CARDIODIABESITY PART TWO Resource and Economic Impact of Progression





OVERVIEW

The importance of preventing disease progression

In our earlier report,¹ we introduced the term **cardiodiabesity**, which is used to identify the comorbid state of cardiovascular disease (CVD), prediabetes/diabetes and overweight/obesity. We described its burden on society and the role that prevention plays in reducing that burden.

The prevalence of adult diabetes has increased steadily over the course of ~10 years with 1.2 million new cases diagnosed in 2021.²

Although death rates from heart disease had declined for nearly a decade leading up to 2020, they surged in the wake of the COVID-19 pandemic.

Consequently, the costs for cardiodiabesity conditions have continued to rise, with a combined estimate of \$719 billion annually.² The use of newer, costlier medications to treat these conditions and their risk factors is predicted to increase significantly by 2029.³ Furthermore, people with one cardiodiabesity-related condition are at risk for developing others and progressing to the next disease stage. As such, preventing disease progression is the key to addressing cardiodiabesity and reducing the cost of care.

All sources can be found at the end of this document.



Between 1999 and 2020, the rate of adult obesity in the United States climbed from 30.5% to 41.9% and is projected **to surpass 50%** by 2030.²

Preventing disease progression is a priority

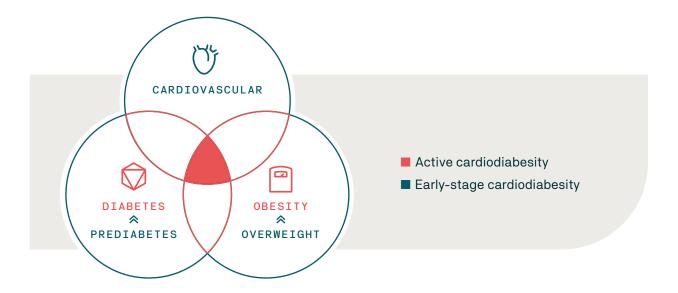
Comorbidities contribute to costs.

Preventing cardiodiabesity and halting its progression are increasingly high priorities, not only because they are cost-effective, but because they also offer long-term health benefits.¹

However, to design an appropriate prevention strategy, it is important to understand how the health care resources are used and where the costs originate. Health care utilization is primarily determined by the need for service, which is based on levels of illness and disability. In addition, the availability of service and resources necessary for providing and paying for the service are also determining factors.



Identifying cardiodiabesity when disease progression is **preventable or can be managed** in a primary care setting is the key to addressing the inappropriate use of resources, such as ED visits, that drive up costs.



In this report, we highlight the stages of cardiodiabesity, the health care resource utilization for each stage and the total cost of care among a commercially insured population. Since these relationships may vary by patient characteristics, it is necessary to distinguish certain patient cohorts to tailor the best interventions.

Of the 127,400,000 commercially insured adults identified in our earlier report, a total of 2,211,189 patients were diagnosed with comorbid conditions for early-stage cardiodiabesity, while a total of 998,064 patients have at least one comorbid diagnosis for active cardiodiabesity.

Cardiodiabesity progression

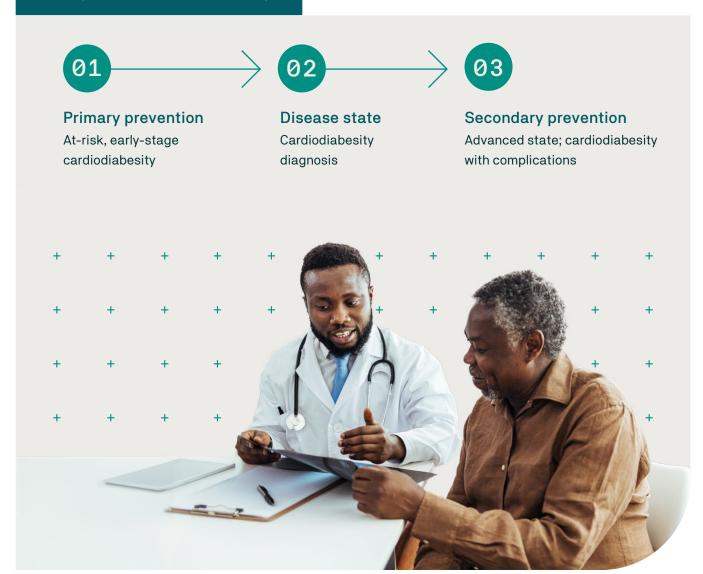
Cardiodiabesity is a progressive disease which advances from identifiable and treatable risk factors in the early stages to the development of more severe complications in the later stages. Conditions worsen as the disease progresses, resulting in more resource utilization and higher costs of care.

