between patients with and without diabetes. This finding requires further investigation to be explained. The 18 to 30 year-old participants with diabetes also had the highest rate of ED claims of all age groups. This trend has also been found in other states' Medicaid populations (Michigan DHHS, 2016). Regarding racial/ethnic disparities, the catch-all *Other* category had the lowest rates of ED and inpatient hospitalization claims, regardless of diabetes status. This raises further questions about the health experiences of the participants in this uncategorized racial/ethnic group.

The trends in utilization over time, as presented in Figure 5, tell a mixed story that demonstrates the complexity in understanding patterns of diabetes care. On one hand, it meets expectations that participants with diabetes incurred more of all four types of claims in every year, compared to those without diabetes. It also makes sense that the participants with diabetes who received all three care measures had more

physician office claims and prescription drug claims than those who did not receive all three measures. The comprehensive care measures are usually obtained in ambulatory care settings, suggesting that those who obtain them are using more primary care. And those who receive this care may adhere to their medications more strictly, therefore incurring more claims from refilling prescriptions more often.

On the other hand, it is unclear why the participants who received all three care measures had higher rates of ED utilization than those who did not. This raises the broader question of whether the participants who received the care measures had fewer diabetes complications, or whether they received the care measures as part of treatment for acute complications. This ambiguity, which should be examined in future research, makes it difficult to explain the differences in care utilization between those who did and did not receive care that met the HEDIS performance measures.

Participant proximity to a hospital may explain some of the differences in rates of diabetes-related inpatient claims across zip codes, as displayed in Figure 6. Research shows that living closer to a hospital can increase a person's utilization of hospital-based care (McGuirk & Porell, 1984). There are few hospitals in the rural zip codes in Sussex County, which show relatively low rates of inpatient claims. But rural residents have also been known to bypass their local hospital in order to receive care at more distant facilities (Radcliff, Brasure, Moscovice, & Stensland, 2003). This may be necessary for the treatment of diabetes, which can require specialized procedures that smaller rural hospitals do not provide. Additionally, urban Medicaid participants with limited transit options may not have easy access to a hospital, even if it is not very far

away. All of these factors add complexity to the interpretation of the geographic differences shown in Figure 6.

The top 10 diagnoses associated with the ED and inpatient claims of participants with diabetes all represent potential complications of the disease. Every one of the top 10 ED diagnoses can be related to having diabetes, including lower back pain (Eivazi & Abadi, 2012) and breast cancer screening (Hardefeldt, Edirimanne, & Eslick, 2012). The top 10 inpatient diagnoses also represent some of the most severe complications that can result from diabetes, such as kidney and heart failure. These diagnoses align with existing evidence on the reasons for ED visits among patients with diabetes (Washington, Andrews, & Mutter, 2013), although several of the diagnoses also rank among the most common reasons for ED visits in the total national adult population (Weiss, Wier, Stocks, & Blanchard, 2014).

Finally, the group of participants who ranked in the top 10 percent of diabetes-related inpatient claims per year has a different demographic composition than the full study sample. These higher-need diabetes patients are disproportionately Black compared to the full study sample. They are also disproportionately older and male. This higher-need subgroup has a rate of receiving all three care measures per year that is 4.6 percentage points higher than that of the total sample. This supports the idea that participants with diabetes are more likely to receive these measures when they have greater health challenges and complications.

Chapter 7

POLICY IMPLICATIONS

Based on the literature review presented earlier in this report, the Medicaid program can be said to face three distinct challenges regarding diabetes:

1. Reducing the prevalence of diabetes among Medicaid participants.
2. Improving the quality of care for Medicaid participants with diabetes.
3. Reducing the differences between subgroups of Medicaid participants in their rates of diabetes and their diabetes care quality.

This chapter presents some of the strategies being pursued by various state Medicaid programs to meet these challenges.

On one hand, certain factors constrain Medicaid's ability to address these challenges. States face federal limitations in their Medicaid policymaking, as they must receive approval from CMS for any changes to eligibility rules, covered services, benefit levels, and provider reimbursement methods. This process involves amending the state's Medicaid State Plan, which is a contract that governs the state's joint operation of Medicaid with the federal government (Mahan, 2012). Even if a state's Medicaid policy change is approved by CMS, it can face further legal and political hurdles at the state level. Many states, not including Delaware, require Medicaid policy changes to be enacted through law or statute, rather than simply regulated by the state Medicaid agency (NACHC, 2006). This means that the policy must be

approved by the state legislature, making it subject to political opposition and the procedural hindrances of the lawmaking process (KFF, 2015).

Medicaid also faces more fundamental limitations in addressing the health and care quality of its participants. The program does not directly administer health services. As an insurance plan, Medicaid pays for the services of qualified third-party vendors. This leaves Medicaid unable to completely control the nature and quality of care provided to participants, especially among fee-for-service vendors outside of MCOs, where care quality is less standardized (Roohan, Butch, Anarella, Gesten, & Shure, 2006). Medicaid is even more deeply limited in its ability to influence the health of its participants because health care accounts for only 10 percent of a person's overall health status (Schroeder, 2007). Among the myriad determinants of health, the effects of Medicaid are limited in comparison to those of personal behavior, genetic predisposition, and social/environmental circumstances. The health of Medicaid participants lies largely outside of the program's control.

Despite these limitations, Medicaid has significant leeway to take new approaches in response to the challenges of diabetes. The federal government affords states the opportunity to pilot new Medicaid policies through Section 1115 waivers. These waivers exempt states from certain federal Medicaid rules for three to five years (Hinton, Rudowitz, & Musumeci, 2017). The passage of the ACA introduced even greater state Medicaid flexibility with the advent of the Center for Medicare and Medicaid Innovation (CMMI). This CMS center works with states to test innovative payment and service delivery reforms (Berenson & Cafarella, 2012). States can

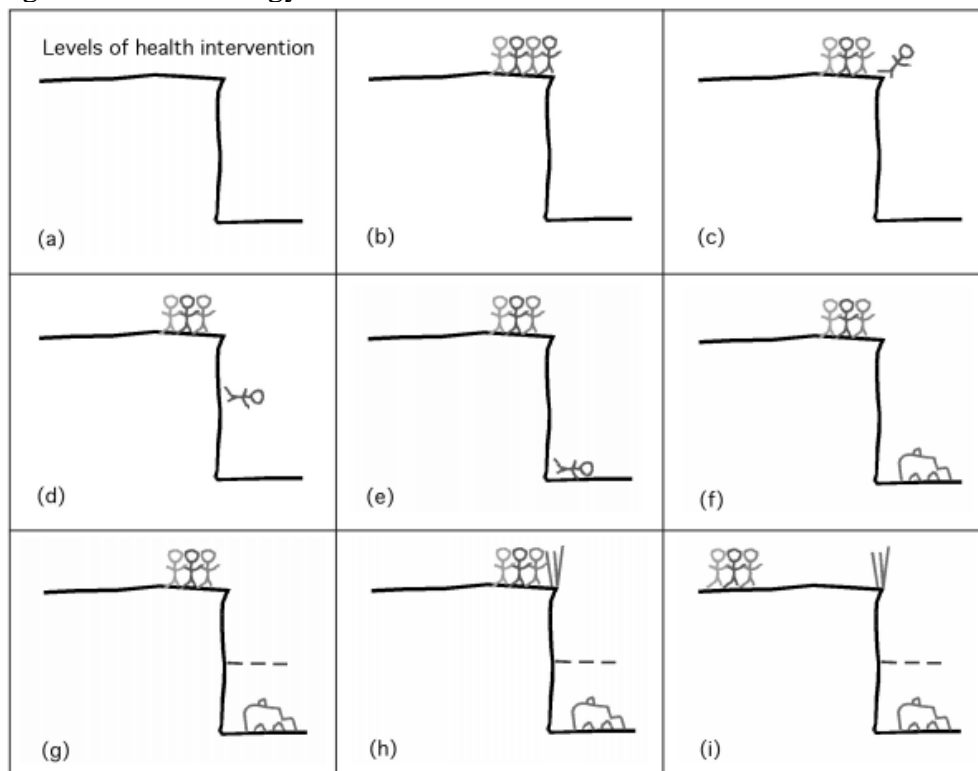
receive grant funding through this center's State Innovation Models (SIM) initiative to test new policies, as well as technical assistance through CMS's Medicaid Innovation Accelerator Program (Van Vleet & Paradise, 2014; "Medicaid Innovation Accelerator Program", n.d.). Medicaid's position as a major purchaser of health services also allows it to influence standards of health care quality. Medicaid contractually requires MCOs to achieve various quality and performance metrics (Smith et al., 2016). The leverage that Medicaid wields in specifying vendor services and standards allows it to pursue many policy goals.

