Cardiovascular Event Incidence and Cost in Type 2 Diabetes: A Commercial and Medicare Claim Based Actuarial Analysis

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Diabetes is a significant concern in the US population with its high prevalence, morbidity, mortality and medical cost. Based on data from the 2009-2012 National Health and Nutrition Examination Survey (NHANES), CDC has estimated that 25.9% of the 2012 U.S. population aged 65+, 16.2% of 45-64 year olds and 4.1% of 20-44 year olds were living with diabetes, both diagnosed and undiagnosed. The annual incidence of new diabetes cases was 11.5, 12.0 and 3.6 cases per 1,000 for these populations, respectively.[1]

Diabetes is associated with an increased risk of the development of cardiovascular disease (CVD), including coronary artery disease, cerebrovascular disease, and peripheral arterial disease. CVD is the major cause of both mortality and morbidity for adults with diabetes, as well as a major contributor to the total cost of medical care.[2] CVD is 1.8 to 2.5x more prevalent in persons with diabetes compared to those without diabetes, and cardiovascular (CV) event rates are 2.7x higher for those with diabetes vs those without.[3,4,5] The lifetime cost of CV-related complications in diabetes patients has been estimated to account for 32% of total diabetes medical costs.[6,7]

The objective of this analysis was to identify the annual rate and cost of CV events in patients with type 2 diabetes mellitus (T2DM) and the contribution of these CV events to both T2DM annual costs as well as total Medicare fee for service (FFS) and commercially insured population annual costs. We based our analysis on the 2014 Truven Health Analytics MarketScan Commercial Claims Database (MarketScan) and the 2014 Medicare 5% sample, using the methodology specified in Appendix B.

Key Findings

Patients with T2DM in the commercial population:

- Are a significant contributor to total population spend: T2DM prevalence is 3.8% (5.0% in 18-64 year olds) but members with T2DM account for 13.7% of total commercial population costs
- Have an average risk score (based on age/gender and comorbidities) that is 3.5x higher than the non T2DM population (Health and Human Services (HHS) Hierarchical Condition Category (HCC) risk score 3.85 versus 1.11 – see Appendix B for risk score methodology)
- Utilize health services at a higher rate compared with the demographically adjusted non-T2DM population:
    - Admission rate/1000 is 3.4x higher (183.1 compared with 53.7)
    - Emergency department visits/1000 are 2.3x higher (309.8 compared with 134.4)
    - Physician office visits/100 are 1.9x higher (744.8 compared with 393.2)
- Incur average allowed monthly costs that are 2.6x higher than the demographically adjusted non-T2DM population ($1,581 per member per month (PMPM) compared with $611 PMPM)
- Have a higher rate of CV events compared to the demographically adjusted non-T2DM population, including:
    - 4.4x higher MI rate
    - 4.7x higher stroke rate
    - 5.1x higher unstable angina admission rate
    - 9.0x higher heart failure admission rate
    - 4.7x higher coronary revascularization rate
- Account for 31% to 45% of the total adult commercial population CV events including:
    - 32.5% of the MIs
    - 31.7% of the strokes
    - 32.7% of the unstable angina admissions
    - 45.2% of the heart failure admissions
    - 36.8% of the coronary revascularization procedures
- Are a significant contributor to total commercial population's CV event costs: T2DM prevalence is 5% in adults, but T2DM adult members account for 36% of total adult commercial CV event costs
- Incur incremental CV event costs that account for 1.1% of total adult commercial population costs ($4.89 PMPM of total $446 PMPM – see Appendix B for incremental cost calculation methodology)

Patients with T2DM in the Medicare FFS population:

- Are a significant contributor to total population spend: T2DM prevalence is 22.1%, but beneficiaries with T2DM account for 37.9% of total Medicare FFS costs
- Have an average risk score (based on age/gender and comorbidities) that is 1.7x higher than the non T2DM population (Center for Medicare and Medicaid Services (CMS) HCC risk score 1.64 versus 0.99 – see Appendix B for risk score methodology)
- Utilize health services at a higher rate compared with the demographically adjusted non-T2DM population:
    - Admission rate/1000 is 2.5x higher (624.9 compared with 245.9)
    - Emergency department visits/1000 are 1.85x higher (749.8 compared with 404.3)
    - Physician office visits/100 are 1.49x higher (1,080.2 compared with 723.1)
- Incur average allowed monthly costs that are 2.2x higher than the demographically adjusted non-T2DM population ($1,834 PMPM compared with $850 PMPM)
- Have a higher rate of CV events compared to the demographically adjusted non-T2DM population, including:
    - 3.3x higher MI rate
    - 2.4x higher stroke rate
    - 3.2x higher unstable angina admission rate
    - 4.0x higher heart failure admission rate
    - 2.8x higher coronary revascularization rate
- Account for 40% to 53% of the total Medicare FFS population CV events including:
    - 49.0% of the MIs
    - 40.4% of the strokes
    - 47.8% of the unstable angina admissions
    - 53.0% of the heart failure admissions
    - 46.1% of the coronary revascularization procedures
    - 41.1% of CV deaths
- Incur incremental CV event costs that account for 6.9% of total Medicare FFS population costs ($73 PMPM of total $1,064 PMPM - see Appendix B for incremental cost calculation methodology).

CV events among patients with T2DM are a significant contributor to T2DM commercial and Medicare patient cost as well as to total commercial and Medicare population cost. This study establishes values for metrics of interest to payers and providers and highlights cost and quality opportunities to impact CV event rates in patients with T2DM.

This report was commissioned by Boehringer Ingelheim, Inc. The findings reflect the research of the authors; Milliman does not endorse any product or organization. If this report is reproduced, we ask that it be reproduced in its entirety, as pieces taken out of context can be misleading. As with any economic or actuarial analysis, it is not possible to capture all factors that may be significant. Because we present national average data based on the 2014 MarketScan and 2014 Medicare 5% sample data, the findings should be interpreted carefully before they are applied to any particular situation. Findings for particular populations and for different time periods will vary from these findings. Tyler Engel is a member of the American Academy of Actuaries and meets the Qualification Standards of the American Academy of Actuaries to render the actuarial opinion in this report.

BACKGROUND

Diabetes is a significant concern in the US population with its high prevalence, morbidity, mortality and medical cost. Based on data from the 2009-2012 National Health and Nutrition Examination Survey (NHANES), CDC has estimated that 25.9% of the 2012 U.S. population aged 65+, 16.2% of 45-64 year olds and 4.1% of 20-44 year olds were living with diabetes, both diagnosed or undiagnosed. The annual incidence of new diabetes cases was 11.5, 12.0 and 3.6 cases per 1,000 for these populations respectively.[1] The percentage of US adults with diagnosed diabetes has risen from 3.5% in 1990 to 7.9% in 2008 and to 8.3% in 2012.[8]

Diabetes is a major risk factor for the development of cardiovascular disease (CVD), including coronary artery disease, cerebrovascular disease, and peripheral arterial disease, and CVD is the major cause of both mortality and morbidity for adults with diabetes. [2] Compared with patients without diabetes, patients with diabetes have been shown to have a 2 to 6 fold higher risk of mortality from CV events.[9] A 2002 study by Nichols and colleagues found that CVD is 75% more prevalent in patients with diabetes, when compared with an age and sex matched population without diabetes.[10]

Although the prevalence of diabetes has been rising, the incidence of myocardial infaction, stroke, lower extremity amputations, end stage renal disease, and death due to hyperglycemia have all declined during the period from 1990-2010. The incidence of myocardial infarction declined by 67.8%, and the incidence of stroke declined by 52.7% among U.S. adults diagnosed with diabetes.[11] These findings are encouraging, but despite the lower rates of these complications among the population with diabetes, the increasing prevalence of diabetes in adults contributes to a significant volume of CV events in the diabetes population.[11]

Several studies have addressed cost and healthcare resource utilization for CVD in diabetes. A study using 1999-2002 health insurance claims, medical records, and patient survey data to estimate costs of diabetes and its comorbidities, found that the presence of macrovascular complications of diabetes (coronary heart disease, heart failure, hemiplegia, and amputation) was associated with costs that were 70% to 150% higher than when those complications were not present.[12] Another study found that annual per-person medical costs were markedly higher for patients with diabetes with comorbid CVD compared to patients with diabetes without CVD ($10,172 per patient per year vs $4,402 per patient per year).[10] A study of T2DM, using data from a single 700,000- life HMO in 2003, found that diabetes patients with macrovascular disease experienced costs that were 3 times higher than those without macrovascular disease. Inpatient hospital care and pharmacy were the main cost drivers.[13] A claims-based study of commercially insured T2DM patients aged 40 and older diagnosed between January 1, 2007, and April 30, 2011and followed for up to 5 years compared cardiovascular outcomes and healthcare utilization for those with established CVD versus those with CVD risk factors only. The per-patient annual cost was $12,962 for the total population $16,227 for the population with established CVD and $10,059 for the population with CVD risk factors.[14]

We used actuarial techniques and methodology to examine commercially insured and Medicare FFS T2DM populations to quantify the total costs of cardiovascular events, the additional costs that cardiovascular events impose on the population, and the contribution of cardiovascular events to total population event rates and costs.

RESULTS: COMMERCIAL POPULATION

This section provides population-level statistics for commercially insured members with T2DM. Using the 2014 MarketScan data as our index year, we identified commercially insured patients with T2DM using standard HEDIS criteria. Description of the databases, methodology, and claim coding details can be found in Appendix A, B and C.

DEMOGRAPHIC CHARACTERISTICS

Figure 1 provides the 2014 prevalence, average age and risk score for the T2DM population, non T2DM population and the total population in the MarketScan data. The risk scores are calculated using publicly available algorithms HHS HCC commercial risk scores that account for age, gender and comorbidities (see Appendix B).

Figure 1: Key Demographic Characteristics
T2DM Population vs. Total Population (Commercial)

	Commercial
Total Members in Sample	18,491,028
T2DM Patients in Sample	702,616
T2DM Prevalence	3.8%
T2DM Prevalence (As a % of 18-64 year olds Only)	5.0%
Total Members	
Average Age	33.7
% Female	51.1%
Average Risk Score*	1.22
Total Members without T2DM	
Average Age	33.0
% Female	51.3%
Average Risk Score*	1.11
T2DM Patients	
Average Age	52.0
% Female	45.5%
Average Risk Score*	3.85

Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year for HCC risk score)
Notes: *Risk Scores represent the HHS-HCC Gold risk score for the commercial population (see appendix B for methodology). Mortality rate not included as mortality is not noted in the MarketScan database except for those who die during an inpatient stay.

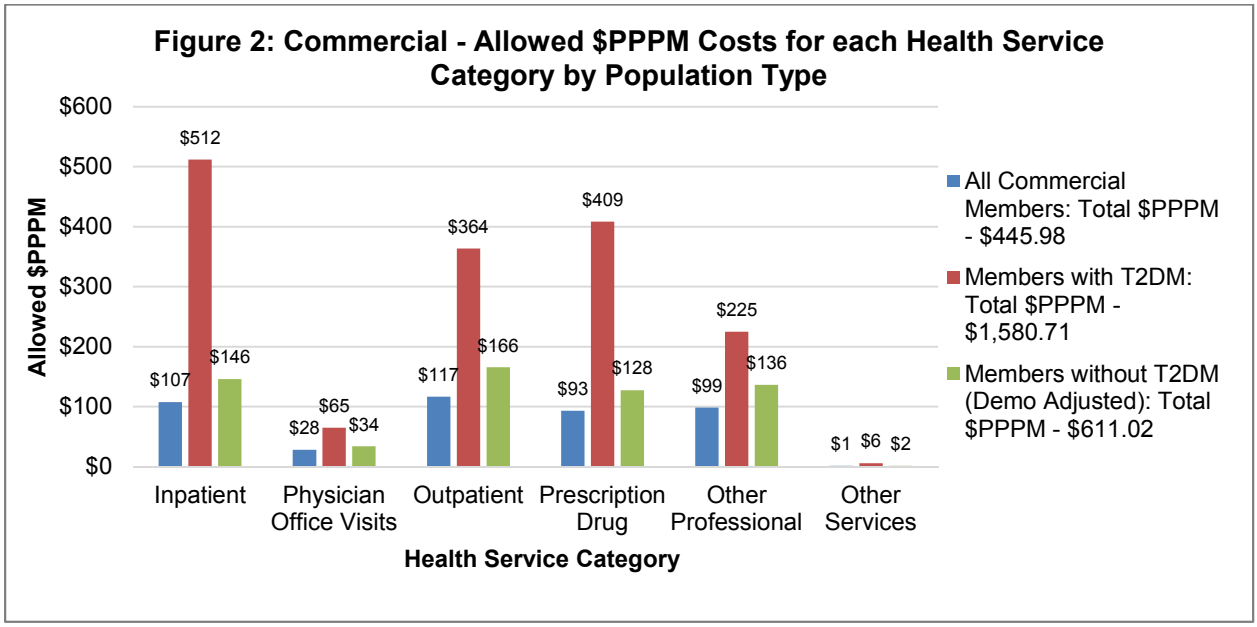
Figure 1: Key Points

- 5.0% T2DM prevalence in the commercially insured population for 18-64 year olds and 3.8% for the total commercial population (0-64 year olds)
- The burden of diabetes is evident when comparing risk scores: **c**ommercial T2DM population has 3.2x higher HHS HCC score than the total commercial population and 3.5x higher than the non T2DM commercial population

T2DM COST AND UTILIZATION METRICS

In this section, we examine allowed claim cost (all reimbursement by the payer plus member cost sharing) and key medical service utilization within the T2DM population and compare these findings to a demographically adjusted (same age/gender mix) non-T2DM population and the total commercial population. The PPPM costs in Figure 2 consider the cost for the indicated population only, while in Figure 3, PMPM allowed cost considers the cost of the indicated population spread across the total commercial population.