In our analysis of patients across two years, **21.5%** of those with early-stage cardiodiabesity proceed to develop active cardiodiabesity within one year.



48.2% of the active cardiodiabesity cohort develop advanced cardiodiabesity with severe complications within one year.

Three phases of cardiodiabesity



Following the phases of cardiodiabesity outlined on the previous page, health care resource utilization is assessed by ascertaining the frequency of inpatient, outpatient hospital or office and ED visits within one year. Total health care costs are estimated as the sum of medical (e.g., outpatient, inpatient and ED visits) and pharmacy costs (combination of payments from health plans and patients) within the same period. Detailed methodology is available in appendix A.

Defining the phases of cardiodiabesity

EARLY-STAGE CARDIODIABESITY

Cardiovascular disease

- + Hypertension stage 1
- + Systolic blood pressure 130-139
- + Diastolic blood pressure 80-89
- + High cholesterol

Prediabetes

+ Or chronic kidney disease stage 1-2

Overweight

+ BMI 25-30kg/m²

ACTIVE CARDIODIABESITY

Cardiovascular disease

- + Hypertension stage 2
- + Systolic blood pressure >140
- + Diastolic blood pressure >90
- + Vascular dementia

Controlled or uncontrolled Type 2 diabetes (T2D) with retinopathy or neuropathy

+ Or chronic kidney disease stage 3-4

Obesity

+ $BMI > 30 kg/m^2$

EARLY-STAGE CARDIODIABESITY Progression to cardiodiabesity

Includes incidence of:

- + $BMI > 30 kg/m^2$
- + Diastolic blood pressure >90
- + Hypertension stage 2
- + Retinopathy or neuropathy
- + Systolic blood pressure >140
- + T2D or chronic kidney disease stage 3-4
- + Vascular dementia

ACTIVE CARDIODIABESITY Progression to advanced state/complications

Includes incidence of:

- + Amputation
- + Aneurysm
- + Bariatric surgery
- + Diabetes with severe complications
- + End-stage renal disease
- + Heart failure exacerbation
- + Myocardial infarction
- + Stroke

How does cardiodiabesity impact resource utilization and cost?

Exorbitant resource utilization caused by serious health conditions remains a major concern and threat to the U.S. health care system. In our earlier report, we highlighted the importance of preventing disease progression to control cost. Our present analyses show that cardiodiabesity poses a substantial economic risk to payers. The average total cost of care within one year of assessment is as high as \$13,499 PMPY for a patient with early-stage cardiodiabesity, or up to \$19,051 PMPY for a patient with active cardiodiabesity.

These costs are further magnified with the increasing number of comorbidities or as patients progress from one disease phase to the next.

The effect of disease progression on cost and health care resource utilization is substantial in this population. Comparing those who advance to a more severe disease state to those who do not, this effect is evident in our study.



The progression of cardiodiabesity is costly and the associated health care resource overutilization is preventable.

The average total cost of care by number of patient's conditions per year

Early-stage \$13,383 PMPY \$14,153 PMPY \$14,553 PMPY cardiodiabesity ONE CONDITION TWO CONDITIONS THREE CONDITIONS

Active \$17,972 PMPY \$27,444 PMPY \$43,232 PMPY cardiodiabesity ONE CONDITION TWO CONDITIONS THREE CONDITIONS

That represents a cost increase of 53% to 141% as number of comorbidities grows.

Early-stage to active cardiodiabesity progression

Among early-stage patients who progress to active cardiodiabesity within one year, the average total cost of care increases 155% (\$9,195 to \$23,466 PMPY) compared to a 42% increase (\$7,608 to \$10,769 PMPY) among patients who do not progress.

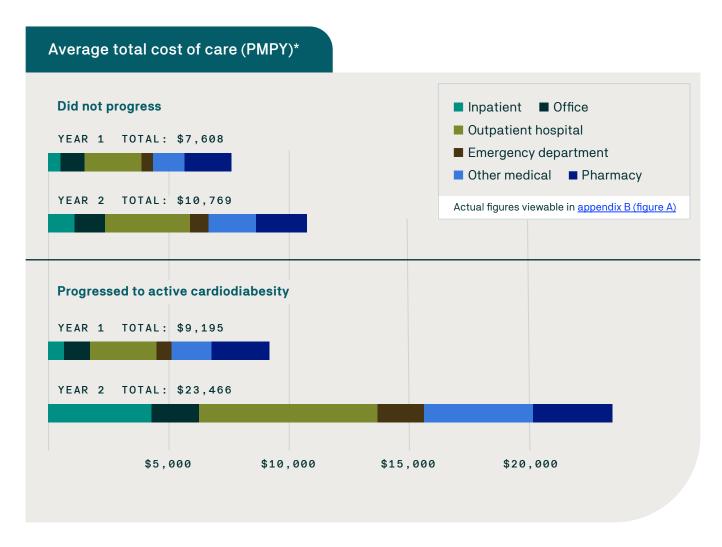
For patients who progress in the disease, inpatient costs jump over **550%** within one year, from an average of **\$658 PMPY** to an average of **\$4,302 PMPY**. ED visit costs increase **203%** from an average of **\$637 PMPY** to **\$1,930 PMPY**. The cost for office visits grows over **80%**, from an average of **\$1,087 PMPY** to **\$1,983 PMPY**.

