

Appendix A1: Descriptive demographic, comorbidity, and outcome statistics (n=50,861)

Demographics	Mean or Percent
Age (y), mean \pm SD	65.64 \pm 9.42*
Male	49,629 (98)
Female	1,232 (2)
White	43,730 (86)
Black	5,606 (11)
Other	1,525 (3)
HbA1c Measures	
HbA1c Variability Measures mmol/mol (%)	
Standard deviation	0.81 \pm 0.67
Coefficient of variation	10.78 \pm 7.67
Adjusted standard deviation	1.29 \pm 1.04
Mean HbA1c levels	
<53 mmol/mol (<7%)	22,834 (45)
\geq 53 mmol/mol (\geq 7%) & <64 mmol/mol (<8%)	19,214 (38)
\geq 64 mmol/mol (\geq 8%) & <75 mmol/mol (<9%)	6,031 (12)
\geq 75 mmol/mol (\geq 9%)	2,782 (5)
HbA1c Overall Trends mmol/mol (%)	
Slope coefficient	-0.0005 \pm 0.003
Diabetes Complications	
Retinopathy complications [†]	12,312 (24)
Nephropathy complications [†]	9,500 (19)
Neuropathy complications [†]	17,749 (35)
Cerebrovascular complications [†]	9,568 (19)
Cardiovascular complications (some) [†]	12,568 (25)
Cardiovascular complications (severe) [†]	16,262 (32)
Peripheral vascular complications [†]	10,566 (21)
Metabolic complications [†]	792 (2)
Diabetes Management	
Microalbumin missing	19,161 (38)
Microalbumin normal	27,719 (54)
Microalbumin high	3,981 (8)
Serum creatinine missing	861 (2)
Serum creatinine normal	45,646 (90)
Serum creatinine high	4,354 (9)
Started sulfonylurea as second drug	44,397 (87)
Started thiazolidinones as second drug	3,722 (7)
Started insulin as second drug	2,742 (5)
Cardiovascular comorbidities	
BMI missing	1,966 (4)
BMI normal	4,443 (9)
BMI overweight	16,080 (32)
BMI obese	28,372 (56)
Blood pressure missing	38 (0)
Blood pressure normal	32,890 (65)

High blood pressure	17,933 (35)
LDL missing	2,155 (4)
Mean LDL ≤ 100	29,632 (58)
Mean LDL > 100	19,074 (38)
Congestive heart failure [‡]	9,045 (18)
Cardiac arrhythmias [‡]	15,046 (30)
Valvular disease [‡]	7,287 (14)
Pulmonary circulatory disorder [‡]	1,430 (3)
Chronic pulmonary disease [‡]	17,276 (34)
Other comorbidities	
Paralysis [‡]	1,350 (3)
Other neurological disorder [‡]	3,804 (7)
Hypothyroidism [‡]	5,804 (11)
Renal failure [‡]	4,049 (8)
Liver disease [‡]	2,376 (5)
Peptic Ulcer Excluding Bleeding [‡]	2,107 (4)
AIDS [‡]	140 (0)
Lymphoma [‡]	555 (1)
Metastatic cancer [‡]	921 (2)
Solid Tumor Without Metastasis [‡]	10,905 (21)
Rheumatoid arthritis [‡]	2,202 (4)
Coagulopathy [‡]	2,902 (6)
Weight loss [‡]	2,417 (5)
Fluid and electrolyte disorders [‡]	8,551 (17)
Blood loss anemias [‡]	1,039 (2)
Deficiency anemias [‡]	10,919 (21)
Alcohol abuse [‡]	3,686 (7)
Drug abuse [‡]	1,833 (4)
Psychoses [‡]	8,927 (18)
Depression [‡]	12,948 (25)
Provider Process Quality Variables	
Provider % HbA1c ≥ 9% (≥ 75 mmol/mol) in baseline period, mean ± SD	9 ± 4
Provider BP % ≥ 140 or ≥ 90 in baseline period, mean ± SD	39 ± 7
Provider LDL % > 100 in baseline period, mean ± SD	39 ± 10
Outcomes	
All-cause mortality	4,759 (9)
ACSC hospitalization	9,261 (18)
MI or stroke	2,676 (5)

*Values are n (%) unless indicated otherwise.