The Medicaid program has the ability to employ all four of the major types of public policies, to borrow from the classic typology of governmental action in O'Hare (1989). Medicaid can, first and foremost, directly spend program funds on goods and services. This is Medicaid's primary policy lever, as it pays vendors to provide health care to participants. Second, Medicaid can monetarily reward or penalize participants and care providers in order to elicit certain outcomes. For instance, some states charge Medicaid participants higher copayments for ED visits to discourage the use of this type of care (Ollove, 2015), while CMS offers bonus payments to providers to encourage the use of electronic health records ("Medicaid electronic health record", 2013). Third, Medicaid has the power to create and enforce non-monetary rules and regulations. These include eligibility rules for participants, and standards that providers must meet in order to receive reimbursement. Fourth, Medicaid can disseminate information that educates or persuades participants. As one example, Michigan's Medicaid program sends text messages to families to remind them to

renew their enrollment (Edwards, Rodin, & Artiga, 2013). Medicaid thus has the full range of policy measures at its disposal to achieve program goals.

Medicaid's policy options to address diabetes can be organized as interventions at various points along the development of the disease, from root causes, through onset, to health complications and death. This progression of diabetes lends itself to two complementary visual frameworks of the social determinants of health, shown in Figures 7 and 8.

Figure 7 - Cliff analogy for social determinants of health

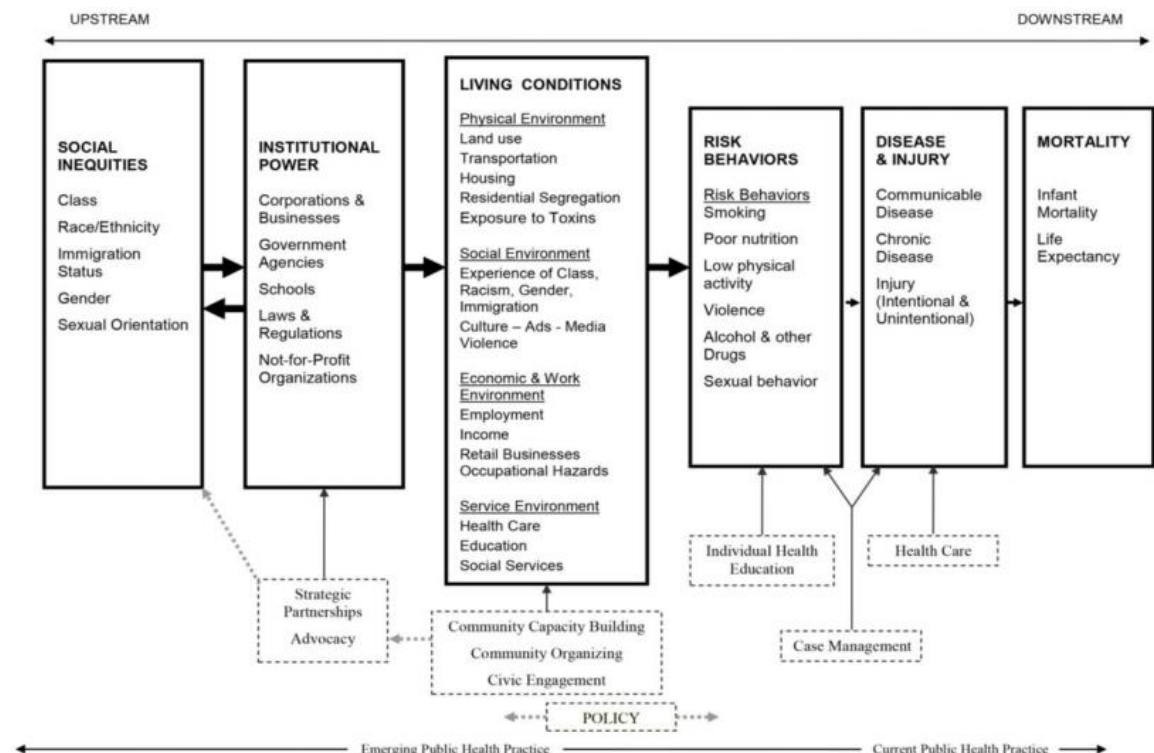


Source: Jones, Jones, Perry, Barclay, & Jones (2009).

Figure 7 uses the analogy of falling off a cliff to depict the development of a health problem. People are pushed towards the edge of the cliff by the social

determinants of health, a combination of socioeconomic, environmental, and behavioral factors. A person then develops diabetes when they plunge off the cliff, and they require health care after hitting the ground. This cliff analogy can be mapped onto another diagram of the social determinants of health (and in particular, health inequities), shown in Figure 8.

Figure 8 - Flow diagram of social determinants of health



Source: Bay Area Regional Health Inequities Initiative (2013).

Figure 8 presents the determinants of health as a continuum from upstream to downstream. The four leftmost panels represent the forces that lead a person to experience a health problem. The moment of falling off the health cliff occurs between the *risk behaviors* and *disease and injury* panels, and the two rightmost panels

describe what happens at the bottom of the cliff. Promising policy approaches exist for Medicaid to intervene at several points within this framework, in order to reduce the prevalence of diabetes among participants, optimize their care, and reduce disparities.

Reducing Prevalence of Diabetes

To reduce the prevalence of diabetes at the downstream level, Medicaid can promote primary prevention programs for participants at risk of developing the disease. This level of intervention corresponds to panel (b) in Figure 7, because it seeks to hold back the individuals who teeter at the edge of the diabetes cliff. At this stage of the analogy, people must rely on their own behavior to avoid falling, since there is no protective fence at the edge. Individual-level primary prevention involves the *risk behaviors* panel in Figure 8.

As one particularly promising policy, Medicaid could enable more at-risk participants to receive elements of a structured diabetes prevention program. Many clinical trials have demonstrated that individuals can reduce their risk of diabetes through an intensive lifestyle intervention (Diabetes Prevention Program Research Group, 2002; Pan et al., 1997; Tuomilehto et al., 2001). These clinical interventions have been translated into more informal settings to achieve similar outcomes (Johnson et al., 2013). Today, the CDC's National Diabetes Prevention Program (NDPP) is delivered in settings across the country, offering participants a standardized one-year curriculum that promotes a healthier lifestyle and weight loss. A recent evaluation found that NDPP reduced hospital care utilization in a Medicare population with prediabetes, and yielded annual savings for Medicare of \$1,112 per person (Alva,

Hoerger, Jeyaraman, Amico, & Rojas-Smith, 2017). In light of these results, the Medicare program will begin covering the cost of NDPP for all beneficiaries with prediabetes starting in 2018 (“Medicare Diabetes Prevention Program”, 2017). These beneficiaries will not pay any expense to participate in NDPP, which can cost hundreds of dollars when not covered through insurance.

However, most state Medicaid programs, including Delaware, have not yet widely adopted coverage for NDPP. Montana Medicaid has covered this benefit for high-risk participants since 2012 (Brokaw, 2014). Minnesota Medicaid is currently operating a pilot study that not only offers NDPP free of charge, but also provides incentive payments to participants who adhere to the program (Desai et al., 2017). Maryland and Oregon are in the midst of a two-year demonstration project to deliver NDPP through MCOs (“Medicaid selects MCO”, 2016). Evaluation results are forthcoming on how well these efforts lower the risk of diabetes and reduce costs for Medicaid. Diabetes prevention programs have also shown promising results when delivered in primary care clinics, and are even being adapted to digital platforms such as smartphone apps (Ma et al, 2013; Joseph, 2016). These pilot studies and innovations in program delivery will offer Medicaid an increasing range of options to reduce the prevalence of diabetes through primary prevention.