Together, these three segments represent close to **50%** of the total increase in costs of disease progression.



The average pharmacy costs increase over 39%, from \$2,385 PMPY to \$3,310 PMPY.

Pharmacy costs associated with diabetes represent the largest segment of pharmacy increase (9%).



^{*} Cumulative average irrespective of number of comorbidities each patient has.

These trends correspond with the observed changes in resource utilization during the follow-up period.

While the frequency of outpatient visits (whether hospital or office) is highest among the segments, suggesting patients are receiving some form of care, they account for lower costs when compared to inpatient or ED visits. As such, any substantial increases in the latter two are concerning. See appendix B (figure B) for details.

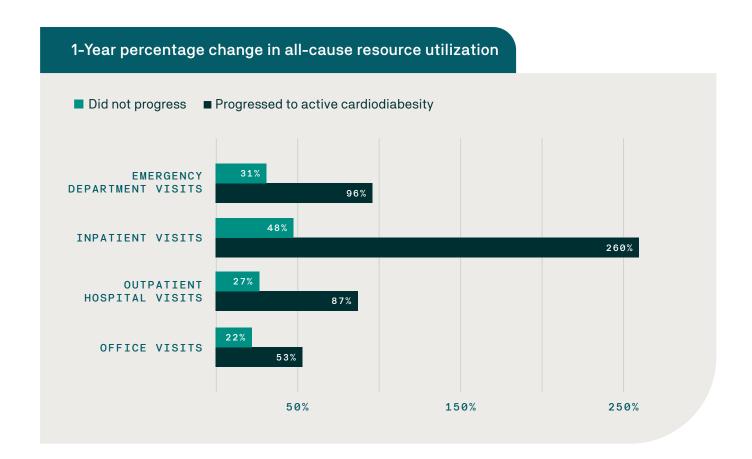
Among those who progress to active cardiodiabesity within one year, there is a substantial 260% increase in all-cause inpatient hospital visits.

Visits to the ED increase **96%** and office visits increase **53%**. Of the inpatient visits, **13%** of admissions are for cardiovascular disease, offering an opportunity for earlier intervention to potentially avoid these admissions.

The procedures or services with significant increases over one year that may be attributed to these costs include:

300%
CARDIOVASCULAR CARE

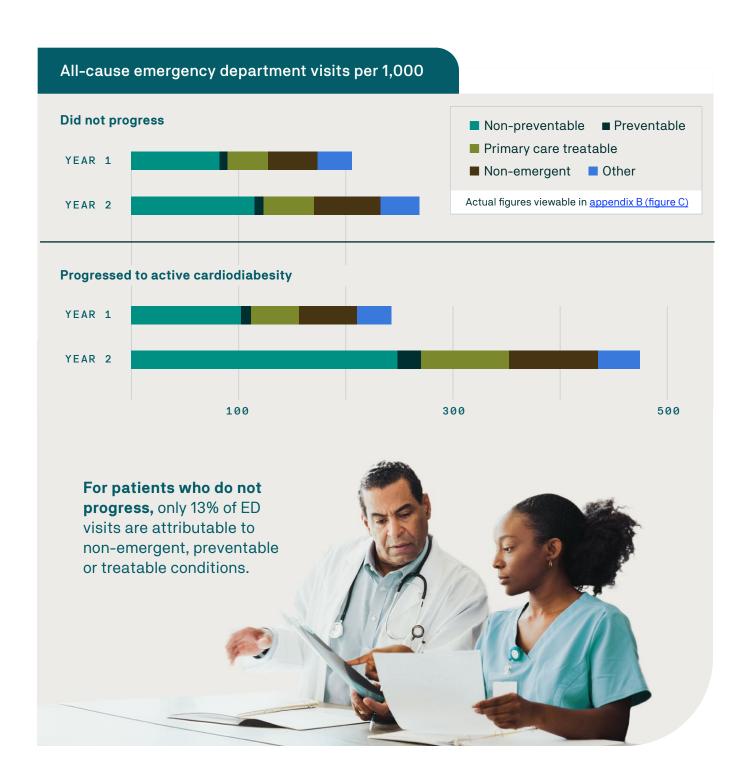
311% LIVER/KIDNEY CARE*



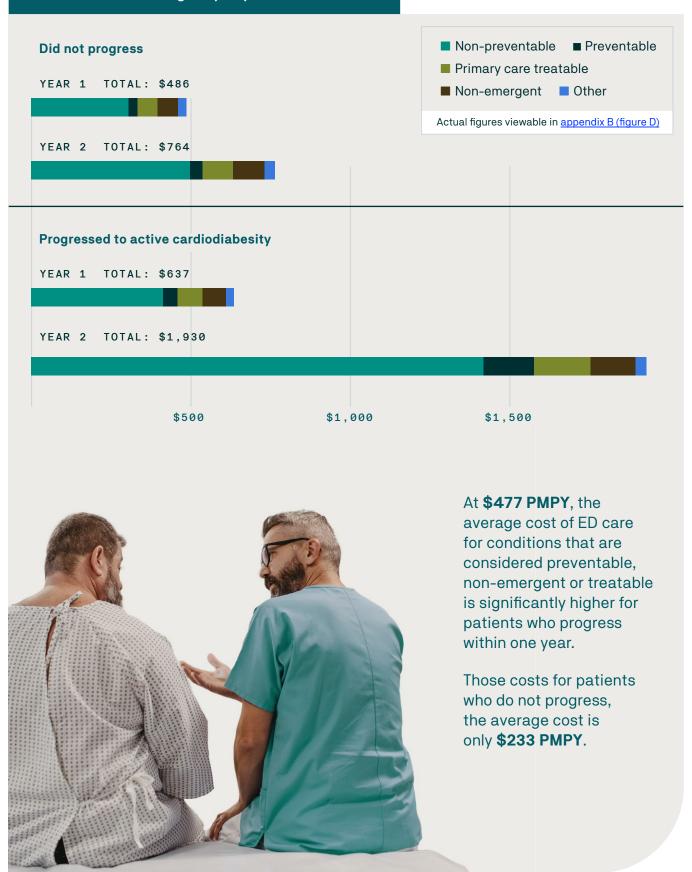
^{*} Liver/kidney care includes thrombectomy, liver or renal transplant, liver or renal ultrasound, dialysis, paracentesis, transfusion blood and transfusion platelets.

Because inappropriate ED utilization is an area for immediate intervention, we identify the frequency of preventable visits to the emergency room.

Among those patients who progress to active cardiodiabesity within one year, 39% of ED visits are attributed to conditions that are considered non-emergent, preventable or treatable by a primary care physician, suggesting these visits could be managed in other settings.



Average total cost of care (PMPY) associated with all-cause emergency department visits



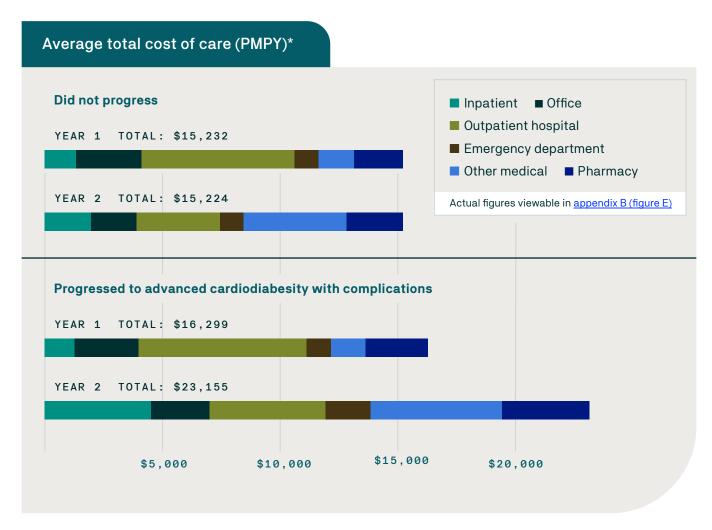
Active cardiodiabesity to advanced cardiodiabesity with complications

Among the active cardiodiabesity cohort that progresses to more severe complications within one year, the average total cost of care increases 42%, from \$16,299 PMPY to \$23,155 PMPY. Inpatient costs soar over 254% within the one year, from an average of \$1,282 PMPY to \$4,536 PMPY.

ED visit costs rise 84% from an average of \$1,048 PMPY to \$1,927 PMPY. The average pharmacy costs increase over 40%, from \$2,654 PMPY to \$3,717 PMPY.

As with those with earlystage cardiodiabesity, pharmacy costs associated with diabetes represent the largest segment of pharmacy increase (21%).

The costs for those who do not progress remain flat.



^{*} Cumulative average irrespective of number of comorbidities each patient has.