[†]Young severity index

[‡]Elixhauser comorbidity

Table A2: Cox Proportional Hazard Model Predicting Mortality (n=50,861)*

	Hazard Ratio	P< t	95% Confidence Interval	
HbA1c Measures				
HbA1c Adjusted Standard Deviation (ref=Quartile 1: <0.610%)				
Quartile 2 (>=0.610 &<0.970)	1.00	0.986	0.92	1.09
Quartile 3 (>=0.970 &<1.600)	1.14	0.005	1.04	1.25
Quartile 4 (>=1.600)	1.42	<0.001	1.28	1.58
HbA1c levels (ref=<53 mmol/mol (<7%))				
>=53 mmol/mol (>=7%) &<64 mmol/mol (<8%)	0.94	0.093	0.88	1.01
>=64 mmol/mol (>=8%) &<75 mmol/mol (<9%)	0.94	0.243	0.84	1.04
>=75 mmol/mol (>=9%)	1.24	0.002	1.08	1.43
HbA1c slope (ref=Quartile 1; <-0.001094%)				
Quartile 2 (>=-0.001094 &<-0.0001268)	0.94	0.143	0.86	1.02
Quartile 3 (>=-0.0001268 &<0.0007676)	0.94	0.163	0.86	1.03
Quartile 4 (>=0.0007676)	1.02	0.674	0.94	1.10
Age	1.05	<0.001	1.04	1.05
Male	1.36	0.013	1.07	1.73
White (ref=Black)	1.10	0.072	0.99	1.22
Other	0.91	0.374	0.74	1.12
Diabetes Complications				
Retinopathy complications [†]	0.99	0.821	0.93	1.06
Nephropathy complications [†]	1.00	0.954	0.92	1.09
Neuropathy complications [†]	0.97	0.270	0.91	1.03
Cerebrovascular complications [†]	1.03	0.434	0.96	1.11
Cardiovascular complications (some) [†]	0.96	0.360	0.89	1.04
Cardiovascular complications (severe) [†]	1.10	0.051	1.00	1.21
Peripheral vascular complications [†]	1.22	<0.001	1.14	1.30
Metabolic complications [†]	0.89	0.265	0.73	1.09
Diabetes Management				
Microalbumin missing (ref=microalbumin normal)	1.17	<0.001	1.09	1.25
Microalbumin high	1.21	<0.001	1.09	1.35
Serum creatinine missing (ref=serum creatinine normal)	1.16	0.169	0.94	1.45
Serum creatinine high	1.24	<0.001	1.13	1.36
Started thiazolidinones as second drug (ref=sulfonylurea)	0.90	0.060	0.80	1.00
Started insulin as second drug	1.31	<0.001	1.17	1.48
Cardiovascular comorbidities				
BMI missing (ref=BMI normal)	0.89	0.183	0.75	1.06
BMI overweight	0.81	<0.001	0.74	0.88
BMI obese	0.78	<0.001	0.71	0.86
Blood pressure missing	1.45	0.311	0.71	2.96
High blood pressure	0.97	0.255	0.91	1.03

LDL missing	1.13	0.078	0.99	1.29
Mean LDL \geq 100	1.09	0.006	1.03	1.16
Congestive heart failure \ddagger	1.39	<0.001	1.27	1.52
Cardiac arrhythmias \ddagger	1.11	0.003	1.04	1.19
Valvular disease \ddagger	0.94	0.106	0.86	1.01
Pulmonary circulatory disorder \ddagger	1.42	<0.001	1.24	1.63
Chronic pulmonary disease \ddagger	1.31	<0.001	1.23	1.39
Other Comorbidities				
Paralysis \ddagger	1.36	<0.001	1.17	1.58
Other neurological disorder \ddagger	1.35	<0.001	1.23	1.48
Hypothyroidism \ddagger	0.86	0.001	0.78	0.94
Renal failure \ddagger	1.17	0.005	1.05	1.31
Liver disease \ddagger	1.42	<0.001	1.25	1.60
Peptic Ulcer Excluding Bleeding \ddagger	0.92	0.213	0.81	1.05
AIDS \ddagger	0.87	0.661	0.46	1.63
Lymphoma \ddagger	1.27	0.025	1.03	1.56
Metastatic cancer \ddagger	3.87	<0.001	3.42	4.38
Solid Tumor Without Metastasis \ddagger	1.21	<0.001	1.13	1.29
Rheumatoid arthritis \ddagger	0.87	0.044	0.76	1.00
Coagulopathy \ddagger	1.20	<0.001	1.09	1.33
Weight loss \ddagger	1.38	<0.001	1.25	1.54
Fluid and electrolyte disorders \ddagger	1.23	<0.001	1.14	1.32
Blood loss anemias \ddagger	1.15	0.073	0.99	1.34
Deficiency anemias \ddagger	1.09	0.016	1.02	1.17
Alcohol abuse \ddagger	1.32	<0.001	1.17	1.48
Drug abuse \ddagger	1.23	0.019	1.03	1.46
Psychoses \ddagger	1.12	0.010	1.03	1.22
Depression \ddagger	1.16	<0.001	1.08	1.25
Provider Process Quality Variables				
Provider % HbA1c \geq 9% (\geq 75mmol/mol) in baseline period	1.37	0.439	0.62	3.03
Provider BP % \geq 140 and \geq 90 in baseline period	1.21	0.440	0.75	1.96
Provider LDL% > 100 in baseline period	0.98	0.906	0.69	1.39