Figure 2 provides the average PPPM allowed cost of the commercial T2DM population, the demographically adjusted non-T2DM population and the total population, by major service category.



Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: Inpatient and Skilled Nursing costs include Facility and Professional costs. PPPM: per patient per month. Allowed costs represent all reimbursement from the payer plus member cost sharing. The demo adjusted non-T2DM population reflects non-T2DM members with the same age/gender mix as the T2DM members. The $PPPM for the total commercial population is equivalent to the $PMPM for the total commercial population.

We calculated the $PMPM costs for the commercial T2DM population which takes all costs and member months for the T2DM population and divides by all costs and member months of the total population. Figure 3 provides the T2DM population $PMPM and the portion of total commercial population spend from the T2DM population.

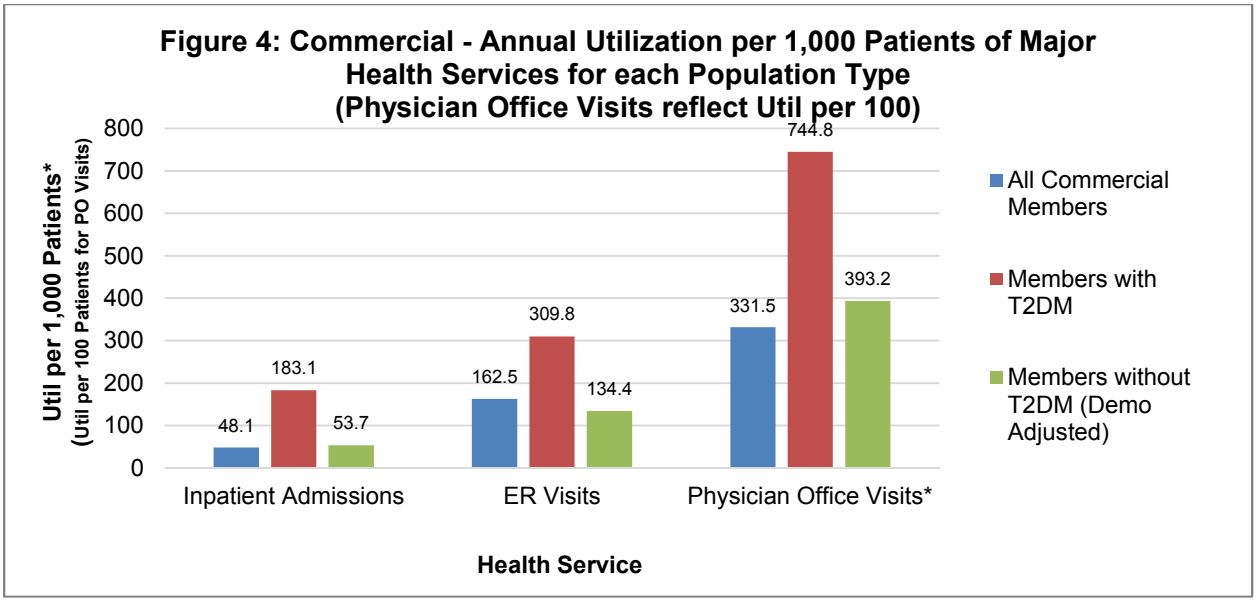
Figure 3: Portion of Allowed PMPM Costs for each Health Service Category by Population Type (Commercial)					
Service Type	All Commercial Members		Members with T2DM		
	Allowed $PMPM	Distribution of Spend	Allowed $PMPM	Distribution of Spend	Portion of Total Population $PMPM from T2DM Population
Inpatient	$107.49	24.1%	$19.74	32.4%	18.4%
Physician Office Visits	$28.35	6.4%	$2.51	4.1%	8.9%
Outpatient	$116.98	26.2%	$14.02	23.0%	12.0%
Prescription Drug	$93.07	20.9%	$15.74	25.8%	16.9%
Other Professional	$98.65	22.1%	$8.68	14.2%	8.8%
Other Services	$1.44	0.3%	$0.23	0.4%	15.7%
Total	**$445.98**	**100%**	**$60.91**	**100%**	**13.7%**

Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: Inpatient and Skilled Nursing costs include Facility and Professional costs. PMPM: per member per month. Allowed costs represent all reimbursement from the payer plus member cost sharing. Due to rounding some numbers may not calculate to the decimal noted.

Figures 2 and 3: Key Points

- The average allowed monthly cost for a commercially insured member with T2DM is 2.6x the average allowed monthly cost for an demographically adjusted non-T2DM commercially insured member
- Although the prevalence of T2DM is 3.8%, costs for members with T2DM are 13.7% of the total commercially insured population's allowed cost including:
    - 18.4% of the total IP spend
    - 8.9% of the total physician office visit spend

Figure 4 provides the utilization rates of key services/1,000 for the commercial T2DM population, the demographically adjusted non-T2DM population and the total population, by major service category. We report utilization on a per 1,000 population basis except for physician office visits which we report on a per 100 population basis for scaling purposes. The utilization in Figure 4 considers the utilization for the indicated population while the utilization shown in Figure 5 spreads the utilization from the T2DM population across the total population.



Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM members with the same age/gender mix as the T2DM members
*Physician office visits are reported on a per 100 member basis

Figure 5 provides the annual utilization rates of key services per 1,000 total commercial members and the portion coming from the T2DM population.

Figure 5: Annual Utilization per 1,000 Commercial Members for each Health Service Category (Commercial)

Service Type	Annual Utilization/1,000 Commercial Members	Annual Utilization/1,000 Commercial Members from the T2DM Population	Portion of Annual Commercial Utilization from the T2DM Population
Inpatient	48.1	7.1	14.7%
ER Visits	162.5	11.9	7.3%
Physician Office Visits	3,315.2	287.0	8.7%

Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)

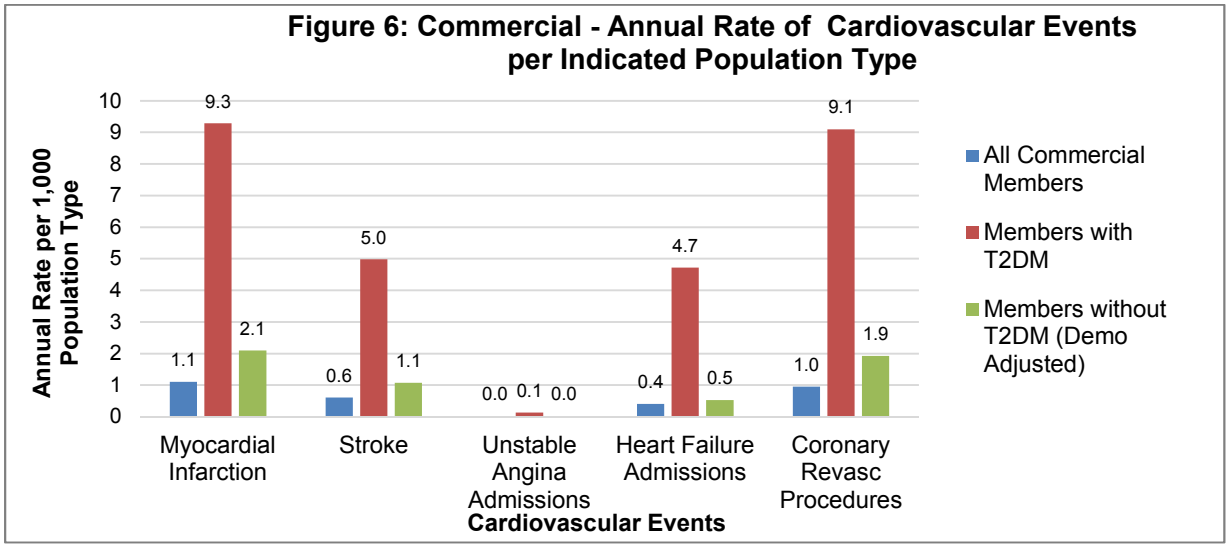
Figures 4 and 5: Key Points

- Commercially insured members with T2DM utilize significantly more services than demographically adjusted non-T2DM members, including:
  - 3.4 x the number of IP admissions
  - 2.3 x the number of ER visits
  - 1.9 x the number of physician office visits
- Commercial members with T2DM account for a significant portion of the total commercial population utilization:
  - 14.7% of the total IP utilization
  - 8.7% of the total physician office visit utilization

CARDIOVASCULAR EVENTS

Patients with T2DM are at higher risk for CV events and have a higher incidence of CV events. Because of the higher incidence of CV events, patients with T2DM account for a significant portion of CV events and CV costs in the total population.

Figure 6 provides the annual rate of CV events among the commercial T2DM population, the demographically adjusted non-T2DM population and the total population.



Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM members with the same age/gender mix as the T2DM members. Due to rounding some numbers may not calculate to the decimal noted.

Figure 7 provides the annual rates of CV events per 1,000 total commercial members and the proportion of the total commercial population CV events coming from the T2DM population.

Figure 7: Annual Rate of CV Events per 1,000 Commercial Members

Service Type	Annual Rate/1,000 Commercial Members	Annual Rate/1,000 Commercial Members from the T2DM Population	Portion of Total Commercial Annual CV Events from the T2DM Population
Myocardial Infarction	1.10	0.36	32.5%
Stroke	0.61	0.19	31.7%
Unstable Angina Admissions	0.02	0.005	32.7%
Heart Failure Admissions	0.40	0.18	45.2%
Coronary Revascularization Procedures	0.95	0.35	36.8%

Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: Due to rounding some numbers may not calculate to the decimal noted.

Figures 6 and 7 Key Points:

- The rate of CV events is higher for the T2DM compared to the demographically adjusted non-T2DM population, including:
  - 4.4x higher MI rate
  - 4.7x higher stroke rate
  - 5.1x higher unstable angina admission rate
  - 9.0x higher heart failure admission rate
  - 4.7x higher coronary revascularization rate
- The portion of the total commercially insured population's CV events coming from the T2DM population includes:
  - 32.5% of the MIs
  - 31.7% of the strokes

- 32.7% of the unstable angina admissions
- 45.2% of the heart failure admissions
- 36.8% of the coronary revascularization procedures

To calculate the portion of the T2DM population costs as well as total commercial population costs contributed by CV events, we identified all facility and professional costs during the inpatient stay of an inpatient CV event or all costs on the day of an outpatient CV event. Figure 8 reports the average allowed cost per cardiovascular event for the total population and the T2DM population.

Figure 8: Average Allowed Cost for each Cardiovascular Event for the Commercial Population (CV Events for all Members)

	Commercial	
Service Type	**All Members**	**Members with T2DM**
Myocardial Infarction	$49,193	$53,192
Stroke	$39,527	$34,125
Unstable Angina Admissions	$10,721	$10,767
Heart Failure Admissions	$23,322	$22,485
Coronary Revascularization Procedures	$38,921	$41,760

Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing. Costs allocated to each event represent all facility and professional costs incurred during the inpatient CV evetn stay and all costs on the day of the event for those ocurring in the outpatient setting.

Taking the CV event costs for the total population, we calculated the allowed PMPM cost contribution of CV events to the total population's PMPM costs. In addition, we calculated the T2DM population's CV event cost on a T2DM allowed $PPPM basis and on a population allowed $PMPM basis. Figure 9 reports the contribution of CV events to total population spend and the portion contributed by T2DM to the commercially insured population total spend.