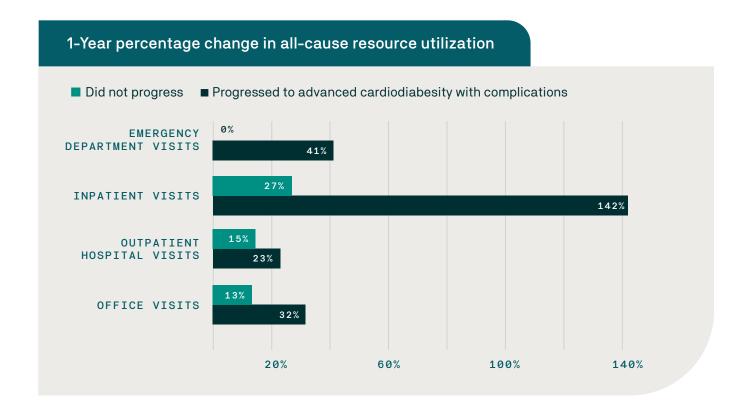
As with the resource utilization trends from early-stage to active cardiodiabesity, there are corresponding trends as the disease progresses from active cardiodiabesity to advanced cardiodiabesity with complications during the follow-up period. See appendix B (figure F) for details.

At a **142%** growth rate, all-cause inpatient visits represent the largest increase within one year. That's followed by ED visits with a **41%** increase and then office visits with a **32%** increase. Of these inpatient visits, **14%** are associated with cardiovascular disease and **8%** are associated with type 2 diabetes.

The procedures or services with significant increases over one year that may be attributed to these costs include:

197%
LIVER/KIDNEY CARE*

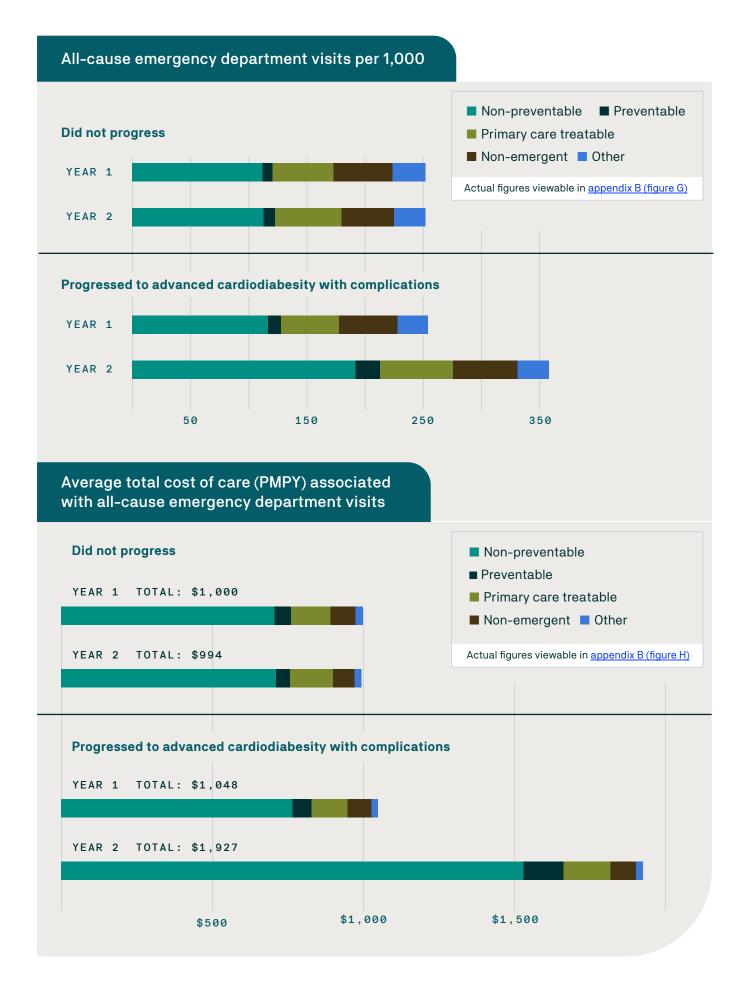
300%
CARDIOVASCULAR CARE



For the group that progressed to advanced cardiodiabesity with complications within a year, there is an 25% relative increase in ED visits for conditions that are considered preventable, non-emergent or treatable by a primary care doctor. There is no increase among those who do not progress to advanced complications.

At \$373 PMPY, the average cost of ED care for conditions that are considered preventable, non-emergent or treatable is significantly higher for those patients who progress to advanced cardiodiabesity in the one-year follow-up period. Those costs for non-progressive cardiodiabesity patients average only \$259 PMPY.

^{*} Liver/kidney care includes thrombectomy, liver or renal transplant, liver or renal ultrasound, dialysis, paracentesis, transfusion blood and transfusion platelets.