Other interventions that attempt to change the health behaviors of Medicaid participants using rewards and punishments appear to be less effective than NDPP at preventing diabetes. Between 2006 and 2011, Florida Medicaid attempted to promote healthy behaviors by offering credits that participants could use to purchase health

products. But barely half of the credits were redeemed, and the initiative had no effect on rates of chronic diseases (Blumenthal et al., 2013). Since then, CMS has awarded Medicaid grants to 10 states to test the use of financial incentives to prevent chronic disease. An interim evaluation report concludes that, so far, these incentives have had no significant effect on care utilization or expenditures (RTI International, 2016). West Virginia Medicaid has even tested the approach of requiring participants to sign a personal responsibility contract in which they promise to “do their best to stay healthy” or else lose certain program benefits (Bishop & Brodkey, 2006). Yet this policy only ended up increasing costly ED visits (Gurley-Calvez, 2012). The scant effects of these carrot-and-stick behavioral policies demonstrate the need for Medicaid to move upstream in tackling the social determinants of diabetes.

Medicaid can address the deeper causes of diabetes by providing participants with supportive services that improve their health and well-being. This midstream level of intervention is shown in panel (h) in Figure 7, where a fence is erected at the edge of the diabetes cliff to provide greater protection against falling off. This fence corresponds to the *living conditions* panel in Figure 8. For example, many Medicaid participants face unstable housing situations or even homelessness (DiPietro, Artiga, & Gates, 2014). Federal law allows Medicaid funds to be used for certain housing services, such as supportive housing for the chronically homeless (Wilkins, Burt, & Locke, 2014). An increasing number of states are using Medicaid dollars for this purpose (Paradise & Ross, 2017). Evidence suggests that improving the quality, affordability, and stability of housing can improve health outcomes (Maqbool,

Viveiros, & Ault, 2015). This makes housing a burgeoning area for Medicaid to address a deeper cause of diabetes.

Medicaid can also help reduce food insecurity, which is another social determinant of diabetes (Seligman et al., 2007). In Oregon, Medicaid care providers now have flexibility to deliver a range of social supports that are not traditionally covered by Medicaid. These supports include financial assistance to buy groceries, and vouchers to spend at farmer's markets (Spencer, Lloyd, & McGinnis, 2015). Medicaid systems can also facilitate the receipt of other food benefits. Five states are currently piloting the use of Medicaid data to automatically enroll eligible children into the National School Lunch Program (NSLP). This strategy has so far increased NSLP enrollment by up to seven percent (Hulsey et al., 2016). Medicaid resources can even be used to provide participants with work supports. Several states, including Delaware, provide disabled Medicaid participants with employment services such as job search assistance and vocational training (Schubel & Solomon, 2015). States are not allowed to spend federal Medicaid dollars on job training for non-disabled adults, but Montana uses state-only Medicaid funds to provide such participants with training and apprenticeships (Whitney, 2016). These nascent efforts show promise to help mitigate some of the hardships that can lead to diabetes.

Medicaid can also play a role in broader place-based strategies to improve the health of participants. Promising approaches in this realm involve building partnerships between Medicaid and other community organizations. In one leading example, Hennepin Health, a Medicaid MCO in Minnesota, has created an integrated

medical and social service system that connects high-need participants to an array of supports through collaborations between clinical and community health teams. Hennepin Health reduced ED visits by nine percent between 2012 and 2013, and slightly improved the average HbA1c score among participants with diabetes (Sandberg et al., 2014). In Chicago, the CommunityRx program connects Medicaid participants with nearly 15,000 community health resources using existing health records technology (Lindau et al., 2016). The Medicaid program cannot singlehandedly alter the basic socioeconomic conditions that engender diabetes, but it can indeed help catalyze broader efforts to create healthier communities.

Improving Diabetes Care

Medicaid's second diabetes challenge concerns what happens to participants after they fall off the health cliff and develop the disease. The policy options for improving diabetes care take place at the bottom of the cliff, in the *disease and injury* and *mortality* panels in Figure 8.

The first logical step in improving diabetes care is to remove participant barriers to access, because even the highest-quality services have little impact if participants cannot make use of them when they need to. This corresponds to panels (e) and (f) in Figure 7, where a person is initially lying alone at the bottom of the cliff, but then an ambulance comes to assist them. This ambulance represents access to health services for Medicaid participants with diabetes.

Reducing the churning of participants in and out of Medicaid would help improve access to diabetes care. Medicaid requires participants to immediately report

any income changes, and participants can suddenly lose coverage if their monthly income rises above the eligibility limit. Participants can also unknowingly lose coverage if they miss the annual eligibility redetermination process (Buettgens, Nichols, & Dorn, 2012). The average Medicaid participant thus only stays enrolled for eight months at a time (Ku et al., 2009). The constant exit and re-entry of participants disrupts access to preventive care. It has also been found to increase the use of hospital care for participants with diabetes (Hall, Harman, & Zhang, 2008). Medicaid churning could be ameliorated through the policy of guaranteeing 12 months of continuous eligibility from the time of enrollment. Twenty-four states already do this for child participants, but only two states, Montana and New York, currently extend this policy to adults, using Section 1115 waiver authority (Brooks, Wagnerman, Artiga, Cornachione, & Ubri, 2017). One study estimates that granting 12-month continuous eligibility to all adult participants would expand Medicaid's average monthly caseload by 15 percent (Swartz, Short, Graefe, & Uheroi, 2015). This would offer more participants the stable access to care that chronic diseases such as diabetes require. The net effect of this policy on Medicaid program costs would depend on how much it reduces administrative expenses and promotes more appropriate care utilization, compared to the higher costs of increased monthly caseloads (Swartz et al., 2015).

The unwillingness of many primary care providers to accept new Medicaid patients, often due to low reimbursement rates, poses another barrier to diabetes care. In one survey, over 90 percent of physicians reported being inadequately reimbursed by Medicaid for diabetes-related care (Pozniak, Olinger, & Shier, 2010). To improve

physician participation, the ACA required all states to raise their Medicaid primary care reimbursement rates up to the rates paid by Medicare (Tollen, 2015). This federal rule expired at the end of 2014, but the temporary boost in Medicaid payment rates was associated with a nearly eight percent increase in appointment availability in a survey of 10 states (Polsky et al., 2015). Delaware Medicaid already reimburses providers at 98 percent of Medicare rates, which is the fourth highest rate of all states (Zuckerman, Skopec, & McCormack, 2014), and any reimbursement increases would raise total program costs significantly. However, given the importance of primary care in the treatment of diabetes, states with limited appointment availability for Medicaid participants could benefit from finding ways to increase provider compensation.

The use of community health workers (CHW's) represents a third promising approach to improving access to diabetes care. CHW's are trusted community members who engage in frontline public health activities such as visiting homes, counseling peers, and arranging for medical care (AADE, 2015). CHW's address practical barriers to diabetes care, as well as cultural and linguistic barriers (Shah, Kaselitz, & Heisler, 2013; Perez-Escamilla et al., 2015). Studies of CHW-based interventions have found that they increase the use of primary care (Kangovi et al., 2014) and improve diabetes management (Han et al., 2017; Spencer et al., 2011). However, state Medicaid programs have not traditionally covered the services of CHW's. A 2013 CMS rule change has enabled Medicaid to reimburse CHW's for services recommended by a physician (Medicaid and Children's Health, 2013). An increasing number of states are now finding ways to finance CHW's through

Medicaid, mainly as part of managed care delivery reforms (Albritton, 2016). The use of CHW's for diabetes care even shows evidence of yielding cost savings for Medicaid (Fedder, Chang, Curry, & Nichols, 2003). It is thus a promising option for the program to increase access to diabetes care.