Figure 9: Commercial - Portion of Allowed PMPM and T2DM PPPM Costs Contributed by Cardiovascular Events (Commercial)

Service Type	**Total Commercial Population CV Event Cost Contribution to $PMPM**	**T2DM CV Event Cost Contribution to T2DM $PPPM**	**T2DM CV Event Cost Contribution to Total Population $PMPM**	**Portion of Total Commercial Population CV Event Costs From the T2DM Population**
Myocardial Infarction	$4.52	$41.17	$1.59	35%
Stroke	$1.99	$14.16	$0.55	27%
Unstable Angina Admissions	$0.01	$0.12	$0.00	33%
Heart Failure Admissions	$0.78	$8.85	$0.34	44%
Coronary Revascularization Procedures	$3.09	$31.65	$1.22	39%
Total Cost of CV Events	**$10.40**	**$95.94**	**$3.70**	**36%**
% of Total PMPM / PPPM Cost Due to CV Events	**2.3% (Total PMPM: $445.98)**	**6.1% (T2DM PPPM: $1,580.71)**	**0.8% (Total PMPM: $445.98)**	

Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing. PMPM: per member per month. PPPM: per patient per month Costs allocated to each event represent the facility and professional costs for events occurring in the inpatient setting and all costs on the day of the event for those ocurring in the outpatient setting. Due to rounding some numbers may not calculate to the decimal noted.

Figure 9 Key Points:

- CV events from the T2DM population make up 36% of the total commercial CV event costs
- 0.8% of total commercial population PMPM cost is contributed by CV events from the T2DM population

In addition to calculating the costs associated with the CV event inpatient stay or CV event outpatient day, we calculated an *incremental cost* of a CV event, estimated by taking the difference between the average PPPM of the T2DM population with a CV event and the risk adjusted average PPPM of the T2DM population not having a CV event. This includes not only the costs during the inpatient stay of the CV event or the day of the outpatient CV event, but all other costs incurred during the year of the event. We segmented the T2DM population into those with and without events in 2014 and compared the annual costs between the T2DM patients with and without CV events. To account for the underlying demographic and morbidity differences between these two cohorts, we risk adjusted the cost of the T2DM population without CV events to reflect the same risk mix as the T2DM population with CV events. The risk adjustment was made using the HHS HCC risk scores for the commercial population.

Figure 10 provides the cost calculation for the incremental cost of CV events among the T2DM population. See Appendix B for detailed methodology.

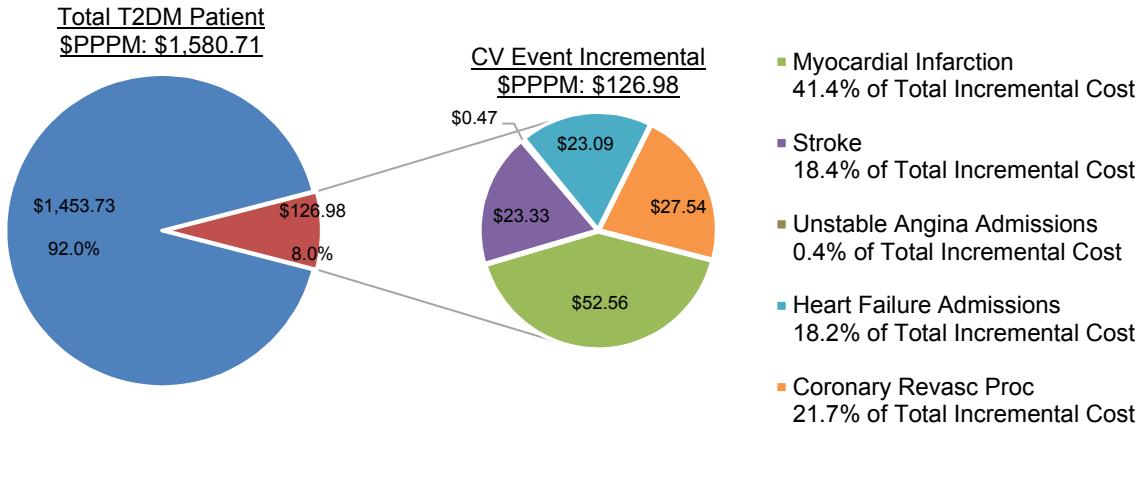
Figure 10: Incremental CV Event Cost Calculation (Commercial)

	Type 2 Diabetes Patients	
	Having CV Event in 2014 (includes CV deaths)	**Not Having CV Event in 2014**
Member Count	14,889	687,727
% of Type 2 Diabetes Patients	2.12%	97.88%
Average HCC Risk Score	8.35	3.75
2014 Allowed $PPPM	$9,219.15	$1,417.32
Incremental CV event cost $PPPM	$7,801.82	
Incremental CV event cost $PPPM (risk adjusted)	$6,063.45	
Incremental CV event cost $PPPM (All Patients with T2DM)	$163.38	
Incremental CV event cost $PPPM (risk adjusted) (All Patients with T2DM)	$126.98 (8.0% of T2DM PPPM)**	
Incremental CV event cost $PMPM	$6.30	
Incremental CV event cost $PMPM (risk adjusted) (Total population)	$4.89 (1.1% of Total PMPM)**	

Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing.**Total PMPM: $445.98, T2DM PMPM $60.91
CV Events include myocardial infarctions, strokes, unstable angina admissions, heart failure admissions, and coronary revascularization procedures. The risk scores reflects use of the HHS-HCC Gold risk score.

We allocated the incremental CV event cost by CV event type. Figure 11 provides the distribution of T2DM CV event costs by CV event and the contribution to total T2DM PPPM costs.

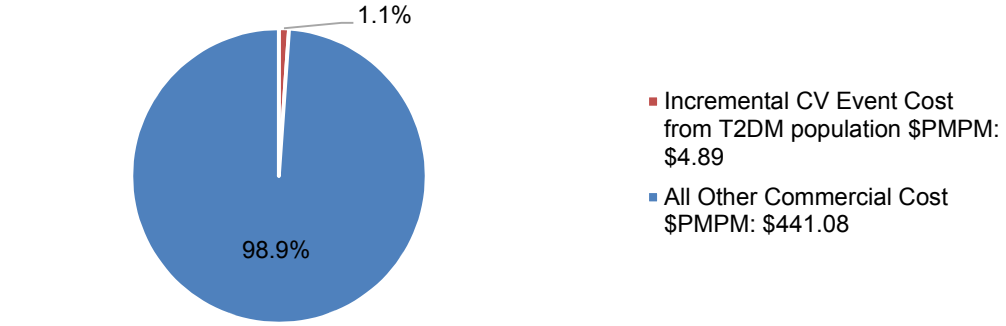
Figure 11: Estimated Distribution of Each Cardiovascular Event to Total Incremental Event Cost and as a Portion of Commercial Spend



Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing.

Figure 12 provides the portion of total commercial costs that come from the T2DM population's CV events.

Figure 12: Incremental CV Event Cost as a % of Total Commercial $PMPM ($445.98)



Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing.

Figure 10, 11, and 12 Key Points:

- 8.0% of T2DM commercial costs is from T2DM incremental CV event costs
- Approximately $5 PMPM or 1.1% of total commercial cost is from T2DM incremental CV event costs

RESULTS: MEDICARE POPULATION

This section provides population-level statistics for Medicare FFS beneficiaries with T2DM. Using the 2014 Medicare 5% sample data as our index year, we identified all Medicare beneficiaries with T2DM using standard HEDIS criteria. Description of the databases, methodology, and claim coding details can be found in Appendix A, B and C.

DEMOGRAPHIC CHARACTERISTICS

Figure 13 provides the 2014 prevalence, average age, mortality rate and risk score for the T2DM population, non T2DM population and the total population in the Medicare 5% sample. The risk scores are calculated using publicly available algorithms from the Centers for Medicare and Medicaid Services Hierarchical Condition Category (CMS HCC) risk scores that account for age, gender and comorbidities (see Appendix B). Additional detail for the Medicare population by eligibility category is provided in Appendix D.

Figure 13: Key Demographic Characteristics
T2DM Population vs. Total Population (Medicare)

	Medicare
Total Members in Sample	1,441,306
T2DM Patients in Sample	318,668
T2DM Prevalence	22.1%
Total Members	
Average Age	71.7
% Female	55.4%
Average Risk Score*	1.14
Annual Mortality Rate	4.7%
Total Members without T2DM	
Average Age	71.5
% Female	56.1%
Average Risk Score*	0.99
Annual Mortality Rate	4.3%
T2DM Patients	
Average Age	72.2
% Female	52.7%
Average Risk Score*	1.64
Annual Mortality Rate	6.4%

Source: Milliman Analysis of Medicare 5% Sample (2014 index year, 2013 look back year for HCC risk score)
Notes: *Risk Scores represent the Medicare CMS-HCC risk score for the Medicare population (see appendix B for methodology).

Figure 13: Key Points

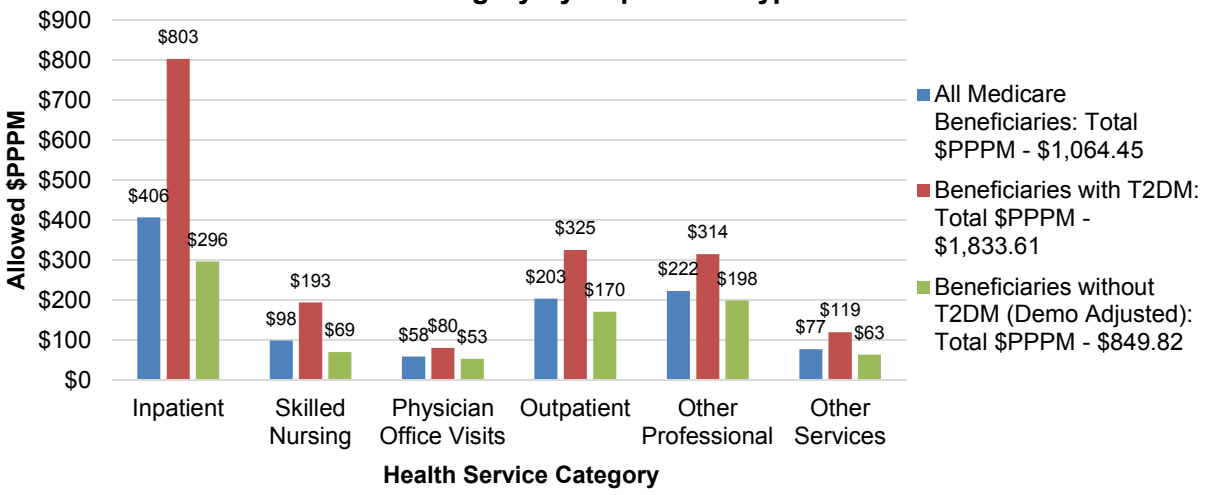
- 22.1% T2DM prevalence rate in the Medicare FFS population
- T2DM Medicare population has an annual mortality rate 1.4x that of the total Medicare population and 1.5x that of the non T2DM population
- The burden of diabetes is evident when comparing risk scores: Medicare T2DM population has 1.4x higher HCC score than the total Medicare population and 1.6x higher than the Medicare non T2DM population

T2DM COST AND UTILIZATION METRICS

In this section, we examine allowed claim cost (all reimbursement by the payer plus member cost sharing) and key medical service utilization within the T2DM population and compare these findings to a demographically adjusted non-T2DM population and the total Medicare population. Note that prescription drug costs under Medicare Part D are not available for the FFS Medicare population.

Figure 14 provides the average Medicare FFS per patient per month (PPPM) allowed cost of the T2DM population, the demographically adjusted non-T2DM population and the total population, by major service category. The PPPM costs in Figure 14 considers the cost for the indicated population only, while in Figure 15, per member per month (PMPM) allowed cost considers the cost of the indicated population spread across the total population.

Figure 14: Medicare - Allowed PPPM Costs for each Health Service Category by Population Type



Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: Inpatient and Skilled Nursing costs include Facility and Professional costs. PPPM: per patient per month. Allowed costs represent all reimbursement from the payer plus member cost sharing. The demo adjusted non-T2DM population reflects non-T2DM beneficiaries with the same age/gender mix as the T2DM beneficiaries. The $PPPM for the total Medicare population is equivalent to the $PMPM for the total Medicare population.

We calculated the PMPM allowed cost for the T2DM population which takes all costs and member months for the T2DM population and divides by all costs and member months of the total population. Figure 15 provides the T2DM population $PMPM and the portion of total Medicare FFS spend from the T2DM population.

