

SUPPLEMENTARY MATERIALS

Healthcare resource utilization and cost among patients with type 1 diabetes in the United States

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Supplementary Table 1. ICD-9-CM and ICD-10-CM Codes for Charlson Comorbidity Index and Comorbid Conditions

Clinical Condition	ICD-9-CM	ICD-10-CM
Charlson Comorbidity Index¹³		
AIDS/HIV	042.x–044.x	B20.x
Any malignancy, including lymphoma and leukemia	140.x–195.8, 200.x–208.x	C00.x–C26.x, C30.x–C41.x, C43.x–C58.x, C60.x–C76.x, C81.x–C96.x
Cerebrovascular disease	362.34, 430.x–438.x	G45.x, G46.x, H34.0, I60.x–I69.x
Chronic pulmonary disease	416.8, 416.9, 490.x–505.x, 506.4, 508.1, 508.8	I27.8, I27.9, J40.x–J47.x, J60.x–J67.x, J68.4, J70.1, J70.3
Congestive heart failure	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 425.4–425.9, 428.x	I09.9, I11.0, I25.5, I13.0, I13.2, I42.0, I42.5–I42.9, I43.x, I50.x, P29.0
Dementia	290.x, 294.1, 331.2	F01.x–F03.x, F05.1, G30.x, G31.1
Diabetes with chronic complication	250.4–250.7	E10.2–E10.5, E10.7, E11.2–E11.5, E11.7, E12.2–E12.5, E12.7, E13.2–E13.5, E13.7
Diabetes without chronic complication	250.0–250.3, 250.8, 250.9	E10.0, E10.1, E10.6, E10.8, E10.9, E11.0, E11.1, E11.6, E11.8, E11.9, E12.0, E12.1, E12.6, E12.8, E12.9, E13.0, E13.1, E13.6, E13.8, E13.9
Hemiplegia or paraplegia	334.1, 342.x, 343.x, 344.0–344.6, 344.9	G04.1, G11.4, G80.1, G80.2, G81.x, G82.x, G83.0–G83.4, G83.9
Metastatic solid tumor	196.x–199.x	C77.x–C80.x
Mild liver disease	070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 070.6, 070.9, 570.x, 571.x, 573.3, 573.4, 573.8, 573.9, V42.7	B18.x, K70.0–K70.3, K70.9, K71.3–K71.5, K71.7, K73.x, K74.x, K76.0, K76.2–K76.4, K76.8, K76.9, Z94.4
Moderate or severe liver disease	456.0–456.2, 572.2–572.8	I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7

Clinical Condition	ICD-9-CM	ICD-10-CM
Myocardial infarction	410.x, 412.x	I21.x, I22.x, I25.2
Peptic ulcer disease	531.x–534.x	K25.x–K28.x
Peripheral vascular disease	47.1, 093.0, 437.3, 440.x, 441.x, 443.1–443.9, 557.1, 557.9, V43.4	I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9
Renal disease	403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 582.x, 583.0–583.7, 585.x, 586.x, 588.0, V42.0, V45.1, V56.x	I12.0, I13.1, N03.2–N03.7, N05.2– N05.7, N18.x, N19.x, N25.0, Z49.0–Z49.2, Z94.0, Z99.2
Rheumatic disease	446.5, 710.0–710.4, 714.0–714.2, 714.8, 725.x	M05.x, M06.x, M31.5, M32.x– M34.x, M35.1, M35.3, M36.0
Comorbid Conditions		
Anxiety	293.84, 300.00–300.02, 300.09, 300.21–300.23, 300.29, 300.3x, 308.3x, 309.21, 309.24, 309.28, 309.81, 313.0x	F40.xx-F48.xx
Asthma ²⁹	493.xx	J45.xx
Autoimmune thyroid disease		
Hashimoto's thyroiditis	245.2x	E06.3x
Hyperthyroidism (Grave's disease)	242.xx	E05.xx
Hypothyroidism ³⁰	244.xx	E02.xx, E03.xx
Celiac disease	579.0x	K90.0x
Depression ³¹	296.20–296.25, 296.30–296.35, 296.82, 300.4x, 309.0x, 309.28, 311.xx	F32.xx, F33.xx, F34.1x, F41.2x, F43.2x
Diabetic ketoacidosis	250.1x, 249.1x	E08.1x, E09.1x, E10.1x, E13.1x
Hyperglycemia	250.02, 250.03, 250.1x, 250.2x, 250.3x	R73.xx
Hyperlipidemia ³²	272.0x-272.4x	E78.0x-E78.5x
Hypertension	401.xx-405.xx	I10.xx-I13.xx, I15.xx