After connecting participants to diabetes care, Medicaid's next task is to ensure that the care is appropriate and of high quality. This corresponds to panel (f) in Figure 7, and concerns what happens to the person once they are inside the ambulance, which symbolizes the health care system. Medicaid and the wider health care system are currently engaged in myriad care quality improvement efforts, a full survey of which lies outside the scope of this report. However, strategies based on the Chronic Care Model show particular promise to help Medicaid improve diabetes care. According to the Chronic Care Model, the chief element of optimal care is to treat conditions in a proactive, rather than reactive, manner, in which providers collaborate to deliver team-based, coordinated care (ADA, 2016). This model seeks to eliminate the fragmentation and inefficiencies that often occur in diabetes care. In general, efforts to restructure diabetes care delivery around the Chronic Care Model have been associated with improved glycemic control, preventive screening rates, and treatment adherence (Stellefson, Dipnarine, & Stopka, 2013; Baptista et al., 2016).

The recently established Medicaid Health Homes initiative can help Medicaid align diabetes care with the Chronic Care Model. Medicaid Health Homes provide team-based coordinated care to participants who have at least one chronic condition, with a special emphasis on mental health and community supports (CMS, 2016d).

States receive an enhanced 90 percent federal matching rate for services provided through Health Homes for two years after adoption (“Health homes”, n.d.). Medicaid Health Homes have not existed long enough to produce definitive evidence of effectiveness (Spillman, Allen, & Spencer, 2015), but states such as Missouri and Vermont have reported promising effects on hospitalization rates and adherence to treatment (Schubel & Solomon, 2015). Health Homes also borrow elements from a concept called the patient-centered medical home (PCMH), which is a team-based care delivery model in which a primary care physician coordinates all patient needs (“Defining the PCMH”, n.d.). The PCMH model itself has been found to improve diabetes care quality and outcomes (Nielsen, Buelt, Patel, & Nichols, 2016).

Currently, states must amend their Medicaid State Plans to establish a Health Homes program, which 19 states have done as of late 2016 (CMS, 2016d). Yet states can also use other Medicaid policy levers to encourage diabetes care coordination. Capitated payments already give MCOs a financial incentive to coordinate care. States can strengthen this incentive by paying MCOs fixed per-participant amounts that cover even longer time periods, such as a year, and allowing the MCO to keep a share of unspent funds. These are known as global or total-cost-of-care payments (Silow-Carroll, Edwards, & Rodin, 2013). Medicaid can also incentivize care quality by tying reimbursement to the achievement of clinical outcome measures (Leddy, McGinnis, & Howe, 2016). These payment methods must strike a balance between cost control and care quality. Nevertheless, their use will likely increase as Medicaid faces a mounting cost burden from chronic diseases.

After improving access to and coordination of care, a third domain for optimizing diabetes care involves the use of self-management education to help participants avoid complications. This corresponds to panel (g) of Figure 7, where a net is built on the side of the cliff. This net symbolizes self-care, because it cushions the impact of falling off the diabetes cliff and lessens the need for medical attention. The ADA considers diabetes self-management education (DSME) to be a cornerstone of effective treatment of the disease (Haas et al., 2014). DSME teaches patients crucial self-care behaviors such as healthy eating, blood glucose monitoring, and proper use of medications. DSME can be delivered in one-on-one or group settings in a variety of venues. The content follows a nationally standardized curriculum that is revised every five years by key stakeholders (Haas et al., 2014). Research shows that DSME improves patients' glycemic control in a dose-response manner (Chrvala, Sherr, & Lipman, 2016). The majority of private health insurance plans cover DSME, and Medicare pays for up to 10 hours of DSME in the first year after doctor referral (ChangeLab Solutions, n.d.). DSME classes often cost money to attend when not covered by insurance (Garfield, 2015).

However, only 33 states currently cover DSME under Medicaid, with Delaware not among them (Cauchi et al., 2016). Studies have found that as few as three percent of Medicaid participants with diabetes receive any structured DSME (New York State Department of Health, 2015), and participants have reported that the cost of DSME classes poses a barrier to attendance (Peyrot & Rubin, 2008). Medicaid could therefore potentially increase the receipt of DSME by providing greater

coverage for the service. Research shows that DSME yields benefits that outweigh the costs (i.e. *cost effective*) (Boren, Fitzner, Panhalkar, & Specker, 2009; Li, Zhang, Barker, Chowdhury, & Zhang, 2010), with some studies even finding it to reduce overall per capita expenditures for Medicaid (i.e. *cost saving*) (Balamurugan, Ohsfeldt, Hughes, & Phillips, 2003). Several states have recently adopted Medicaid coverage for DSME after projecting significant savings (CDC, 2016c). This makes DSME a promising avenue for Medicaid to improve diabetes care.

Medicaid can also facilitate access to elements of DSME through other modes of delivery besides standalone classes. DSME lessons can be embedded in hospital care for diabetes complications, where it shows promise to reduce future hospitalizations (Magee, Khan, Desale, & Nassar, 2014). It can also be streamlined for delivery in primary care settings, which has also shown positive results (Chomko, Odegard, & Evert, 2016). Elements of DSME can even be delivered over the phone, such as through automated reminders to stay physically active or adhere to one's medication. Telephone-based DSME has been found to reduce acute care utilization in an urban Medicaid population (Quan et al., 2015). This is an especially low-cost way to expose a greater number of Medicaid participants to DSME.

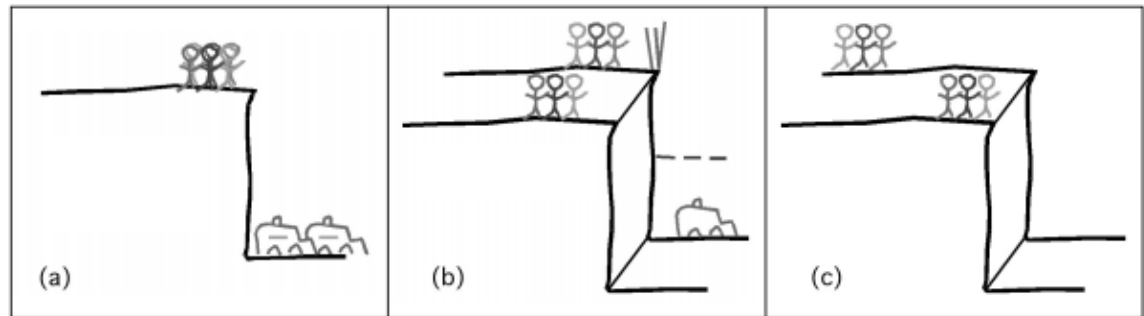
In sum, many policy options exist for Medicaid to optimize diabetes care by reducing barriers to access, improving coordination, and promoting self-management.

Reducing Disparities in Diabetes Prevalence and Care Quality

As observed in this report and other studies, there are disparities in diabetes prevalence and care quality across Medicaid participant subgroups. To demonstrate

the concept of health disparities, Jones et al. (2009) expand the cliff analogy to a third dimension, as shown in Figure 9.

Figure 9 - Three-dimensional cliff analogy for health disparities



Source: Jones, Jones, Perry, Barclay, & Jones (2009).

Figure 9 depicts how various sub-populations, in this case sub-populations within the Medicaid program, can have differing levels of protection from falling off the diabetes cliff. They may also have differing levels of health resources at the bottom of the cliff. These disparities occur in the general public as well, but they are more striking when observed within Medicaid, since Medicaid offers all participants a baseline level of access to affordable care.