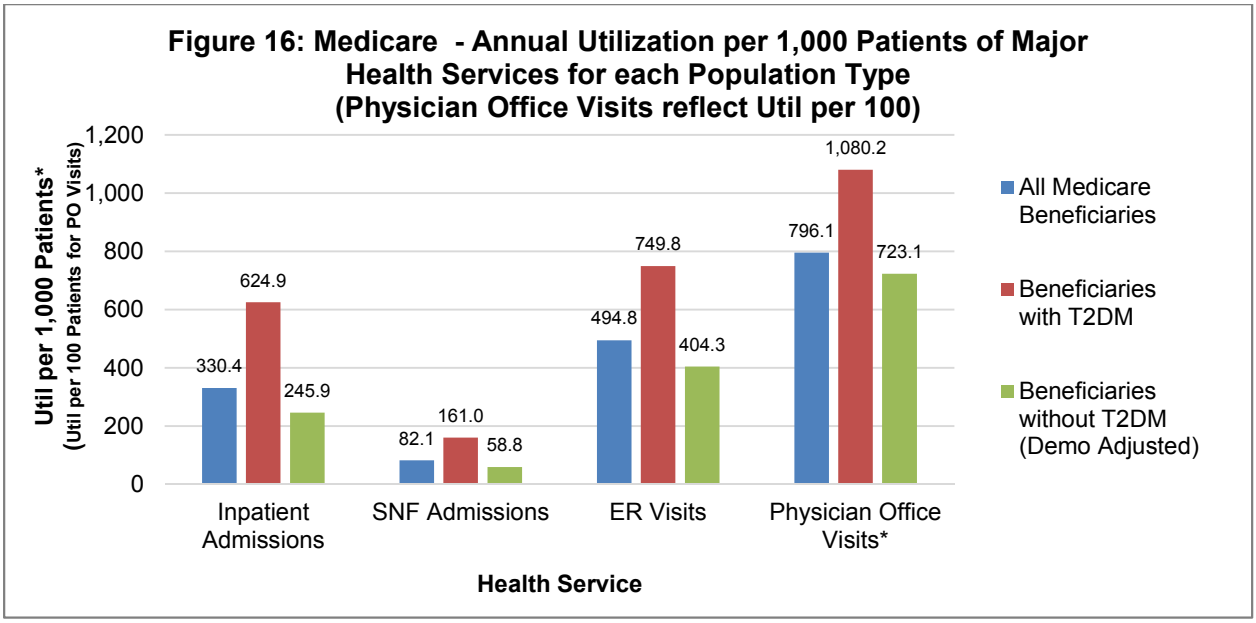
Figure 15: Portion of Allowed $PMPM Costs for each Health Service Category by Population Type (Medicare)					
Service Type	All Medicare Beneficiaries		Beneficiaries with T2DM		Portion of Total Population $PMPM from T2DM Population
	Allowed $PMPM	Distribution of Spend	Allowed $PMPM	Distribution of Spend	
Inpatient	$405.96	38.1%	$176.53	43.8%	43.5%
Skilled Nursing	$98.01	9.2%	$42.53	10.5%	43.4%
Physician Office Visits	$58.46	5.5%	$17.59	4.4%	30.1%
Outpatient	$203.13	19.1%	$71.38	17.7%	35.1%
Other Professional	$221.89	20.8%	$69.11	17.1%	31.1%
Other Services	$77.01	7.2%	$26.21	6.5%	34.0%
Total	**$1,064.45**	**100%**	**$403.35**	**100%**	**37.9%**

Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: Inpatient and Skilled Nursing costs include Facility and Professional costs. Allowed costs represent all reimbursement from the payer plus member cost sharing. PMPM: per member per month. Due to rounding some numbers may not calculate to the decimal noted.

Figures 14 and 15: Key Points

- The average allowed $PPPM for a Medicare beneficiary with T2DM is 2.2x the average allowed $PPPM for a demographically adjusted non-T2DM beneficiary
- Although the prevalence of T2DM is 22.1%, PMPM costs for beneficiaries with T2DM are 37.9% of the total Medicare FFS population's allowed PMPM cost including:
  - 43.5% of the total inpatient (IP) spend
  - 43.4% of the total skilled nursing facility (SNF) spend
  - 30.1% of the total physician office visit spend

Figure 16 provides the annual utilization of key services for the Medicare FFS T2DM population, the demographically adjusted non-T2DM population and the total population, by major service category. We report utilization on a per 1,000 population basis except for physician office visits which we report on a per 100 population basis for scaling purposes. The utilization in Figures 16 considers the utilization for the indicated population while the utilization shown in Figure 17 spreads the utilization from the T2DM population across the total population.



Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM beneficiaries with the same age/gender mix as the T2DM beneficiaries.
*Physician office visits are reported on a per 100 member basis

Figure 17 provides the annual utilization rates of key services per 1,000 total Medicare FFS beneficiaries and the portion coming from the T2DM population.

Figure 17: Annual Utilization per 1,000 Medicare FFS Beneficiaries by Health Service Category

Service Type	Annual Utilization/1,000 Medicare Beneficiaries	Annual Utilization/1,000 Medicare Beneficiaries from the T2DM Population	Portion of Annual Medicare Utilization from the T2DM Population
Inpatient Admissions	330.44	137.46	41.6%
Skilled Nursing Facility Admissions	82.07	35.41	43.1%
ER Visits	494.78	164.94	33.3%
Physician Office Visits	7,960.57	2,376.18	29.8%

Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM beneficiaries with the same age/gender mix as the T2DM beneficiaries. Due to rounding some numbers may not calculate to the decimal noted.

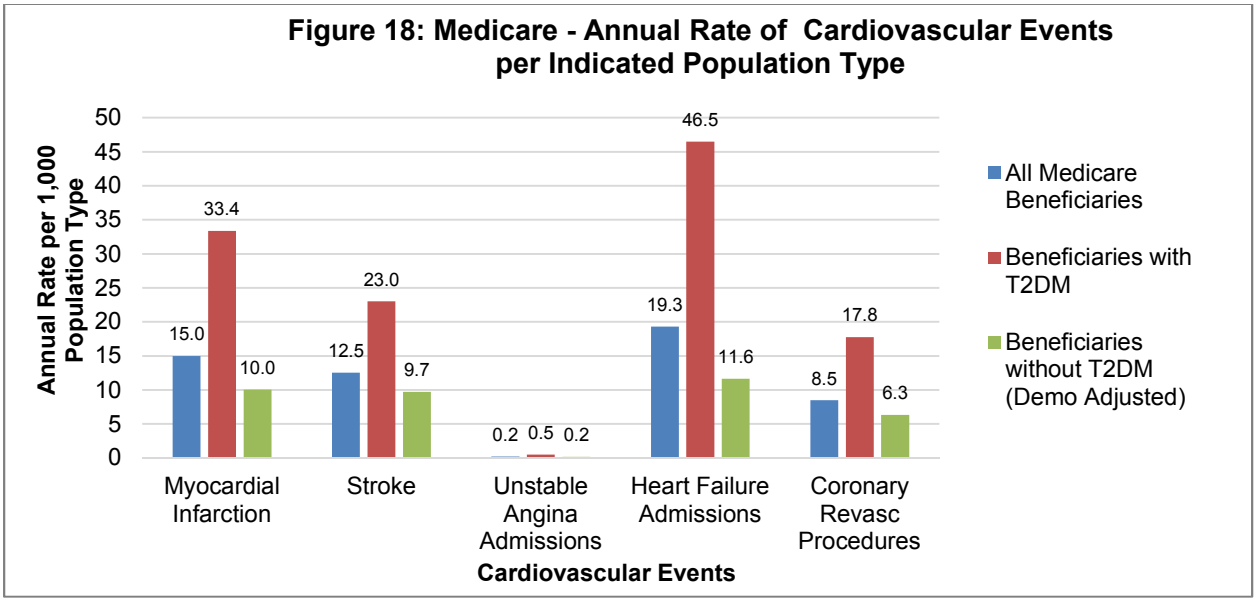
Figure 16 and 17: Key Points

- Medicare beneficiaries with T2DM utilize significantly more services than demographically (age/gender) adjusted non-T2DM beneficiaries:
  - 2.5 x the number of IP admissions
  - 2.7 x the number of SNF admissions
  - 1.9 x the number of ER visits
  - 1.5 x the number of physician office visits
- Medicare beneficiaries with T2DM account for a significant percentage of the total Medicare utilization:
  - 41.6% of the total IP utilization
  - 43.1% of the total SNF utilization
  - 29.8% of the total physician office visit utilization

CARDIOVASCULAR EVENTS

Patients with T2DM are at higher risk for CV events and have a higher incidence of CV events. Because of the higher incidence of CV events, patients with T2DM account for a significant portion of CV events and CV costs in the total population.

Figure 18 provides the annual rate of 5 CV events (myocardial infarction, stroke, unstable angina admissions, heart failure admissions and coronary revascularization procedures) among the Medicare FFS T2DM population, the demographically adjusted non-T2DM population and the total population. The rates in Figure 18 reflect the rates among the indicated population while the rates in Figure 19 spread the CV events of the T2DM population across the total population.



Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM beneficiaries with the same age/gender mix as the T2DM beneficiaries. Due to rounding some numbers may not calculate to the decimal noted.

Figure 19 provides the portion of the total Medicare FFS population CV events coming from the T2DM population.

Figure 19: Annual Rate of CV Events per 1,000 Medicare FFS Beneficiaries

Service Type	Annual Rate/1,000 Medicare Beneficiaries	Annual Rate/1,000 Medicare Beneficiaries from the T2DM Population	Portion of Total Medicare Annual CV Events from the T2DM Population
Myocardial Infarction	14.98	7.34	49.0%
Stroke	12.54	5.06	40.4%
Unstable Angina Admissions	0.22	0.11	47.8%
Heart Failure Admissions	19.30	10.23	53.0%
Coronary Revascularization Procedures	8.47	3.91	46.1%

Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: Due to rounding some numbers may not calculate to the decimal noted.

Figures 18 and 19 Key Points:

- The rate of CV events is higher for the T2DM population compared to the rate for the demographically adjusted non-T2DM population, including:
  - 3.3x higher MI rate
  - 2.4x higher stroke rate
  - 3.2x higher unstable angina admission rate
  - 4.0x higher heart failure admission rate
  - 2.8x higher coronary revascularization rate

- The portion of the total Medicare FFS population CV events coming from the T2DM population includes:
  - 49.0% of the MIs
  - 40.4% of the strokes
  - 47.8% of the unstable angina admissions
  - 53.0% of the heart failure admissions
  - 46.1% of the coronary revascularization procedures

To calculate the portion of the T2DM population costs as well as total Medicare FFS costs contributed by CV events, we identified all facility and professional costs during the inpatient stay of an inpatient CV event or all costs on the day of an outpatient CV event. Figure 20 reports the average allowed cost per cardiovascular event for the total population and the T2DM population.

Figure 20: Average Allowed Cost for each Cardiovascular Event for the Medicare Population (CV Events for all Beneficiaries)

	Medicare	
Service Type	**All Beneficiaries**	**Beneficiaries with T2DM**
Myocardial Infarction	$19,092	$20,688
Stroke	$11,279	$11,880
Unstable Angina Admissions	$5,395	$5,647
Heart Failure Admissions	$10,724	$11,041
Coronary Revascularization Procedures	$15,953	$17,272

Source: Milliman Analysis of Medicare 5% Sample (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing. Costs allocated to each event represent all facility and professional costs incurred during the inpatient CV evetn stay and all costs on the day of the event for those ocurring in the outpatient setting.

Taking the CV event costs for the total population, we calculated the allowed PMPM cost contribution of CV events to the total population's PMPM costs. In addition we calculated the T2DM population's CV event cost on a T2DM allowed PPPM cost basis and on a population allowed PPPM cost basis. Figure 21 reports the contribution of specified CV events to total population spend and the portion contributed by T2DM to the Medicare FFS population total spend.

For the Medicare population, we include the cost of CV related deaths that are not associated with the 5 major CV events. See methodology for identification of CV related deaths not associated with the 5 major CV events and cost calculation.