What you need to take away

Preventing progression is critical to life and cost savings.

While it appears that some patients may be receiving some form of care, in many cases that care may not include evidence-based interventions that halt disease progression. As we suggested in our earlier report, incorporating prevention measures into care protocols can mitigate progression.

These include:

- + Early screening and identification of at-risk patients
- + Helping patients understand how they can reduce risk
- + Understanding the role of micro- and macro-level factors, such as emotional, social, geographic and economic factors
- + Targeting barriers to patient follow-up
- + Developing care metrics that improve health outcomes

When patients and their care team understand the proper role of technological advances, like remote monitoring or devices and procedures that help prevent complications from cardiodiabesity, it goes a long way to minimize barriers for the medically-indicated use of these technologies. These interventions can be effective even in the hospital or post-acute setting to prevent future admissions and ED visits and can often be delivered and supported by clinicians, including pharmacists and community health workers.

Our study shows total cost of care more than doubles, inpatient visits increase more than five times and ED visits increase three times more for patients that progress from early-stage to active cardiodiabesity compared to those patients who don't. For patients that advance from active cardiodiabestiy to complications, the total cost of care increases 42% and visits to the ED increase by 41%, yet remain flat for those who don't progress. Additionally, ED utilization for conditions that are preventable, non-emergent or treatable by a primary care physician is significantly lower among patient cohorts where the disease does not progress to active cardiodiabesity.

With a comprehensive understanding of the holistic impact that cardiodiabesity has on total cost of care, how disease progression leads to unnecessary resource utilization and how early intervention can halt that progression, improved health can be achieved for all patients.



Investing in interventions that are proven to prevent progression and complications—

such as blood pressure control, utilizing statin medications, smoking cessation, and more—and preventing progression are key to saving lives and lowering costs.





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APPENDIX A. DETAILED METHODOLOGY

Data

Data came from the Komodo Health Care Map—a nationally representative, longitudinal and deidentified claims database of more than 150 million insured individuals from all demographic and socioeconomic groups throughout the U.S. in 2019 through 2021. Drawing complete data from both providers and payers, the Komodo Health Care Map provides a near real-time view of the entire patient journey—including medical and pharmacy services delivered in-network, out-of-network, through a specialist, hospital, or retail clinic, among others.

Population

We identified adult patients (≥18 years) across the U.S. from 2019 to 2021 and categorized them in two mutually exclusive cohorts: 'early-stage' and 'active disease' states. The database is representative across various age groups and geographic locations of the insured U.S. population. Patients were derived directly from payer sources, including 100% fully integrated fee-for-service Medicare, Medicare Advantage, Commercial, and Medicaid claims. Patients were followed for one year through 2022.

Cost

Medical Cost: Payments made by health insurance companies for claims associated with laboratory tests, medical procedures performed in a doctor's office, inpatient stays or as an aggregated payment for all services provided during an emergency visit.

Pharmacy Cost: Payments made by health insurance companies for claims associated with prescription drugs.

We imputed medical allowed amounts by assigning missing amounts with the average amount from procedures that had complete cost data, stratifying by procedure type, place of service, patient's region at the time of service (Midwest, Northeast, South and West), type of payer (commercial, Medicare and Medicaid) and the month and year of service. Similarly, we imputed missing pharmacy cost separately for plan pay and patient pay based on the national drug code (NDC), days-supply, place of service, patient's region at the time of service, type of payer and the month and year of service. After imputation, the missing rates for medical allowed amounts and pharmacy costs were less than 9% and 4%, respectively. Medical and pharmacy costs were top-coded at the 99th percentile to avoid the influence of outliers onto the analysis. All costs were adjusted for inflation and reflected the dollar amounts in 2022.

Resource Utilization

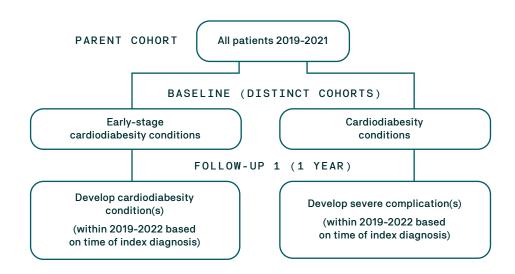
Emergency Department: Patients were identified as receiving care from an emergency department for any condition with any medical claims (place of service code 23; revenue codes 0450, 0451, 0452, 0456, 0459, 0981; and CPT codes 99281, 99282, 99283, 99284, 99285, 99288). Using the New York University ED Algorithm (EDA) (Emergency department visit classification using the NYU algorithm - PubMed (nih.gov)), ED visits were further classified into non-emergent, emergent - primary care treatable, emergent - ED care needed - preventable/avoidable and others.