In many ways, the aforementioned Medicaid policy options for improving diabetes prevention and care quality can also serve to reduce disparities. For example, prevention strategies that address each individual's unique unmet socioeconomic needs, such as food or housing, tend to direct resources to those who need them the most. This should, in theory, work to equalize the prevalence of diabetes across social groups. Care quality efforts can promote equity as well. A study of patient-centered medical homes found that they help reduce racial/ethnic disparities in access to care (Beal, Doty, Hernandez, Shea, & Davis, 2007). The use of community health workers

has shown similar effects (Cosgrove et al., 2014). DSME programs can also target specific communities and cultural contexts, improving care for certain demographic groups (Peek, Ferguson, Roberson, & Chin, 2014). In these ways, improving population health goes hand in hand with improving health equity.

However, some of the Medicaid policies for addressing diabetes may not be sufficient to reduce disparities among participants. Several diabetes management programs for Medicaid participants have shown to improve aggregate outcomes without improving racial/ethnic disparities (Meng et al., 2016; Kominski, Morisky, Afifi, & Kotlerman, 2008). Medicaid pay-for-quality initiatives may even make disparities worse. Unless vulnerable participant groups are properly risk-adjusted, these initiatives may end up penalizing providers for serving participants with higher needs, because these participants may not achieve the same clinical measures as others (Casalino et al., 2007). This unintended consequence has yet to be observed within current Medicaid payment reforms. However, the fact remains that unacceptably large diabetes-related disparities have persisted across Medicaid subgroups after decades of health care improvement efforts. This suggests that more deliberate efforts are needed to close the gaps.

A first step is to improve the collection of data on participant race, ethnicity, language preference, and social needs. This is a crucial starting point, because it can help discover the existence of disparities in the first place. CMS already requires states to collect basic data on participant race/ethnicity. But states could require providers to collect and report a more standardized and comprehensive set of information. This

could involve enhancing the requirements set forth in MCO contracts, providing data collection training to frontline staff, and improving data management systems (National Academy of Medicine, 2009). Several states offer promising examples of leveraging data to improve diabetes outcomes for minority Medicaid participants (Llanos & Palmer, 2006). In 2010, Massachusetts Medicaid used HEDIS measures to identify a disparity in blood pressure control between Black and White participants with diabetes, and then cut the disparity in half in ensuing years through a targeted outreach campaign (Menges Group, 2014).

Second, diabetes prevention and treatment efforts should be culturally and linguistically appropriate for the groups that they serve. Studies show that community-based diabetes programs produce better outcomes when they are tailored to participants' racial/ethnic backgrounds (Zeh, Sandhu, Cannaby, & Sturt, 2012). Cultural competency should also extend into clinical care, as diabetes requires a relationship between the physician and patient that fosters shared goal setting and close communication. Strategies to achieve this can include expanding the use of interpreters and translators, and providing education and professional development for clinical staff (HHS, 2011). Additionally, there is evidence that cognitive bias and stereotyping influences physicians' treatment of minority patients (Smedley et al., 2003; Burgess, Fu, & van Ryn, 2004). Building a more diverse and culturally concordant health workforce would help ensure that minority patients do not receive inferior care because of their appearance or background. This broad goal cannot be

addressed by Medicaid alone, and will require efforts that span the entire health care system.

Third, Medicaid can make use of financial incentives for MCOs to reduce racial/ethnic disparities, such as by tying reimbursement levels to the achievement of disparity reduction metrics (Chien & Chin, 2008). MCOs can provide enhanced services to minority participants who show lower rates of diabetes preventive care. MCOs have successfully employed this strategy in states such as New York and Oregon to reduce diabetes disparities across Medicaid subgroups (Martin, 2007). The overarching idea behind these strategies is to distribute health resources in a progressive and equitable manner, so that the people and communities with the greatest needs receive the most assistance. Ultimately, the diabetes disparities among Medicaid participants result from entrenched socioeconomic inequities that Medicaid cannot resolve by itself. However, the above policies show promise to reduce disparities as part of Medicaid's broader efforts to meet the challenges posed by diabetes.

Chapter 8

RECOMMENDATIONS, STRENGTHS AND LIMITATIONS, AND CONCLUSION

Recommendations for Delaware

Several recommendations follow from the findings of this report. First, Delaware officials should examine in greater detail the results that stand out in the claims analysis. For example, the zip codes that had the lowest and highest rates of diabetes warrant a closer look, because they may indicate communities where Medicaid participants are facing greater health challenges. This closer look could involve exploring the social and environmental factors in these zip codes that may be influencing participant health. The racial/ethnic group disparities should also be investigated, such as the difference in HbA1c test receipt rates between White and Black participants. This investigation could help improve the state's understanding of how and why different racial/ethnic groups within Delaware's Medicaid program may have varying levels of access to appropriate diabetes care. This could help inform state strategies to improve care and reduce gaps in access.

Second, Delaware Medicaid should replicate this report's claims data analyses on an annual basis, in order to monitor emerging trends. This would allow Medicaid to keep track of, among other things, the upward trend in overall diabetes prevalence that has been occurring since 2010, and the potential impacts of any efforts aimed at

improving care for individuals with diabetes. The sudden uptick in diabetes among Hispanic Medicaid participants in 2015 also warrants ongoing attention, as does the general rise in the per capita volume of ED and inpatient claims over time (which may be partly due to changes in provider reporting practices). More ambitiously, claims data could even form the basis of an analytic dashboard that allows Delaware to continuously track the health status of its Medicaid participants. Delaware should explore the possibilities for making greater use of claims data in its routine surveillance of population health, particularly among its low-income population.

Third, Delaware should incorporate Medicaid claims-based findings into its next update of the *Burden of Diabetes in Delaware* report. This aligns with Objective 1 in the Epidemiology and Surveillance section of the Delaware Diabetes Coalition's *Plan to Prevent and Control Diabetes in Delaware*. This objective states that “data will be utilized from the Behavioral Risk Factor Surveillance System, Medicaid, Federally Qualified Health Centers, vital statistics, hospital discharge data, and chief complaint data for updating and producing the annual Burden of Diabetes in Delaware statewide report” (Delaware Diabetes Coalition, 2013, p. 25). Medicaid participants with diabetes are among Delaware's most socioeconomically vulnerable individuals with diabetes. They merit greater attention in the state's public documentation of the disease.

Finally, this report did not survey Delaware's current Medicaid and diabetes policy landscape in enough depth to be able to put forth detailed policy recommendations. Delaware is currently undertaking significant efforts to transform

its health care system in pursuit of the Triple Aim. These efforts touch on many aspects of health care that can address diabetes, such as care coordination and delivery, provider payment incentives, and community health interventions. As one of the most serious socially determined health conditions, diabetes should be used as a reference point in the formulation of Delaware's new approaches to population health.

Strengths and Limitations of Medicaid Claims Analysis

The use of Medicaid claims data to investigate disease prevalence and care quality has methodological strengths and limitations that merit discussion.

Medicaid claims offer certain comparative advantages over other data sources. They cover a very large number of individual lives, which offers the statistical power required for detecting uncommon health conditions and disparities across small subgroups (Crystal, Akincigil, Bilder, & Walkup, 2007). They also include socioeconomically vulnerable individuals who are often underrepresented in clinical trials or private insurance claims. This is important when examining conditions like diabetes that correlate with lower SES (Crystal et al., 2007).

Medicaid claims have some advantages over health survey data. They avoid the self-reporting and non-response biases inherent in surveys, by stemming directly from provider records (Baron & Weiderpass, 2000). Individual claims can be aggregated to produce small-area geographic estimates. This improves upon health surveys such as the National Health Interview Survey, which is not powered to yield credible estimates below the regional level (NCHS, 2016). Medicaid claims also capture the experiences of individuals who are difficult to reach through surveys and

interviews, such as those with cognitive impairments or unstable housing arrangements (Crystal et al., 2007). The dates of service in claims data allow individuals to be tracked over time, which goes beyond the cross-sectional structure of large health surveys such as the Behavioral Risk Factor Surveillance System (BRFSS). Claims data can also be linked to other external data sources such as the U.S. Census Bureau or vital statistics records (“Strengths and limitations”, 2012). This opens up many analytical possibilities.