Figure 21: Medicare - Portion of Allowed PMPM and T2DM PPPM Costs Contributed by Cardiovascular Events				
Service Type	**Total Medicare Population CV Event Cost Contribution to $PMPM**	**T2DM CV Event Cost Contribution to T2DM $PPPM**	**T2DM CV Event Cost Contribution to Total Population $PMPM**	**Portion of Total Medicare Population CV Event Costs From the T2DM Population**
Myocardial Infarction	$23.83	$57.54	$12.66	53%
Stroke	$11.79	$22.78	$5.01	43%
Unstable Angina Admissions	$0.10	$0.23	$0.05	50%
Heart Failure Admissions	$17.24	$42.77	$9.41	55%
Coronary Revascularization Procedure	$11.27	$25.58	$5.63	50%
CV Related Death*	$13.01	$27.00	$5.94	46%
Total Cost of CV Events	**$77.23**	**$175.90**	**$38.69**	**50%**
% of Total PMPM / PPPM Cost Due to CV Events	**7.3% (Total PMPM: $1,064.45)**	**9.6% (T2DM PPPM: $1,833.61)**	**3.6% (Total PMPM: $1,064.45)**	

Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing. PMPM: per member per month. PPPM: per patient per month. Costs allocated to each event represent the facility and professional costs for events occurring in the inpatient setting and all costs on the day of the event for those ocurring in the outpatient setting. Due to rounding some numbers may not calculate to the decimal noted.
*The costs for CV related death are for deaths not due to other events listed in the table. See methodology for identifying Medicare CV related deaths not associated with any of the 5 CV events and cost.

Figure 21 Key Points:

- CV events from the T2DM population make up 50% of total Medicare CV event costs
- 3.6% of total Medicare population PMPM cost is contributed by CV events from the T2DM population

In addition to calculating the costs associated with the CV event inpatient stay or CV event outpatient day, we calculated an *incremental cost* of a CV event, estimated by taking the difference between the average PPPM of the T2DM population with a CV event and the risk adjusted average PPPM of the T2DM population not having a CV event. This includes not only the costs during the inpatient stay of the CV event or the day of the outpatient CV event, but all other costs incurred during the year of the event. We segmented the T2DM population into those with and without events in 2014 and compared the annual costs between the T2DM patients with and without CV events. To account for the underlying demographic and morbidity differences between these two cohorts, we risk adjusted the cost of the T2DM population without CV events to reflect the same risk mix as the T2DM population with CV events. The risk adjustment was made using the CMS HCC risk scores for the Medicare population.

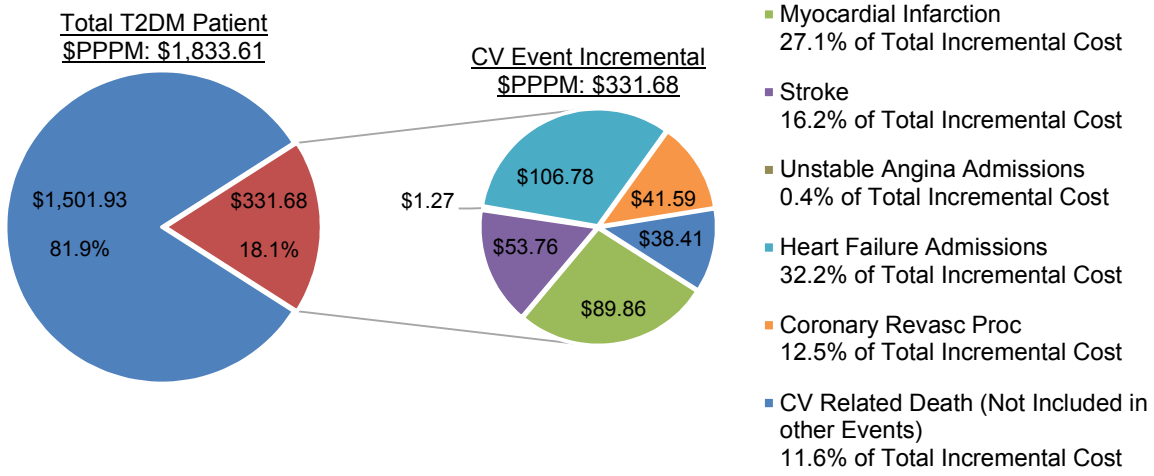
Figure 22 provides the cost calculation for the incremental cost of CV events among the T2DM population. See Appendix B for detailed methodology.

Figure 22: Incremental CV Event Cost Calculation (Medicare)		
	T2DM Beneficiaries	
	Having CV Event in 2014 (includes CV deaths)	Not Having CV Event in 2014
Member Count	30,835	287,833
% of Type 2 Diabetes Patients	9.68%	90.32%
Average HCC Risk Score	2.52	1.54
2014 Allowed $PPPM	$6,232.41	$1,425.07
Incremental CV event cost $PPPM	$4,807.34	
Incremental CV event cost $PPPM (risk adjusted)	$3,902.94	
Incremental CV event cost $PPPM (All Patients with T2DM)	$408.54	
Incremental CV event cost $PPPM (risk adjusted) (All Patients with T2DM)	$331.68 (18.1% of T2DM PPPM)**	
Incremental CV event cost $PMPM	$89.87	
Incremental CV event cost $PMPM (risk adjusted) (Total population)	$72.96 (6.9% of Total PMPM)**	

Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing. **Total PMPM: $1064.45, T2DM PMPM $403.37
CV Events include myocardial infarctions, strokes, unstable angina admissions, heart failure admissions, coronary revascularization procedures and other CV related deaths not included in the previously mentioned events. The risk scores used here reflect the Medicare CMS-HCC risk score.

We allocated the incremental CV event cost by CV event type. Figure 23 provides the distribution of T2DM CV event costs by CV event and the contribution to total T2DM PPPM costs.

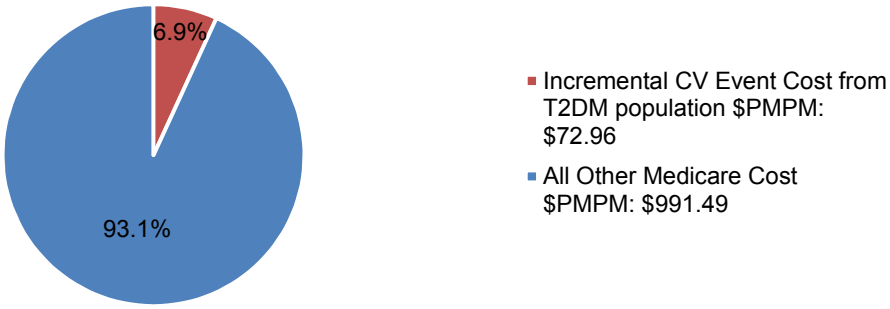
Figure 23: Estimated Distribution of Incremental Cardiovascular Event Costs and Portion of T2DM PPPM Costs (Medicare)



Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing.

Figure 24 provides the portion of total Medicare costs that come from the T2DM population's CV events.

Figure 24: Incremental T2DM CV Event Cost as a % of Total Medicare $PMPM ($1,064.45)

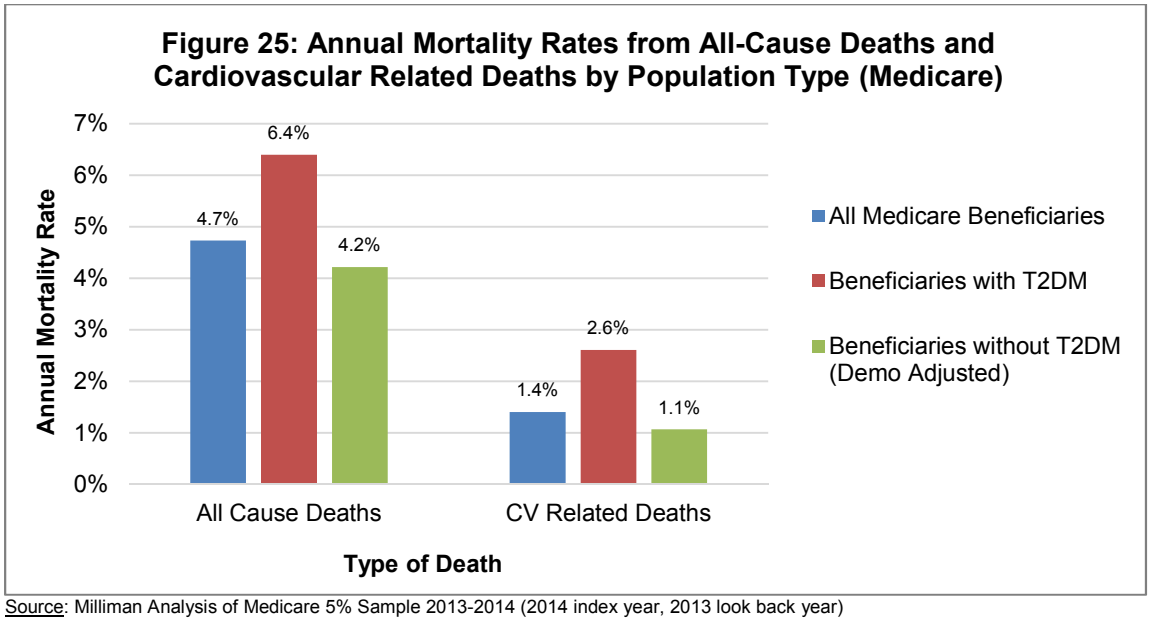


Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: Allowed costs represent all reimbursement from the payer plus member cost sharing.

Figure 22, 23, and 24 Key Points:

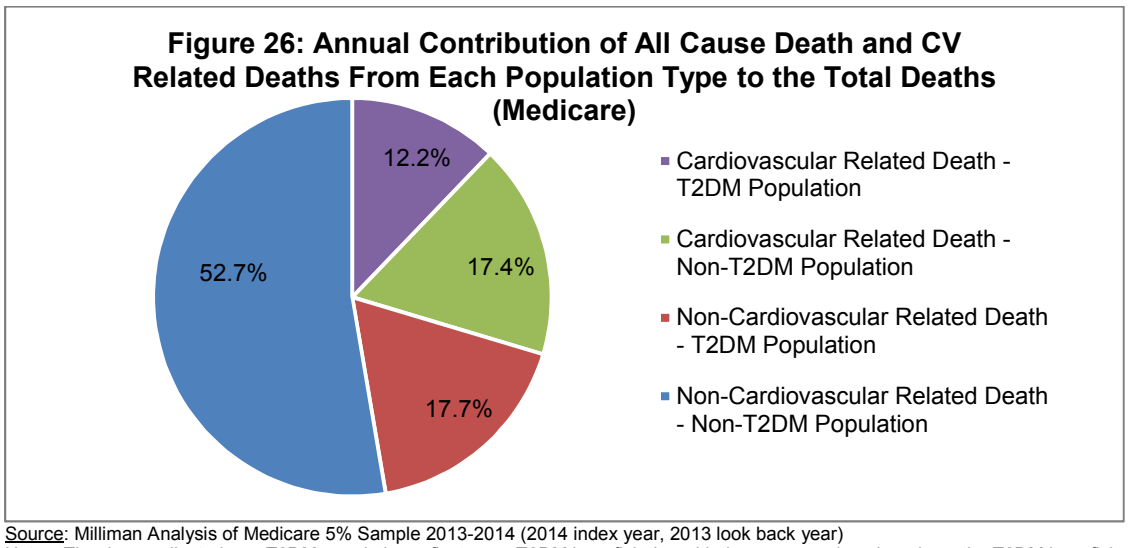
- 18.1% of T2DM Medicare FFS cost is from T2DM's incremental CV event costs
- Approximately $73 PMPM or 6.9% of total Medicare FFS cost is from T2DM incremental CV event costs

Figure 25 reports all cause and CV cause death rates for the Medicare population.



Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM beneficiaries with the same age/gender mix as the T2DM beneficiaries

Figure 26 reports the all cause and CV cause deaths from the T2DM and non-T2DM population as a portion of all Medicare deaths.



Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM beneficiaries with the same age/gender mix as the T2DM beneficiaries

Figure 25 and 26 Key Points:

- 29.9% of Medicare all cause deaths are among the T2DM population
- 41.1% of the Medicare CV deaths are among the T2DM population
- Contribution of CV deaths to all cause deaths:
  - 29.6% for total population
  - 40.8% for T2DM population

CONCLUSIONS

In this study, we examined commercially insured and Medicare populations of patients with T2DM to understand the contribution of CV events to medical service utilization and costs. Previous investigations have been based on smaller populations and single payer sources. Our analysis addressed both the Medicare FFS population and the commercially insured population.

In addition to confirming higher costs for patients with T2DM in both these populations compared to a demographically adjusted non-T2DM population, we found that the T2DM population contributes 38% of total Medicare FFS population's costs and 13.7% of total commercially insured population's costs.

We found the annual rate of CV events to be 2-4x higher in the Medicare population and 4-9x higher in the commercial population compared to a demographically adjusted non-T2DM population. In the Medicare FFS population, the T2DM population incurred approximately 40%-53% of the total number of MIs, strokes, admissions for unstable angina and heart failure, and cardiovascular procedures while that number was 32%-45% for the T2DM commercial population. The annual mortality in 2014 for Medicare FFS patients with T2DM was 6.4%, compared with 4.7% for the total Medicare population and 41.1% of the CV related deaths in the Medicare FFS population come from patients with T2DM.