*Year fixed effects not shown. Model also includes Veterans Affairs Medical Center random effects.

\ddagger Young Severity Index

\ddagger Elixhauser comorbidity

Appendix A3: Cox Proportional Hazard Models: Effect of HbA1c variability and Levels on Mortality: Two year baseline (n=27,398)*

Model 1**	Hazard Ratio	P< t 	95% Confidence Interval	
HbA1c Standard Deviation (ref=Quartile 1: <0.310%)				
Quartile 2 (>=0.310 &<0.500)	1.11	0.085	0.99	1.25
Quartile 3 (>=0.500 &<0.820)	1.15	0.030	1.01	1.31
Quartile 4 (>=0.820)	1.36	<0.001	1.18	1.58
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	0.87	0.003	0.80	0.95
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	0.99	0.938	0.86	1.15
>=9% (>=75 mmol/mol)	1.16	0.146	0.95	1.41
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	1.00	0.995	0.89	1.12
Quartile 3 (>=0.0006751 &<0.0019423)	0.95	0.375	0.85	1.06
Quartile 4 (>=0.0019423)	1.04	0.551	0.92	1.16
Model 2				
HbA1c Coefficient of Variation (ref=Quartile 1: <04.49%)				
Quartile 2 (>=4.49 &<7.06)	1.18	0.005	1.05	1.33
Quartile 3 (>=7.06 &<11.22)	1.21	0.004	1.06	1.37
Quartile 4 (>=11.22)	1.40	<0.001	1.21	1.62
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	0.89	0.007	0.81	0.97
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	1.02	0.733	0.89	1.18
>=9% (>=75 mmol/mol)	1.20	0.065	0.99	1.46
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	1.02	0.766	0.91	1.14
Quartile 3 (>=0.0006751 &<0.0019423)	0.94	0.298	0.84	1.05
Quartile 4 (>=0.0019423)	1.03	0.573	0.92	1.16
Model 3				
HbA1c Adjusted Standard Deviation (ref=Quartile 1: <0.30%)				
Quartile 2 (>=0.30 &<0.48)	1.14	0.028	1.01	1.28
Quartile 3 (>=0.48 &<0.80)	1.16	0.023	1.02	1.32
Quartile 4 (>=0.80)	1.35	<0.001	1.16	1.56
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	0.87	0.003	0.80	0.95
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	1.00	0.979	0.87	1.16
>=9% (>=75 mmol/mol)	1.17	0.119	0.96	1.43
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	1.00	0.982	0.89	1.12
Quartile 3 (>=0.0006751 &<0.0019423)	0.95	0.334	0.85	1.06
Quartile 4 (>=0.0019423)	1.04	0.451	0.93	1.17

*Models include baseline demographics, Elixhauser comorbidities, Young severity index, BMI, microalbumin, serum creatinine, blood pressure, LDL, starting a thiazolidinedione or insulin compared to sulfonylurea, provider quality controls, year fixed effects and Veterans Affairs Medical Center random effects.

The first model included **HbA1c standard deviation, **HbA1c** levels, **HbA1c** slope and all the covariates above. A second model replaced **HbA1c** standard deviation with **HbA1c** coefficient of variation and a third model replaced **HbA1c** standard deviation with **HbA1c** adjusted standard deviation.