Claims also offer certain advantages over patient medical records. Medical records do not always follow a consistent format. Not all care providers collect the same medical information, and this information may not be shared between providers. Medical records therefore contain gaps in the documentation of a patient’s health history and receipt of care. These gaps can be especially problematic when profiling patients with diabetes, who often receive care from several different providers (Wilson & Bock, 2014). Additionally, many providers have not fully adopted the use of electronic medical records (Hsiao & Hing, 2014). Hard copy records are more difficult to use for research purposes, since they require more labor-intensive extraction of information (Ferver, Burton, & Jesilow, 2009). Claims data avoid many of these challenges by electronically logging every service encounter across all covered providers.

On the other hand, Medicaid claims have important challenges and limitations for use in health research. Claims are created solely to obtain reimbursement from Medicaid, and are not designed for research purposes. The information that they

provide regarding a patient's health status is limited to diagnosis codes and procedure codes. Claims lack the clinical detail of medical records, which provide richer information such as vital signs, symptoms, laboratory results, and patient health habits (Wilson & Bock, 2014).

The billing purpose of Medicaid claims can also lead to incomplete or inaccurate reporting. Fee-for-service providers have been found to underreport procedures that Medicaid does not reimburse (Steinwachs et al., 1998). They may also bundle multiple procedures into a single claim that leaves out details of the encounter (Ferver et al., 2009). Moreover, the billing clerks who create the claims must use their judgment in applying the proper codes to diagnoses and procedures. Coding errors can result from this human element (Tyree, Lind, & Lafferty, 2006; Bright, Avorn, & Everitt, 1989). Managed care encounter claims show even greater variation in accuracy and completeness. Managed care providers do not need to submit claims for payment, since they receive a fixed capitation. Therefore, they sometimes lack the billing incentive to report all encounters. At least 19 states, including Delaware, reported incomplete encounter data to CMS in 2011 (Murrin, 2015). The incompleteness of Medicaid managed care encounter data has been recognized as a growing challenge for researchers, as an increasing number of participants are being covered through managed care (Byrd & Dodd, 2015; Sing, 2004).

Medicaid claims have other limitations for exploring participants' health and utilization of care. They do not capture services that are not covered by Medicaid, such as care received in charity clinics. Likewise, they do not reflect the health

experiences of participants during any gaps in enrollment. Medicaid claims also do not capture participants who do not utilize any health care. This likely skews the analytic sample towards participants with greater health needs, since the healthiest participants may not have any claims. Findings from Medicaid claims data cannot necessarily be generalized to other populations, such as those with Medicare or private insurance. And the analysis in this report covers only the state of Delaware, which may not be characteristic of other states. Extrapolation to other settings should thus be made with caution.

The vast majority of the claims analyzed in this report come from managed care encounters. This means that they cannot be used to estimate the costs of care. As mentioned in Chapter 4, the amounts billed for managed care encounters do not reflect the true cost to Medicaid, since Medicaid pays a fixed capitation rate to MCOs; nor do these billed amounts necessarily indicate the costs incurred by the MCOs themselves. Some studies have sought to impute MCO costs of care based on Medicaid fee-for-service schedules, but this requires assumptions about how MCOs reimburse providers (Hilltop Institute, 2016).

The zip code aggregations in this report have limited interpretive value for two reasons. First, zip codes can encompass broad geographies that contain both rural and urban communities. This may hide meaningful variation across smaller areas that better correspond to distinct communities. Second, zip code boundaries are imperfect spatial approximations that do not necessarily represent the true location of individual addresses. This geographic ambiguity can hinder the spatial analysis of health data

(Grubestic & Matisziw, 2006). Future research could expand on this report's geographic analysis by geocoding Medicaid participant addresses by census tract, which are more stable and granular geographies than zip codes (Coburn et al., 2007). All of these strengths and limitations of Medicaid claims must be weighed when considering the use of these data for research purposes.

The methods used to identify participants with diabetes have limitations as well. The restriction of the sample to participants ages 18 to 64 does not capture the full burden of diabetes for Medicaid, since many elderly participants and some children have the disease as well. Also, claims data cannot identify participants who have undiagnosed diabetes, which comprises 30 percent of all cases (Ali et al., 2014).

The HEDIS criteria likely underestimate the prevalence of diabetes for several reasons. First, the criteria err on the side of avoiding false positive detection (i.e. higher *specificity*) rather than false negatives (i.e. higher *sensitivity*), especially with the requirement of having two separate diabetes-related non-acute care encounters. HEDIS-like algorithms have been found to miss 10 to 25 percent of diabetes cases when compared to patient self-reports or medical records (Hebert et al., 1999; Miller, Safford, & Pogach, 2004; Rector et al., 2004). In the present study, the overall prevalence of diabetes increases to 12.4 percent when using an alternative method that only requires a single diabetes-related claim.

Second, the HEDIS diabetes scenario 2 uses CPT codes to identify acute inpatient claims, but 28,447 claims in the study data had missing CPT codes. This likely caused some acute inpatient diabetes claims to go undetected. Third, the HEDIS

criteria consider a patient to have diabetes for only one year beyond the year of the identifying claims. In subsequent years, the patient must satisfy the criteria again to be re-counted as having diabetes, even though they still in all likelihood have the disease. This two-year diabetes window serves to reduce the calculated year-to-year prevalence rates. Fourth, injectable insulin was excluded from the HEDIS diabetes drug codes in order to avoid capturing participants who have type 1 diabetes. But this likely caused some type 2 participants to be excluded as well, since they too can be prescribed injectable insulin.

The HEDIS diabetes care receipt rates found in this report are also likely underestimated, due to the significant number of missing CPT codes in the claims data. As a method of operationalizing diabetes care quality, these performance measures also fail to capture many aspects of diabetes treatment. They do not include certain ADA-recommended preventive procedures, such as a foot examination or cholesterol screening (ADA, 2017, p. S27), with the latter having been removed from the HEDIS criteria in 2015 (“NCQA updates”, 2014). Despite these omissions, at least one study has found that receiving the HEDIS care measures correlates with improved diabetes outcomes (Harman et al., 2010). Another limitation is that, as explained in Chapter 4, the HEDIS HbA1c score measure could not be ascertained from the claims data. Even if it could be ascertained, the ADA cautions that the 8.0 percent threshold is somewhat arbitrary and may not be appropriate for every patient, depending on their personal treatment goals (O’Connor et al., 2011). Most importantly, the HEDIS performance measures do not account for the myriad factors involved in treating a

disease as complex as diabetes. No two cases of diabetes are exactly alike, and treatment quality depends on each patient's unique priorities, circumstances, and health needs, none of which are conveyed within a Medicaid claim.

Finally, it must be noted that the analyses in this report are strictly observational. No statistical adjustments were made for potential confounding variables. The results therefore do not permit a causal interpretation.

Conclusion

Diabetes is a pressing public health issue in the U.S and the state of Delaware. The disease can bring severe health complications for the individual. It also imposes a shared economic burden on the general public in the form of higher health care spending and lower productivity, and diminishes aspects of community wellness. On the surface, diabetes results from behavioral risk factors related to obesity. However, these behaviors have roots in the modern diet, the built environment, and other underlying social and economic structural factors. Diabetes also disproportionately afflicts racial/ethnic minorities and individuals of low socioeconomic status.

The Medicaid program plays a key role in financing and facilitating the treatment of diabetes in America. Yet Medicaid's delivery of diabetes care has many problems, including a lack of coordination between providers, and inappropriate use of ED and inpatient hospital care. This increases Medicaid expenditures without translating into improved patient health outcomes. These challenges not only strain the resources of the Medicaid program, but also affect the quality of care received by participants with diabetes.