We calculated the incremental cost associated with CV events for patients with T2DM. In the Medicare FFS population, the incremental cost represents 18.1% of the T2DM PPPM or 6.9% of the total FFS Medicare population PMPM cost (approximately $73 PMPM). In the commercially insured population, the incremental cost represents 8.0% of total T2DM cost or 1.1% of total commercially insured population PMPM cost (approximately $5 PMPM).

Findings from our claims data analyses support earlier findings that patients with T2DM contribute a substantial portion of total population CV events and cost. Considering the CV burden associated with T2DM, payers and providers alike should focus care management efforts on reducing CV events among the T2DM population.

APPENDIX A: KEY DATA SOURCES

Medicare 5% Sample. The Medicare 5% sample is a limited data set containing all Medicare paid claims generated by a statistically-balanced sample of Medicare beneficiaries. Information includes county of residence, diagnosis codes, procedure codes, DRG codes, site of service information, beneficiary age, eligibility status and an indicator for HMO enrollment. Member identification codes are consistent from year to year and allow for multiyear longitudinal studies. The Medicare data does not include Part D prescription drug data. We used 2013-2014 data.

Truven Health Analytics MarketScan Commercial Claims Database. The Truven Health Analytics MarketScan Commercial Claims Database (MarketScan) contains all paid claims generated by 15-50 million commercially insured lives annually (depending on the year of data). The MarketScan database represents the inpatient and outpatient healthcare service use of individuals nationwide who are covered by the benefit plans of large employers, health plans, government, and public organizations. The data includes diagnosis codes, procedure codes, DRG codes, and NDC codes, along with site of service information and the amounts paid by commercial insurers. The MarketScan database links paid claims and encounter data to detailed patient information across sites and to types of providers. Patient identifiers are consistent over time, allowing for longitudinal studies. The annual medical database includes private sector health data from approximately 100 payers. We used the MarketScan data from 2009-2014.

APPENDIX B: METHODOLOGY

Our analysis followed the steps below:

1. Identify eligible denominator population in the 2014 Medicare 5% Sample and MarketScan database:

Using the eligibility file of both databases, we required that members meet the following eligibility requirements.

- At least one month of coverage in 2014
- 12 month of coverage in 2013
- For Medicare:
  - Part A and Part B coverage for all months of eligibility
  - Not enrolled in an HMO (Medicare Advantage) in any months of eligibility
- For commercial:
  - Age 18-64
  - Not enrolled in a capitated plan
  - Prescription drug coverage for all months of eligibility
  - Inclusive of employees and dependents

2. Identify T2DM patients in the 2014 denominator population

The identification of diabetes follows HEDIS criteria. Individuals qualify based on meeting any of the below:

- At least two outpatient visits, observation visits, or nonacute inpatient claims on different dates of service, with an ICD-9 code of diabetes in any position of the claim. Visit type need not be the same for the two claims. See "diabetes ICD-9 codes" and "claim type codes" in Appendix C
- OR, at least one acute inpatient encounter with an ICD-9 code of diabetes in any position of the claim. See "diabetes ICD-9 codes" and "claim type codes" in Appendix C
- OR, at least one ED visit with a diagnosis of diabetes. See "diabetes ICD-9 codes" tab and "claim type codes" in Appendix C
- OR for the commercial population, one or more prescription drug claims for a diabetes drug (http://www.ncqa.org/HEDISQualityMeasurement/HEDISMeasures/HEDIS2016/HEDIS2016NDCLicense/HEDIS2016FinalNDCLists.aspx)

The identification algorithm for Type 1 and T2DM is as follows:

Type 1 diabetes (for exclusion proposes)
Meets HEDIS diabetes definition AND
Has a 5th digit for 250.xx coded at least 1 time and the 5th digit is always coded with 1 or 3, OR
Has 5th digit for 250.xx coded at least 1 time and the 5th digit is 1 or 3 the majority of the time

T2DM
Meets HEDIS diabetes definition AND
Does not meet Type 1 diabetes definition

3. Identify 2014 Cardiovascular events among patients with T2DM

For each patient with T2DM, identify incidence of each of the following events using the 2014 claim experience:

- **All cause death (Medicare only)**
- **Death from cardiovascular causes (Medicare only)**
  - For deaths in a hospital (identified by discharge status), designate as CV related if the inpatient death admission has any of the following:
    - MI, stroke, HF, pulmonary embolism, cardiac arrhythmia or unstable angina DRG
    - Coronary revascularization procedure
    - Peripheral vascular procedures or amputation
    - MI, stroke, HF, pulmonary embolism, cardiac arrhythmia or unstable angina ICD9 diagnosis codes, coded in any position of the IP claim (for MI do not include ICD-9: 412 old MI)
  - For deaths not occurring in a hospital, follow steps below to determine if CV related:

        - Claims on day of death coded with any of the following conditions in the PRIMARY position of the claim:
          MI (do not include ICD-9: 412 old MI)
          Stroke
          HF
          Unstable angina
          Cardiac arrhythmia
          Pulmonary embolism
    - Claims on day of death coded with coronary revascularization, peripheral vascular procedure or amputation procedure codes
    - If no claims on day of death, or if no claims coded with the above, perform 14 day look back from the death date for IP admissions and designate as CV related if admission meets any of the following criteria:
        - MI, stroke, HF, pulmonary embolism, cardiac arrhythmia or unstable angina DRG
        - Coronary revascularization procedure
        - Peripheral vascular procedures or amputation
    - If no IP claims within 14 days of death or no IP claims within 14 days meeting the above criteria, examine facility OP claims in 14 days prior to death and designate as CV related if claim for:
        - Coronary revascularization procedure
        - Peripheral vascular procedures or amputation
    - If no claims meeting any of the above criteria, identify ER claims in the 14 days prior to the death date and designate as CV related if coded in the PRIMARY position for:
      MI (do not include ICD-9: 412 old MI)
      Stroke
      HF
      Unstable angina
      Cardiac arrhythmia
      Pulmonary embolism

- **Myocardial infarction without death –**
    - IP admissions - MI DRG (280, 281, 281, 296, 297, 298) or MI in any position of claim (do not include ICD-9: 412 old MI)
    - Stand-alone ER visits – MI ICD9 in primary position (do not include ICD-9: 412 old MI)
- **Stroke without death –**
    - IP - stroke DRG or stroke in primary position of claim
    - ER – stroke ICD9 in primary position
- **Hospitalization for unstable angina (DRG 311) without death**
- **Hospitalization for heart failure (DRG 291, 292, 293) without death**
- **Coronary revascularization procedure without death**

4. Calculate cost of CV events – 2 methods

- Cost of event: all costs during IP stay of event or day of event
- Calculation of incremental risk-adjusted annual cost difference between patients with T2DM with and without CV events. Risk adjustment was calculated as follows:
    - For Medicare, we risk adjusted using CMS hierarchical condition category (HCC) scores which consider age/gender and comorbidities. 12 months of 2013 data for each individual was used to calculate a risk score that predicts 2014 costs.
    - For commercial, we used a federally certified risk adjustment methodology developed by the US Department of Health and Human Services (HHS) to account for differences in age, gender, and comorbidity. The methodology uses a hierarchical condition category (HCC) system to categorize diagnosis codes by severity for calculating “metal-level” risk scores (i.e., platinum, gold, silver, bronze, and catastrophic) (Centers for Disease Control and Prevention 2013). The risk scores are intended to predict cost in the subsequent year. The gold metal level was chosen to best reflect the risk score for an average commercially insured population.

Claims were grouped into the following service categories using the Milliman Health Cost Guideline Grouper based on ICD-9 procedure codes, CPT codes, HCPCS codes, revenue codes, DRGs and place of service codes.

Service Category	Description
Inpatient	Includes all facility and professional charges associated with an inpatient stay (medical, surgical, psych/SA, acute rehab, LTAC)
Skilled Nursing	Includes all facility and professional charges associated with a stay in a skilled nursing facility.
Physician Office Visits	Includes visits to a physician's office or other professional's office, visits to the insured's home or custodial facility, and some professional case management services. Costs include the charges of the primary professional or the referral professional.
Outpatient	Includes all facility charges for services occurring in the outpatient facility setting, i.e. ER visits not resulting in an IP stay, OP surgery, lab, radiology, pathology, PT/OT/ST, infused drugs etc.
Other Professional	Includes services performed by a physician or other qualified professional which are not included in the inpatient, skilled nursing, or physician office visits. Also includes DME, ambulance and prosthetics.
Other Services	Includes the costs associated with home health and hospice.
Prescription Drugs	Includes drug claims covered under the prescription drug benefit

APPENDIX C: CODE SET DETAIL

The following CPT and Revenue codes were used to identify claims as Acute Inpatient, Observation, Nonacute Inpatient, Emergency Department, or Outpatient site of service.

Claim type	CPT code	Revenue codes
Outpatient	99201-99205, 99211-99215, 99241-99245, 99341-99345, 99347-99350, 99381-99387, 99391-99397, 99401-99404, 99411, 99412, 99420, 99429, 99455, 99456, G0402, G0438,G0439,G0463,T1015	0510-0517,0519-0523, 0526-0529, 0982, 0983
Non-acute inpatient	99304-99310, 99315, 99316, 99318, 99324-99328, 99334-99337	0118, 0128, 0138, 0148, 0158, 0190-0194,0199, 0524, 0525, 0550-0552, 0559,0660-0663,0669
Acute inpatient	99221-99223, 99231-99233, 99238, 99239, 99251-99255, 99291,99468,99469,99471,99472,99475-99480	010x, 0110-0115, 0117,0119-0125, 0127,0129-0135, 0137,0139-0145, 0147,0149-0155, 0157,0159-0162, 0164,0166-0175,0179,0200-0204,0206-0214, 0219, 0720-0724, 0729, 0987
Observation	99217-99220	
Emergency department	99281-99285	0450-0452,0456,0459, 0981

The following ICD-9-CM diagnosis codes were used to identify diabetes.

Code	Code Description
250.00	diabetes mellitus without mention of complication, type ii or unspecified type, not stated as uncontrolled
250.01	diabetes mellitus without mention of complication, type i [juvenile type], not stated as uncontrolled
250.02	diabetes mellitus without mention of complication, type ii or unspecified type, uncontrolled
250.03	diabetes mellitus without mention of complication, type i [juvenile type], uncontrolled
250.10	diabetes with ketoacidosis, type ii or unspecified type, not stated as uncontrolled
250.11	diabetes with ketoacidosis, type i [juvenile type], not stated as uncontrolled
250.12	diabetes with ketoacidosis, type ii or unspecified type, uncontrolled
250.13	diabetes with ketoacidosis, type i [juvenile type], uncontrolled
250.20	diabetes with hyperosmolarity, type ii or unspecified type, not stated as uncontrolled
250.21	diabetes with hyperosmolarity, type i [juvenile type], not stated as uncontrolled
250.22	diabetes with hyperosmolarity, type ii or unspecified type, uncontrolled
250.23	diabetes with hyperosmolarity, type i [juvenile type], uncontrolled
250.30	diabetes with other coma, type ii or unspecified type, not stated as uncontrolled

Code	Code Description
250.31	diabetes with other coma, type i [juvenile type], not stated as uncontrolled
250.32	diabetes with other coma, type ii or unspecified type, uncontrolled
250.33	diabetes with other coma, type i [juvenile type], uncontrolled
250.40	diabetes with renal manifestations, type ii or unspecified type, not stated as uncontrolled
250.41	diabetes with renal manifestations, type i [juvenile type], not stated as uncontrolled
250.42	diabetes with renal manifestations, type ii or unspecified type, uncontrolled
250.43	diabetes with renal manifestations, type i [juvenile type], uncontrolled
250.50	diabetes with ophthalmic manifestations, type ii or unspecified type, not stated as uncontrolled
250.51	diabetes with ophthalmic manifestations, type i [juvenile type], not stated as uncontrolled
250.52	diabetes with ophthalmic manifestations, type ii or unspecified type, uncontrolled
250.53	diabetes with ophthalmic manifestations, type i [juvenile type], uncontrolled
250.60	diabetes with neurological manifestations, type ii or unspecified type, not stated as uncontrolled
250.61	diabetes with neurological manifestations, type i [juvenile type], not stated as uncontrolled
250.62	diabetes with neurological manifestations, type ii or unspecified type, uncontrolled
250.63	diabetes with neurological manifestations, type i [juvenile type], uncontrolled
250.70	diabetes with peripheral circulatory disorders, type ii or unspecified type, not stated as uncontrolled
250.71	diabetes with peripheral circulatory disorders, type i [juvenile type], not stated as uncontrolled
250.72	diabetes with peripheral circulatory disorders, type ii or unspecified type, uncontrolled
250.73	diabetes with peripheral circulatory disorders, type i [juvenile type], uncontrolled
250.80	diabetes with other specified manifestations, type ii or unspecified type, not stated as uncontrolled
250.81	diabetes with other specified manifestations, type i [juvenile type], not stated as uncontrolled
250.82	diabetes with other specified manifestations, type ii or unspecified type, uncontrolled
250.83	diabetes with other specified manifestations, type i [juvenile type], uncontrolled
250.90	diabetes with unspecified complication, type ii or unspecified type, not stated as uncontrolled
250.91	diabetes with unspecified complication, type i [juvenile type], not stated as uncontrolled
250.92	diabetes with unspecified complication, type ii or unspecified type, uncontrolled
250.93	diabetes with unspecified complication, type i [juvenile type], uncontrolled
357.2x	polyneuropathy in diabetes
366.41	diabetic cataract
362.0x	diabetic retinopathy

The following ICD-9-CM diagnosis codes were used to identify conditions associated with high cardiovascular risk.