Inpatient: Patients were identified as receiving care while admitted or hospitalized in a hospital with any medical claims (place of service code 21; revenue codes 0100, 0101, 0110, 0111, 0112, 0113, 0114, 0116, 0117, 0118, 0119, 0120, 0121, 0122, 0123, 0124, 0126, 0127, 0128, 0129, 0130, 0131, 0132, 0133, 0134, 0136, 0137, 0138, 0139, 0140, 0141, 0142, 0143, 0144, 0146, 0147, 0148, 0149, 0150, 0151, 0152, 0153, 0154, 0156, 0157, 0158, 0159, 0160, 0164, 0167, 0169, 0170, 0171, 0172, 0173, 0174, 0179, 0190, 0191, 0192, 0193, 0194, 0199, 0200, 0201, 0202, 0203, 0204, 0206, 0207, 0208, 0209, 0210, 0211, 0212, 0213, 0214, 0219, 1000, 1001, 1002, 0022, 0024, 0118, 0128, 0138, 0148, 0158, 0190, 0191, 0192, 0193, 0194, 0199, 0524, 0525, 0550, 0551, 0552, 0559, 0660, 0661, 0662, 0663, 0669, 1000, 1001, 1002; and CPT codes 99221, 99222, 99223, 99231, 99232, 99233, 99238, 99239, 99251, 99252, 99253, 99254, 99255, 99291). Inpatients visits were further categorized into cardiovascular-related (ICD-10 codes I20*, I21*, I22*, I23*, I24*, I25*, I60*, I61*, I62*, I63*, I64*, I65*, I66*, I67*, I68*, I69*, I42*, I43*, I110*, I130*, I132*, I50*, I26*, I80* and I82*), type-2-diabetes-related (ICD codes E11*), or weight-management-related (CPT codes 99201, 99202, 99203, 99204, 99205, 97802, 97803, 97804, 99078, 99401, 99402, 99403, 99404, 99411, 99412 and HCPCS codes G0447, S9452 and S9470) visits.

Outpatient: Patients were identified as receiving care from a physician clinic/office or outpatient hospital with any medical claims (place of service codes 11, 19 and 22; revenue codes 063*, 0760, 0762, 0769; and CPT codes 99201, 99202, 99203, 99204, 99205, 99211, 99212, 99213, 99214, 99215, 99241, 99242, 99243, 99244, 99245, 99341, 99342, 99343, 99344, 99345, 99347, 99348, 99349, 99350, 99381, 99382, 99383, 99384, 99385, 99386, 99387, 99391, 99392, 99393, 99394, 99395, 99396, 99397, 99401, 99402, 99403, 99404, 99411, 99412, 99429, 99455, 99456, 99483, 99217, 99218, 99219, 99220; and HCPCS codes G0402, G0438, G0439, G0463, T1015). Outpatient visits were further categorized into cardiovascular-related, type-2-diabetes-related, or weight-management-related visits using ICD-10, CPT and HCPCS codes (see above).

Statistical Analysis

Descriptive statistics were used to estimate means and standard deviations for continuous measurements and frequencies and percentages for categorical variables. Analyses were conducted using RStudio version 1.4.1564.1. Analyses were age-adjusted.

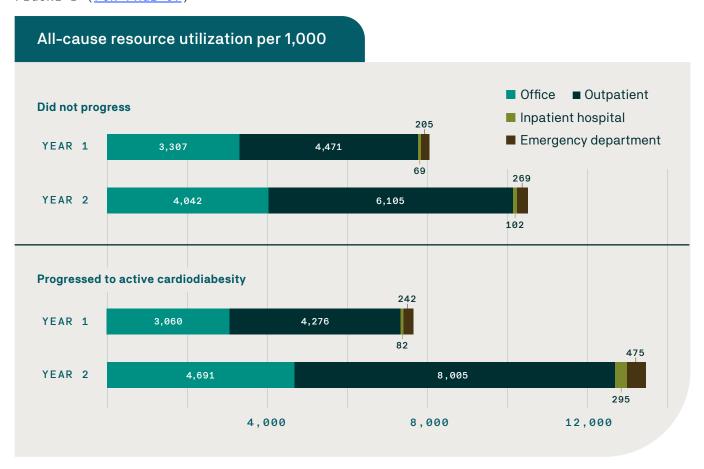


APPENDIX B. SUPPLEMENTAL CHARTS

FIGURE A (FOR PAGE 06)