In light of these challenges, this thesis used claims data to examine the trends and disparities in diabetes prevalence and care utilization among Delaware's Medicaid population. The results suggest that Delaware faces similar diabetes-related Medicaid challenges as have been documented nationally. Delaware Medicaid participants showed a prevalence of diabetes that is most likely higher than that of the state's general population. Some racial/ethnic minority participant groups had higher rates of diabetes than White participants. Delaware Medicaid participants with diabetes showed mixed results in their receipt of three standard elements of diabetes care. They ranked well above the national rate of eye exams, slightly below the national rate of kidney screenings, and well below the national rate of blood glucose testing; though these also varied by race/ethnicity. Finally, the per capita volume of ED and inpatient hospital care has risen over time, and exhibits disparities depending on participant age, sex, race/ethnicity, and place of residence that warrant additional investigation.

This thesis offers a preliminary glimpse into the prevalence and treatment of diabetes among Delaware's Medicaid population. This comes at a time when Delaware is transforming its health care system to achieve the Triple Aim, including better addressing the social determinants of health. Diabetes is one of the most serious socially determined health conditions, and the disease must be kept at the forefront of Delaware's health reform efforts. The findings presented in this thesis offer many important considerations and promising strategies that can strengthen collective efforts to tackle the challenges of diabetes in Delaware and the wider nation.

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Appendix A

LITERATURE REVIEW METHODOLOGY

The literature cited in Chapters 2, 3, 4, and 7 was identified primarily through electronic searches using the University of Delaware library's DELCAT Discovery search portal, which queries the library's entire print and digital collection. See the table below for specific search terms that were used in each chapter. These same terms were also searched in Google to identify any grey literature that is not contained in library databases, such as non-peer-reviewed publications from government agencies or organizations such as the American Diabetes Association.

Chapter	Topic	Search terms
2	What is diabetes?	"Type 2 diabetes" + "what is", "symptoms", "diagnosis", "complications", "prognosis"
2	Risk factors	"Type 2 diabetes" + "risk factors", "causes", "behaviors", "genetic", "predisposition"
2	Treatment	"Type 2 diabetes" + "treatment", "management", "medication", "self-care", "cure"
3	Prevalence	"Type 2 diabetes" OR "prediabetes" + "prevalence", "incidence", "rates", "trends", "burden", "public health issue"
3	Upstream factors	"Type 2 diabetes" + "upstream factors", "root causes", "social causes", "cultural", "environmental", "ecological"
3	Inequities	"Type 2 diabetes" + "inequities", "inequalities", "equity", "distribution", "socioeconomic", "disparities", "social determinants"
3	Public consequences	"Type 2 diabetes" + "public consequences", "social consequences", "social costs", "economic costs", "community health", "rights", "liberties"
4	Medicaid overview	"Medicaid" + "overview", "eligibility", "coverage", "size", "expansion", "state policies"
4	Medicaid and diabetes	"Medicaid" AND "diabetes" + "insurance", "prevention", "treatment", "care", "costs", "quality", "access", "utilization"
4	Medicaid claims data	"Medicaid" + "claims data", "research", "diabetes", "care utilization"
7	Policy implications	"Medicaid" AND "diabetes" + "policy implications", "reduce prevalence", "improve care quality", "reduce disparities"
All	Diabetes in Delaware	"Type 2 diabetes" + "Delaware"
All	Medicaid in Delaware	"Medicaid" + "Delaware"

Using the sources found through these searches, additional literature was then identified through the snowballing method (Rashid, n.d.). This involved looking through the source citations and bibliographic references to identify other studies that appeared relevant, and then obtaining the full text of these studies and looking through their source citations. This process was repeated for each topic until it seemed that no new studies could be found.

When considering literature for inclusion in this review, priority was given to studies that were peer-reviewed and published in scholarly journals, were conducted in the United States, and were originally written in English. Several of the topics discussed in these chapters are rapidly evolving with new literature, such as the genetic risk factors of diabetes, or the disease's potential reversibility. To reflect the most current understanding on these topics, priority was given to studies published as recently as possible.

Appendix B

DETAILS OF CALCULATIONS OF TOTAL U.S. AND DELAWARE MEDICAID SPENDING ON DIABETES

1) 50 states' total Medicaid spending on diabetes in 2015 =
 $[(73,861,837 * 0.57) * (0.115) * (\$13,490)] + [(73,861,837 * 0.43) * (0.00046) * (\$13,490)] = \mathbf{\$65,510,856,700}$

Where:

- 73,861,837 is the total Medicaid enrollment in the 50 U.S. states as of December 2015 (CMS, 2016b).
- 0.57 is the 2015 proportion of participants who are adults (CBPP, 2016).
- 0.115 is the 2015 national rate of diabetes among nonelderly adults on Medicaid (CDC, 2015b). A separate rate for elderly adults on Medicaid could not be found.
- \$13,490 is the national per capita cost of diabetes on Medicaid in 2009, the most recent year for which data is available (KFF, 2012a).
- 0.43 is the 2015 proportion of participants who are children (CBPP, 2016).
- 0.00046 is the national rate of diabetes among all children in 2009, the most recent year for which data is available (Dabelea et al., 2014). The rate of diabetes among children on Medicaid could not be found.

2) Percentage of 50 states' total Medicaid spending that was devoted to diabetes in 2015 = $\$65,510,856,700 / \$532,233,348,782 = \mathbf{12.3\%}$

Where:

- \$65,510,856,700 is the result from calculation 1) above
- \$532,233,348,782 is the 50 states' total Medicaid spending in 2015 ("Total Medicaid spending", 2017).

3) Delaware total Medicaid spending on diabetes in 2015 =
 $[(210,636 * 0.57) * (0.115) * (\$13,490)] + [(210,636 * 0.43) * (0.00046) * (\$13,490)] = \mathbf{\$186,820,225}$

Where:

- 210,636 is the total Medicaid enrollment in Delaware as of December 2015 (CMS, 2016b).
- All other numbers are the same as in calculation 1) above

Appendix C

DATA USED IN CLAIMS ANALYSIS

Variable	Source file	Description
Participant ID	Supplemental, eligibility, medical, and drug claims files	Unique participant ID number (Provided to author in lieu of official Medicaid ID number per agreement with DMMA)
Participant sex	Supplemental file	The participant's sex, as listed in the Medicaid enrollment file
Participant race/ethnicity	Supplemental file	The participant's race/ethnicity, as listed in the Medicaid enrollment file. Values include: <ul style="list-style-type: none"> - Asian or Pacific Islander - Black - Caucasian - Subcontinent Asian - Asian Pacific American - Native American - Hispanic or Latino - American Indian or Alaskan - Native Hawaiian - Black (non-Hispanic) - White (non-Hispanic) - Pacific Islander - Other race/ethnicity
Months enrolled (separate variables for each fiscal year)	Eligibility file	The number of months that the participant was enrolled in Medicaid in a given fiscal year. (Provided to author in lieu of exact enrollment dates per agreement with DMMA)
Procedure code	Medical claims file	CPT code that indicates the procedure performed during the encounter
Diagnosis code	Medical claims file	ICD-9 code that indicates the medical diagnosis associated with the encounter
Drug manufacturer code	Drug claims file	Digits 1 – 5 of the National Drug Code. Identifies the manufacturer
Drug code	Drug claims file	Digits 6 – 9 of the National Drug Code. Identifies the drug.