Condition Name	Code Description	ICD9 Code	CPT Code
Myocardial Infarction (MI)	Acute myocardial infarction	410.xx	
Stroke	Subarachnoid hemorrhage	430	
	Intracerebral hemorrhage	431	
	Other unspecified intracranial hemorrhage	432.xx	
	Occlusion and stenosis of precerebral arteries	433.xx	
	Occlusion of cerebral arteries	434.xx	
Unstable Angina	Angina Decubitus	413.0	
	Prinzmetal Angina	413.1	
	Other and unspecified angina pectoris	413.9	
	Intermediate coronary syndrome	411.1	
	Acute coronary occlusion without myocardial infarction	411.81	
	Acute coronary insufficiency/subendocardial ischemia	411.89	
Transient Ischemic Attack	Transient Cerebral Ischemia	435.x	
Coronary Revascularization Procedures	Removal of coronary artery obstruction and insertion of stent(s)	36.0x	
	Bypass anastomosis for heart revascularization(s)	36.1x	
	Heart revascularization by arterial implant	36.2	
	Other heart revascularization	36.3x	
	Transmyocardial laser revascularization, by thoracotomy; (separate procedure)		33140
	Coronary artery bypass, vein only; single coronary venous graft		33510
	Coronary artery bypass, vein only; 2 coronary venous grafts		33511
	Coronary artery bypass, vein only; 3 coronary venous grafts		33512
	Coronary artery bypass, vein only; 4 coronary venous grafts		33513
	Coronary artery bypass, vein only; 5 coronary venous grafts		33514
	Coronary artery bypass, vein only; 6 or more coronary venous grafts		33516
	Coronary artery bypass, using venous graft(s) and arterial graft(s); single vein graft (List separately in addition to code for primary procedure)		33517
	Coronary artery bypass, using venous graft(s) and arterial graft(s); 2 venous grafts (List separately in addition to code for primary procedure)		33518
	Coronary artery bypass, using venous graft(s) and arterial graft(s); 3 venous grafts (List separately in addition to code for primary procedure)		33519

Condition Name	Code Description	ICD9 Code	CPT Code
	Coronary artery bypass, using venous graft(s) and arterial graft(s); 4 venous grafts (List separately in addition to code for primary procedure)		33521
	Coronary artery bypass, using venous graft(s) and arterial graft(s); 5 venous grafts (List separately in addition to code for primary procedure)		33522
	Coronary artery bypass, using venous graft(s) and arterial graft(s); 6 or more venous grafts (List separately in addition to code for primary procedure)		33523
	Coronary artery bypass, using arterial graft(s); single arterial graft		33533
	Coronary artery bypass, using arterial graft(s); 2 coronary arterial grafts		33534
	Coronary artery bypass, using arterial graft(s); 3 coronary arterial grafts		33535
	Coronary artery bypass, using arterial graft(s); 4 or more coronary arterial grafts		33536
	Percutaneous transluminal coronary angioplasty; single major coronary artery or branch		92920
	Percutaneous transluminal coronary atherectomy, with coronary angioplasty when performed; single major coronary artery or branch		92924
	Percutaneous transcatheter placement of intracoronary stent(s), with coronary angioplasty when performed; single major coronary artery or branch		92928
	Percutaneous transluminal coronary atherectomy, with intracoronary stent, with coronary angioplasty when performed; single major coronary artery or branch		92933
	Percutaneous transluminal revascularization of or through coronary artery bypass graft (internal mammary, free arterial, venous), any combination of intracoronary stent, atherectomy and angioplasty, including distal protection when performed; single vessel		92937
	Percutaneous transluminal revascularization of acute total/subtotal occlusion during acute myocardial infarction, coronary artery or coronary artery bypass graft, any combination of intracoronary stent, atherectomy and angioplasty, including aspiration thrombectomy when performed, single vessel		92941
	Percutaneous transluminal revascularization of chronic total occlusion, coronary artery, coronary artery branch, or coronary artery bypass graft, any combination of intracoronary stent, atherectomy and angioplasty; single vessel		92943
	Transcatheter placement of an intracoronary stent(s), percutaneous, with or without other therapeutic intervention, any method; single vessel		92980

Condition Name	Code Description	ICD9 Code	CPT Code
	Transcatheter placement of an intracoronary stent(s), percutaneous, with or without other therapeutic intervention, any method; each additional vessel (List separately in addition to code for primary procedure)		92981
	Percutaneous transluminal coronary balloon angioplasty; single vessel		92982
	Percutaneous transluminal coronary balloon angioplasty; each additional vessel (List separately in addition to code for primary procedure)		92984
	Percutaneous transluminal coronary atherectomy, by mechanical or other method, with or without balloon angioplasty; single vessel		92995
	Percutaneous transluminal coronary atherectomy, by mechanical or other method, with or without balloon angioplasty; each additional vessel (List separately in addition to code for primary procedure)		92996
	Percutaneous transluminal pulmonary artery balloon angioplasty, single vessel		92997
	Percutaneous transluminal pulmonary artery balloon angioplasty, each additional vessel		92998

Code	Code Description for peripheral vascular disease surgery
35565	Art byp graft iliofemoral
35566	Art byp fem-ant-post tib/prl
35570	Art byp tibial-tib/peroneal
35571	Art byp pop-tibl-prl-other
35583	Vein byp graft fem-popliteal
35585	Vein byp fem-tibial peroneal
35587	Vein byp pop-tibl peroneal
35651	Artery bypass graft
35654	Art byp axill-fem-femoral
35656	Art byp femoral-popliteal
35661	Art byp femoral-femoral
35663	Art byp ilioiliac
35665	Art byp iliofemoral
35666	Art byp fem-ant-post tib/prl
35671	Art byp pop-tibl-prl-other
35646	Art byp aortobifemoral
35647	Art byp aortofemoral
3806	Abdomen artery incision
3808	Lower limb artery incision
3816	Abdominal endarterectomy
3818	Lower limb endarterectomy
3836	Abd vessel resect/anast
3838	Leg artery resect/anast
3846	Abd artery resec w repla
3848	Leg artery resec w repla

Code	Code Description amputation
8410	Lower limb amputate nos
8411	Toe amputation
8412	Amputation through foot
8413	Disarticulation of ankle
8414	Amputat through malleoli
8415	Below knee amputate nec
8416	Disarticulation of knee
8417	Above knee amputation
27590	Amputate leg at thigh
27591	Amputate leg at thigh
27592	Amputate leg at thigh
27594	Amputation follow-up surgery
27596	Amputation follow-up surgery
27598	Amputate lower leg at knee
27880	Amputation of lower leg
27881	Amputation of lower leg
27882	Amputation of lower leg
27884	Amputation follow-up surgery
27886	Amputation follow-up surgery
27888	Amputation of foot at ankle
27889	Amputation of foot at ankle
28805	Amputation thru metatarsal
28810	Amputation toe & metatarsal
28820	Amputation of toe
28825	Partial amputation of toe

Inpatient cardiovascular disease DRGs

	Myocardial infarction DRGs
280	Acute myocardial infarction, discharged alive w MCC
281	Acute myocardial infarction, discharged alive w CC
282	Acute myocardial infarction, discharged alive w/o CC/MCC
283	Acute myocardial infarction, expired w MCC
284	Acute myocardial infarction, expired w CC
285	Acute myocardial infarction, expired w/o CC/MCC
296	Cardiac arrest, unexplained w MCC
297	Cardiac arrest, unexplained w CC
298	Cardiac arrest, unexplained w/o CC/MCC
	Stroke DRGs
061	Acute ischemic stroke w use of thrombolytic agent w MCC
062	Acute ischemic stroke w use of thrombolytic agent w CC

063	Acute ischemic stroke w use of thrombolytic agent w/o CC/MCC
064	Intracranial hemorrhage or cerebral infarction w MCC
065	Intracranial Hemorrhage Or Cerebral Infarction w CC or TPA In 24 Hrs
066	Intracranial hemorrhage or cerebral infarction w/o CC/MCC
067	Nonspecific cva & precerebral occlusion w/o infarct w MCC
068	Nonspecific cva & precerebral occlusion w/o infarct w/o MCC
	Transient ischemia DRG
069	Transient ischemia
	Heart failure DRGs
291	HF and shock with MCC
292	HF and shock with CC
292	HF and shock w/o CC MCC
189	Pulmonary edema and respiratory failure
	Unstable angina DRG
311	Angina pectoris
	Pulmonary embolism
175	Pulmonary embolism w MCC
176	Pulmonary embolism w/o MCC
	Cardiac arrhythmia
308	Cardiac arrhythmia & conduction disorders w MCC
309	Cardiac arrhythmia & conduction disorders w CC
310	Cardiac arrhythmia & conduction disorders w/o CC/MCC

Heart failure diagnosis codes (cardiovascular outcome)

Code	Code Description
398.91	Rheumatic heart failure (congestive)
402.01	Malignant hypertension, with heart failure
402.11	Benign hypertension, with heart failure
402.91	Unspecified hypertension, with heart failure
404.01	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.03	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage V
404.11	Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.13	Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage V
404.91	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage I through stage IV or unspecified
404.93	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage V
428.0	Congestive heart failure, unspecified
428.1	Left heart failure

Code	Code Description
428.20	Systolic heart failure, unspecified
428.21	Systolic heart failure, acute
428.22	Systolic heart failure, chronic
428.23	Systolic heart failure, acute on chronic
428.30	Diastolic heart failure, unspecified
428.31	Diastolic heart failure, acute
428.32	Diastolic heart failure, chronic
428.33	Diastolic heart failure, acute on chronic
428.40	Combined systolic and diastolic heart failure, unspecified
428.41	Combined systolic and diastolic heart failure, acute
428.42	Combined systolic and diastolic heart failure, chronic
428.43	Combined systolic and diastolic heart failure, acute on chronic
428.9	Heart failure, unspecified

Cardiac dysrhythmias

ICD9	Code Description
427.xx	Cardiac dysrhythmias

Pulmonary embolism

ICD9	Code Description
415.1x	Pulmonary embolism

Hypertension (comorbidity)

Code	Code Description
401.0	malignant essential hypertension
401.1	benign essential hypertension
401.9	unspecified essential hypertension
402.00	malignant hypertensive heart disease without heart failure
402.01	malignant hypertensive heart disease with heart failure
402.10	benign hypertensive heart disease without heart failure
402.11	benign hypertensive heart disease with heart failure
402.90	unspecified hypertensive heart disease without heart failure
402.91	unspecified hypertensive heart disease with heart failure
404.00	hypertensive heart and chronic kidney disease, malignant, without heart failure and with chronic kidney disease stage i through stage iv, or unspecified
404.01	hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage i through stage iv, or unspecified

Code	Code Description
404.02	hypertensive heart and chronic kidney disease, malignant, without heart failure and with chronic kidney disease stage v or end stage renal disease
404.03	hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage v or end stage renal disease
404.10	hypertensive heart and chronic kidney disease, benign, without heart failure and with chronic kidney disease stage i through stage iv, or unspecified
404.11	hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage i through stage iv, or unspecified
404.12	hypertensive heart and chronic kidney disease, benign, without heart failure and with chronic kidney disease stage v or end stage renal disease
404.13	hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage v or end stage renal disease
404.90	hypertensive heart and chronic kidney disease, unspecified, without heart failure and with chronic kidney disease stage i through stage iv, or unspecified
404.91	hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage i through stage iv, or unspecified
404.92	hypertensive heart and chronic kidney disease, unspecified, without heart failure and with chronic kidney disease stage v or end stage renal disease
404.93	hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage v or end stage renal disease
405.01	malignant renovascular hypertension
405.09	other malignant secondary hypertension
405.11	benign renovascular hypertension
405.19	other benign secondary hypertension
405.91	unspecified renovascular hypertension
405.99	other unspecified secondary hypertension

Hyperlipidemia (comorbidity)

Code	Code Description
272.0	pure hypercholesterolemia
272.1	pure hyperglyceridemia
272.2	mixed hyperlipidemia
272.3	hyperchylomicronemia
272.4	other and unspecified hyperlipidemia

In addition to these lists, we used the HEDIS 2015 Comprehensive Diabetes Care (CDC) list of NDCs to identify T2DM patients in the commercial population using prescription drug data. We do not have prescription drug data in the Medicare 5% sample and therefore did not identify T2DM patients beyond the use of the above diagnosis codes. This list is located at http://www.ncqa.org/HEDISQualityMeasurement/HEDISMeasures/HEDIS2015/HEDIS2015NDCLicense/HEDIS2015FinalNDCLists.aspx.