Clinical Condition	ICD-9-CM	ICD-10-CM
Hypoglycemia	250.3x, 251.0x-251.2x, 250.8x, 270.3x, 775.0x, 775.6x, 962.3x	E15.xx-E16.xx
Limited joint mobility (any, but includes Dupuytren's contracture and carpal tunnel syndrome)	728.6x, 354.xx, 718.8x	M72.0x, G56.0x, M24.80, M24.819 - M24.859, M23.50, M23.8X9, M24.873, M24.876
Macrovascular complications		
Cerebrovascular disease ³²	430.xx-438.xx	I60.xx-I69.xx, G45.xx
Congestive heart failure	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 425.4, 425.5, 425.7, 425.8, 425.9, 428.xx	I09.9x, I11.0x, I13.0x, I13.2x, I25.5x, I42.0x, I42.5x- I42.9x, I43.xx, I50.xx, P29.0x
Coronary heart disease	410.xx-414.xx, 425.xx-429.xx	I20.xx-I25.xx, I42.xx-I44.xx, I50.xx, I51.xx
Peripheral vascular disease	093.0, 437.3, 440.x, 441.x, 443.1- 443.9, 447.1, 557.1, 557.9, V43.4	I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9
Microvascular complications		
Diabetic nephropathy ³²	250.4x	E11.29, E10.29, E11.21, E11.65, E10.21, E10.65
Diabetic neuropathy ^{31,33}	250.6x, 357.2	E11.40, E10.40, E11.40, E11.65, E10.40, E10.65, E08.42, E09.42, E10.42, E11.42, E13.42
Diabetic retinopathy	250.5x, 362.0x, 362.1x, 362.2x, 362.83, 362.53, 362.81, 362.82, 361.xx, 369.xx, 379.23	H25.xx-H26.xx, H28.xx, H34.xx- H36.xx, E10.3x, E11.3x, E12.3x, E13.3x, E14.3x
Osteopenia and Osteoporosis ³⁴	733.9x, 733.0x	M85.8x, M80.x, M81.x

Abbreviations: AIDS = acquired immunodeficiency syndrome; HIV = human immunodeficiency virus; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification; ICD-10-CM = International Classification of Diseases, 10th Revision, Clinical Modification

Supplementary Table 2. Codes for Insulin Pumps, Continuous Blood Glucose Monitors, and Related Diabetes Supplies

Code Description	HCPCS	NDC Codes
Insulin pump and related supplies		
Artificial pancreas device system (e.g., LGS feature) including continuous glucose monitor, blood glucose device, insulin pump and computer algorithm that communicates with all of the devices	S1034	
External ambulatory infusion pump, insulin	E0784	
External ambulatory insulin delivery system, disposable, each, includes all supplies and accessories	A9274	
Infusion set for external insulin pump, needle type	A4231	
Infusion set for external insulin pump, non-needle cannula type	A4230	
Receiver (monitor); external, for use with artificial pancreas device system	S1037	
Sensor; invasive (e.g., subcutaneous), disposable, for use with artificial pancreas device system	S1035	
Syringe with needle for external insulin pump, sterile, 3 cc	A4232	
T: Slim		89152-4629-01 89152-3380-05 08521-2306-10 08521-2309-10
Transmitter; external, for use with artificial pancreas device system	S1036	
Continuous blood glucose monitoring and related supplies		
Artificial pancreas device system (e.g., LGS feature) including continuous glucose monitor, blood glucose device, insulin pump and computer algorithm that communicates with all of the devices	S1034	
Continuous noninvasive glucose monitoring device, purchase	S1030	
Continuous noninvasive glucose monitoring device, rental, including sensor, sensor replacement, and download to monitor	S1031	
Receiver (monitor); external, for use with artificial pancreas device system	S1037	

Code Description	HCPCS	NDC Codes
Receiver (monitor); external, for use with interstitial continuous glucose monitoring system	A9278	
Sensor; invasive (e.g., subcutaneous), disposable, for use with artificial pancreas device system	S1035	
Sensor; invasive (e.g., subcutaneous), disposable, for use with interstitial continuous glucose monitoring system, one unit = 1 day supply	A9276	
Transmitter; external, for use with artificial pancreas device system	S1036	
Transmitter; external, for use with interstitial continuous glucose monitoring system	A9277	

Note: codes for artificial pancreas systems (devices that deliver insulin and monitor blood glucose) are used to define insulin pump and continuous blood glucose monitor usage.

Abbreviations: HCPCS = Healthcare Common Procedure Coding System; LGS = low glucose suspend; NDC = National Drug Code

Supplementary Figure 1. Sample Attrition

	MarketScan Database Excluded → Remaining	Optum EMR Database Excluded → Remaining	Optum Integrated Database Excluded → Remaining
Has at least one potential index claim with a T1DM diagnosis (ICD-9 250.x1, 250.x3; ICD-10 E10.x)	935,096	450,538	79,057
Has an index claim with continuous pre-index enrollment of 6 months	168,045 → 767,051	71,120 → 379,418	33,699 → 45,358
Has at least one dispensing or administration of insulin or an insulin pump during the continuous enrollment period within +/- 90 days around index	253,705 → 513,346	141,399 → 238,019	15,095 → 30,263
No use of sulfonylureas or drug combinations containing sulfonylureas at any time during the study period	111,087 → 402,259	38,829 → 199,190	6,409 → 23,854
No use of TZDs or drug combinations containing TZDs at any time during the study period	19,913 → 382,346	4,813 → 194,377	986 → 22,868
No evidence of secondary or gestational diabetes at any time during the study period	22,822 → 359,524	40,809 → 153,568	3,176 → 19,692
Does not meet the minimum percentage of T1DM claims days for all diabetes claim days corresponding to age at index during up to 365 days of baseline and follow-up*	173,930 → 185,594	67,111 → 86,457	10,533 → 9,159
Has record of at least one insulin product that is not long-acting during the study period	4,171 → 181,423	1,698 → 84,759	211 → 8,948
Included in cohort	181,423	84,759	8,948

* >0% for age <16 years, ≥50% for age 16–45 years, ≥70% for age >45 years

Abbreviations: EMR = electronic medical record; ICD-9 =International Classification of Diseases, Ninth Revision; ICD-10 = International Classification of Diseases, 10th Revision; T1DM = type 1 diabetes mellitus; TZD = thiazolidinedione