Average total cost of care (PMPY)	Did not progress		Progressed to active cardiodiabesity	
	YEAR 1	YEAR 2	YEAR 1	YEAR 2
■ Inpatient	\$530	\$1,104	\$658	\$4,302
■ Office	\$978	\$1,261	\$1,087	\$1,983
Outpatient hospital	\$2,382	\$3,542	\$2,755	\$7,418
■ Emergency department	\$486	\$764	\$637	\$1,930
■ Other medical	\$1,298	\$1,985	\$1,673	\$4,523
■ Pharmacy	\$1,934	\$2,114	\$2,385	\$3,310
Total	\$7,608	\$10,769	\$9,195	\$23,466

FIGURE B (FOR PAGE 07)



APPENDIX B. SUPPLEMENTAL CHARTS

FIGURE C (FOR PAGE 08)

All-cause emergency department visits per 1,000	Did not progress		Progressed to active cardiodiabesity	
	YEAR 1	YEAR 2	YEAR 1	YEAR 2
■ Non-preventable	83	115	103	249
■ Preventable	7	9	9	22
■ Primary care treatable	38	47	45	82
■ Non-emergent	46	62	54	83
■ Other	32	36	32	39

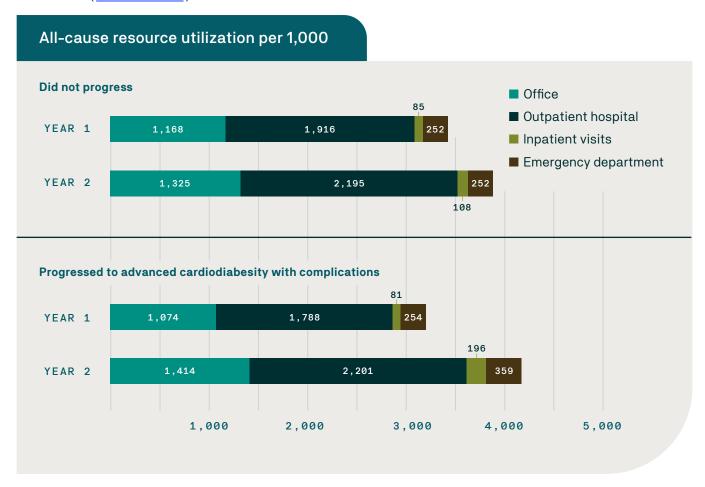
FIGURE D (FOR PAGE 09)

Average total cost of care (PMPY) associated with all-cause Emergency Department visits	Did not progress		Progressed to active cardiodiabesity	
	YEAR 1	YEAR 2	YEAR 1	YEAR 2
■ Non-preventable	\$305	\$499	\$414	\$1,419
■ Preventable	\$28	\$39	\$46	\$159
■ Primary care treatable	\$64	\$95	\$77	\$176
■ Non-emergent	\$64	\$99	\$75	\$142
■ Other	\$25	\$32	\$25	\$34
Total	\$486	\$764	\$637	\$1,930

FIGURE E (FOR PAGE 10)

Average Total Cost Of Care (PMPY)	Did not progress		Progressed to advanced cardiodiabestiy with complications		
	YEAR 1	YEAR 2	YEAR 1	YEAR 2	
■ Inpatient	\$1,340	\$1,978	\$1,282	\$4,536	
■ Office	\$2,779	\$1,933	\$2,718	\$2,491	
Outpatient Hospital	\$6,517	\$3,556	\$7,132	\$4,916	
■ Emergency Department	\$1,000	\$994	\$1,048	\$1,927	
■ Other medical	\$1,529	\$4,366	\$1,465	\$5,568	
■ Pharmacy	\$2,067	\$2,397	\$2,654	\$3,717	
Total	\$15,232	\$15,224	\$16,299	\$23,155	

FIGURE F (FOR PAGE 11)



APPENDIX B. SUPPLEMENTAL CHARTS

FIGURE G (FOR PAGE 12)

All-cause emergency department visits per 1,000	Did not progress		Progressed to advanced cardiodiabesity with complications	
	YEAR 1	YEAR 2	YEAR 1	YEAR 2
■ Non-preventable	112	113	117	192
■ Preventable	9	10	11	21
■ Primary care treatable	52	57	50	63
■ Non-emergent	51	45	50	55
■ Other	28	27	26	27

FIGURE H (FOR PAGE 12)

Average total cost of care (PMPY) associated with all-cause Emergency Department visits	Did not progress		Progressed to advanced cardiodiabesity with complications	
	YEAR 1	YEAR 2	YEAR 1	YEAR 2
■ Non-preventable	\$708	\$712	\$766	\$1,532
■ Preventable	\$53	\$47	\$64	\$133
■ Primary care treatable	\$132	\$141	\$120	\$154
■ Non-emergent	\$82	\$71	\$78	\$86
■ Other	\$25	\$23	\$20	\$22
Total	\$1,000	\$994	\$1,048	\$1,927

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