APPENDIX D: ADDITIONAL DETAILED FINDINGS

Medicare Demographics

Figure D1 summarizes the key demographic characteristics for the Medicare population by Medicare eligibility status.

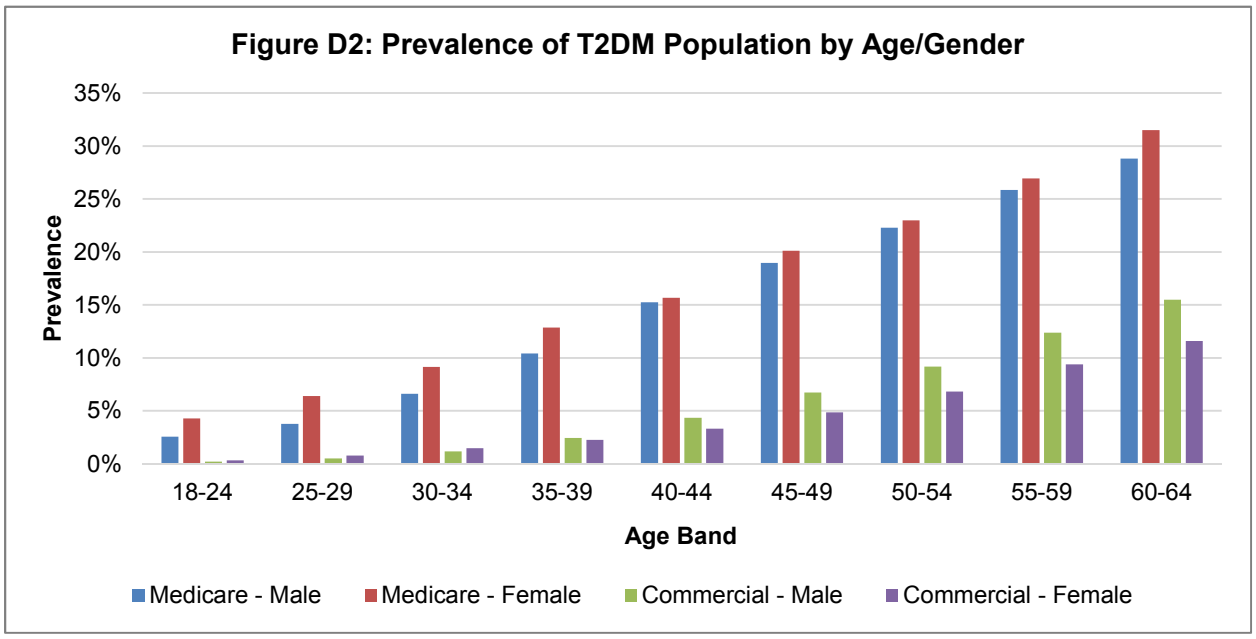
Figure D1: Key Demographic Characteristics of the Medicare T2DM Population vs. Nationwide Medicare FFS Population by Eligibility Category

	Status				
	Total	Aged / Dual Eligible	Aged / non Dual Eligible	Disabled	ESRD
Beneficiaries in Sample					
Total Medicare FFS	1,441,306	150,404	1,047,737	225,825	17,340
Type 2 Diabetes Patients	318,668	50,747	212,163	46,281	9,477
Distribution by Eligibility Status					
Total Medicare FFS	100%	10.4%	72.7%	15.7%	1.2%
Type 2 Diabetes Patients	100%	15.9%	66.6%	14.5%	3.0%
Prevalence					
Type 2 Diabetes	22.1%	33.7%	20.2%	20.5%	54.7%
Average Age					
Total Medicare FFS	71.7	76.5	75.7	50.2	62.8
Type 2 Diabetes Patients	72.2	75.9	75.6	53.8	65.2
Mortality Rate					
Total Medicare FFS	4.74%	8.93%	4.52%	2.12%	15.56%
Type 2 Diabetes Patients	6.40%	9.26%	5.85%	3.34%	18.38%
HCC Risk Score					
Total Medicare FFS	1.14	1.63	1.05	1.06	3.03
Type 2 Diabetes Patients	1.64	2.01	1.46	1.63	3.52

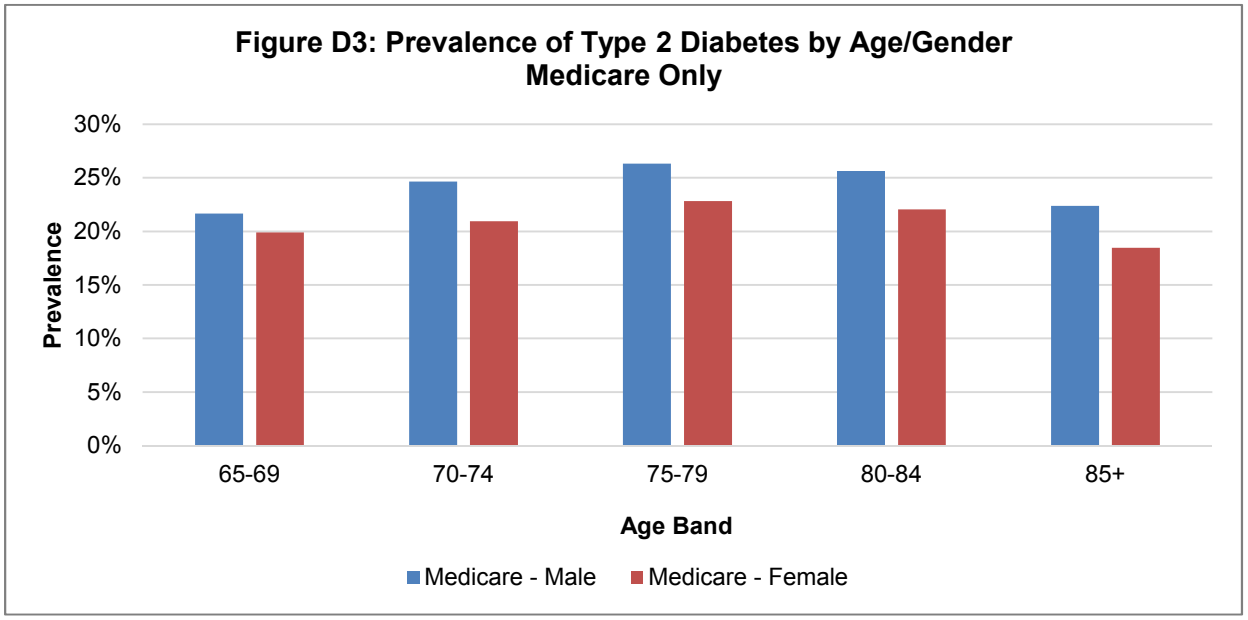
Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)

Prevalence

Figures D2 and D3 present the prevalence of T2DM in the FFS Medicare population and commercial population by age and gender. We subcategorized the population into those aged 65+ and those aged 0-64.



Source: Milliman Analysis of Medicare 5% Sample and Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes:Commercial prevalence is across 18-64 year olds. Medicare prevalence is across 0-64 year old Medicare members. Medicare 0-64 year olds make up 17% of the Medicare FFS population.

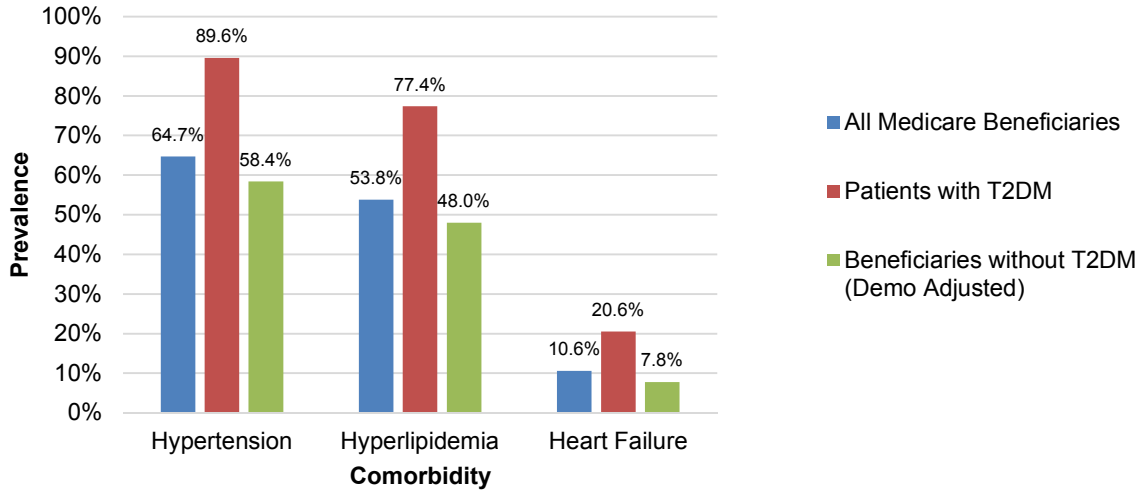


Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: 83% of Medicare FFS members are 65+ years of age.

Comorbidities

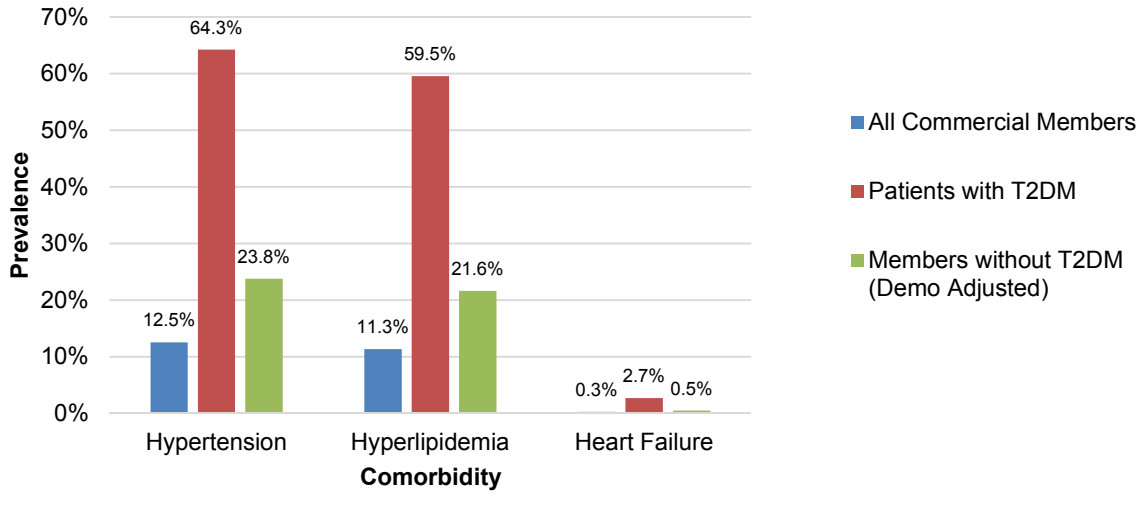
Based on claims in the 2014 index year, we identified the presence of CV comorbidities (hypertension, hyperlipidemia and chronic heart failure) among patients with T2DM. Figures D4 and D5 provide the prevalence by population type for the Medicare and commercial populations.

Figure D4: Prevalence of Key Comorbidities in the Medicare Population by Population Type



Source: Milliman Analysis of Medicare 5% Sample 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM beneficiaries with the same age/gender mix as the T2DM beneficiaries

Figure D5: Prevalence of Key Comorbidities in the Commercial Population by Population Type



Source: Milliman Analysis of Truven MarketScan 2013-2014 (2014 index year, 2013 look back year)
Notes: The demo adjusted non-T2DM population reflects non-T2DM members with the same age/gender mix as the T2DM members

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