Drug package size	Drug claims file	Digits 10 – 11 of the National Drug Code. Identifies the package size.
Claim ID	Medical and drug claims files	Unique identifier for each claim
Fiscal year of service	Medical and drug claims files	The fiscal year in which the encounter took place (Provided to author in lieu of exact date of service per agreement with DMMA)
Order of claim	Medical and drug claims files	Numeric identifier of chronological order of claims. (Provided to author in lieu of exact date of service per agreement with DMMA)
Place of service	Medical and drug claims files	<p>The type of venue where the encounter took place. Values include:</p> <ul style="list-style-type: none"> - Retail Pharmacy - School - Homeless Shelter - Indian Health Service Free-standing Facility - Indian Health Service Provider-based Facility - Tribal 638 Free-standing Facility - Tribal 638 Provider-based Facility - Office - Home - Mobile Unit - Inpatient Hospital - Outpatient Hospital - Emergency Room – Hospital - Ambulatory Surgical Center - Birthing Center - Military Treatment Facility - Skilled Nursing Facility - Nursing Facility - Custodial Care Facility - Hospice - Ambulance – Land - Ambulance - Air or Water - Federally Qualified Health Center - Inpatient Psychiatric Facility - Psychiatric Facility - Partial Hospitalization - Community Mental Health

		Center - Intermediate Care Facility/Mentally Retarded - Residential Substance Abuse Facility - Psychiatric Residential Center - Mass Immunization Center - Comprehensive Inpatient Rehabilitation Facility - Comprehensive Outpatient Rehabilitation Facility - End-Stage Renal Disease Treatment Center - State or Local Public Health Clinic - Rural Health Center - Independent Lab - Unlisted Facility
Participant age	Medical and drug claims files	The participant's age at the time of the encounter

Appendix D

VALUES USED IN CLAIMS ANALYSIS

Table D1 – Values used to identify participants with diabetes in medical claims

Variable	Value
Diagnosis code	250
Diagnosis code	250.02
Diagnosis code	250.1
Diagnosis code	250.12
Diagnosis code	250.2
Diagnosis code	250.22
Diagnosis code	250.3
Diagnosis code	250.32
Diagnosis code	250.4
Diagnosis code	250.42
Diagnosis code	250.5
Diagnosis code	250.52
Diagnosis code	250.6
Diagnosis code	250.62
Diagnosis code	250.7
Diagnosis code	250.72
Diagnosis code	250.8
Diagnosis code	250.82
Diagnosis code	250.9
Diagnosis code	250.92

Table D2 - Values used to classify claim types

Type of claim	Variable	Value
Prescription drug	Claim type code	D - Drug or P - Pharmacy crossover
Physician office	Place of service code	11 - Office
ED method 1	Place of service code	23 - Emergency room
ED method 2	Place of service code	22 - Outpatient hospital and a value of O - Outpatient
Inpatient hospitalization	Place of service code Claim type code	21 - Inpatient hospital and a value of either: I - Inpatient or M - HCFA or Y - Professional crossover
Acute inpatient hospitalization	Procedure code	99221 99222 99223 99231 99232 99233 99238 99239 99251 99252 99253 99254 99255 99291

Table D3 - Values used to assess HEDIS diabetes care quality performance measures

Performance measure	Variable	Value
HbA1c test	Procedure code	83036
HbA1c test	Procedure code	83037
HbA1c test (result < 7.0%)	Procedure code	3044F
HbA1c test (result 7.0% - 9.0%)	Procedure code	3045F
HbA1c test (result > 9.0%)	Procedure code	3046F
Retinal eye exam	Procedure code	67028
Retinal eye exam	Procedure code	67030
Retinal eye exam	Procedure code	67031
Retinal eye exam	Procedure code	67036
Retinal eye exam	Procedure code	67039
Retinal eye exam	Procedure code	67040
Retinal eye exam	Procedure code	67041
Retinal eye exam	Procedure code	67042
Retinal eye exam	Procedure code	67043
Retinal eye exam	Procedure code	67101
Retinal eye exam	Procedure code	67105
Retinal eye exam	Procedure code	67107
Retinal eye exam	Procedure code	67108
Retinal eye exam	Procedure code	67110
Retinal eye exam	Procedure code	67112
Retinal eye exam	Procedure code	67113
Retinal eye exam	Procedure code	67121
Retinal eye exam	Procedure code	67141
Retinal eye exam	Procedure code	67145
Retinal eye exam	Procedure code	67208
Retinal eye exam	Procedure code	67210
Retinal eye exam	Procedure code	67218
Retinal eye exam	Procedure code	67220
Retinal eye exam	Procedure code	67221
Retinal eye exam	Procedure code	67227
Retinal eye exam	Procedure code	67228
Retinal eye exam	Procedure code	92002
Retinal eye exam	Procedure code	92004
Retinal eye exam	Procedure code	92012
Retinal eye exam	Procedure code	92014
Retinal eye exam	Procedure code	92018
Retinal eye exam	Procedure code	92019
Retinal eye exam	Procedure code	92134
Retinal eye exam	Procedure code	92225
Retinal eye exam	Procedure code	92226
Retinal eye exam	Procedure code	92227
Retinal eye exam	Procedure code	92228
Retinal eye exam	Procedure code	92230
Retinal eye exam	Procedure code	92235
Retinal eye exam	Procedure code	92240
Retinal eye exam	Procedure code	92250

Retinal eye exam	Procedure code	92260
Retinal eye exam	Procedure code	99203
Retinal eye exam	Procedure code	99204
Retinal eye exam	Procedure code	99205
Retinal eye exam	Procedure code	99213
Retinal eye exam	Procedure code	99214
Retinal eye exam	Procedure code	99215
Retinal eye exam	Procedure code	99242
Retinal eye exam	Procedure code	99243
Retinal eye exam	Procedure code	99244
Retinal eye exam	Procedure code	99245
Retinal eye exam	Procedure code	3072F
Retinal eye exam	Procedure code	2022F
Retinal eye exam	Procedure code	2024F
Retinal eye exam	Procedure code	2026F
Medical attention for nephropathy	Diagnosis code	38.95
Medical attention for nephropathy	Diagnosis code	39.27
Medical attention for nephropathy	Diagnosis code	39.42
Medical attention for nephropathy	Diagnosis code	39.43
Medical attention for nephropathy	Diagnosis code	39.53
Medical attention for nephropathy	Diagnosis code	39.93
Medical attention for nephropathy	Diagnosis code	39.94
Medical attention for nephropathy	Diagnosis code	39.95
Medical attention for nephropathy	Diagnosis code	54.98
Medical attention for nephropathy	Diagnosis code	55.61
Medical attention for nephropathy	Diagnosis code	55.69
Medical attention for nephropathy	Diagnosis code	250.4
Medical attention for nephropathy	Diagnosis code	250.41
Medical attention for nephropathy	Diagnosis code	250.42
Medical attention for nephropathy	Diagnosis code	250.43
Medical attention for nephropathy	Diagnosis code	403
Medical attention for nephropathy	Diagnosis code	403.01
Medical attention for nephropathy	Diagnosis code	403.1
Medical attention for nephropathy	Diagnosis code	403.11
Medical attention for nephropathy	Diagnosis code	403.9
Medical attention for nephropathy	Diagnosis code	403.91
Medical attention for nephropathy	Diagnosis code	404
Medical attention for nephropathy	Diagnosis code	404.01
Medical attention for nephropathy	Diagnosis code	404.02
Medical attention for nephropathy	Diagnosis code	404.03
Medical attention for nephropathy	Diagnosis code	404.1
Medical attention for nephropathy	Diagnosis code	404.11
Medical attention for nephropathy	Diagnosis code	404.12
Medical attention for nephropathy	Diagnosis code	404.13
Medical attention for nephropathy	Diagnosis code	404.9
Medical attention for nephropathy	Diagnosis code	404.91
Medical attention for nephropathy	Diagnosis code	404.92
Medical attention for nephropathy	Diagnosis code	404.93
Medical attention for nephropathy	Diagnosis code	405.01

Medical attention for nephropathy	Procedure code	90960
Medical attention for nephropathy	Procedure code	90961
Medical attention for nephropathy	Procedure code	90962
Medical attention for nephropathy	Procedure code	90965
Medical attention for nephropathy	Procedure code	90966
Medical attention for nephropathy	Procedure code	90969
Medical attention for nephropathy	Procedure code	90970
Medical attention for nephropathy	Procedure code	90989
Medical attention for nephropathy	Procedure code	90993
Medical attention for nephropathy	Procedure code	90997
Medical attention for nephropathy	Procedure code	90999
Medical attention for nephropathy	Procedure code	99512
Medical attention for nephropathy	Procedure code	3060F
Medical attention for nephropathy	Procedure code	3061F
Medical attention for nephropathy	Procedure code	3062F
Medical attention for nephropathy	Procedure code	3066F
Medical attention for nephropathy	Procedure code	4010F