Appendix A4: Cox Proportional Hazard Models: Effect of HbA1c variability and Levels on MI or Stroke (n=27,398): Two year baseline*

Model 1**	Hazard Ratio	P< t 	95% Confidence Interval	
HbA1c Standard Deviation (ref=Quartile 1: <0.310%)				
Quartile 2 (>=0.310 &<0.500)	1.05	0.567	0.89	1.23
Quartile 3 (>=0.500 &<0.820)	1.17	0.071	0.99	1.40
Quartile 4 (>=0.820)	1.24	0.035	1.02	1.52
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	1.02	0.762	0.90	1.15
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	1.29	0.008	1.07	1.55
>=9% (>=75 mmol/mol)	1.64	<0.001	1.27	2.11
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	1.09	0.299	0.93	1.28
Quartile 3 (>=0.0006751 &<0.0019423)	1.07	0.359	0.92	1.25
Quartile 4 (>=0.0019423)	1.16	0.053	1.00	1.35
Model 2				
HbA1c Coefficient of Variation (ref=Quartile 1: <04.49%)				
Quartile 2 (>=4.49 &<7.06)	0.99	0.889	0.84	1.16
Quartile 3 (>=7.06 &<11.22)	1.13	0.168	0.95	1.34
Quartile 4 (>=11.22)	1.13	0.217	0.93	1.37
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	1.04	0.521	0.92	1.17
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	1.34	0.001	1.12	1.61
>=9% (>=75 mmol/mol)	1.72	<0.001	1.35	2.21
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	1.07	0.431	0.91	1.25
Quartile 3 (>=0.0006751 &<0.0019423)	1.07	0.381	0.92	1.25
Quartile 4 (>=0.0019423)	1.18	0.035	1.01	1.37
Model 3				
HbA1c Adjusted Standard Deviation (ref=Quartile 1: <0.30%)				
Quartile 2 (>=0.30 &<0.48)	1.12	0.157	0.96	1.32
Quartile 3 (>=0.48 &<0.80)	1.19	0.050	1.00	1.42
Quartile 4 (>=0.80)	1.26	0.027	1.03	1.54
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	1.02	0.772	0.90	1.15
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	1.30	0.006	1.08	1.56
>=9% (>=75 mmol/mol)	1.65	<0.001	1.28	2.13
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	1.10	0.264	0.93	1.29
Quartile 3 (>=0.0006751 &<0.0019423)	1.06	0.420	0.91	1.24
Quartile 4 (>=0.0019423)	1.17	0.040	1.01	1.36

*Models include baseline demographics, Elixhauser comorbidities, Young severity index, BMI, microalbumin, serum creatinine, blood pressure, LDL, starting a thiazolidinedione or insulin compared to sulfonylurea, provider quality controls, year fixed effects and Veterans Affairs Medical Center random effects.

The first model included **HbA1c standard deviation, **HbA1c** levels, **HbA1c** slope and all the covariates above. A second model replaced **HbA1c** standard deviation with **HbA1c** coefficient of variation and a third model replaced **HbA1c** standard deviation with **HbA1c** adjusted standard deviation.

Appendix A5: Cox Proportional Hazard Models: Effect of HbA1c variability and Levels on ACSC Hospitalization: Two Year Baseline (n=27,398)*

Model 1**	Hazard Ratio	P< t 	95% Confidence Interval	
HbA1c Standard Deviation (ref=Quartile 1: <0.310%)				
Quartile 2 (>=0.310 &<0.500)	1.01	0.770	0.93	1.10
Quartile 3 (>=0.500 &<0.820)	1.09	0.051	1.00	1.20
Quartile 4 (>=0.820)	1.10	0.085	0.99	1.22
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	0.96	0.170	0.90	1.02
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	1.11	0.051	1.00	1.23
>=9% (>=75 mmol/mol)	1.12	0.123	0.97	1.31
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	0.92	0.033	0.84	0.99
Quartile 3 (>=0.0006751 &<0.0019423)	0.87	<0.001	0.80	0.94
Quartile 4 (>=0.0019423)	0.93	0.089	0.86	1.01
Model 2				
HbA1c Coefficient of Variation (ref=Quartile 1: <04.49%)				
Quartile 2 (>=4.49 &<7.06)	1.02	0.719	0.93	1.10
Quartile 3 (>=7.06 &<11.22)	1.11	0.019	1.02	1.21
Quartile 4 (>=11.22)	1.15	0.007	1.04	1.27
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	0.96	0.199	0.90	1.02
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	1.10	0.048	1.00	1.22
>=9% (>=75 mmol/mol)	1.12	0.129	0.97	1.30
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	0.93	0.072	0.85	1.01
Quartile 3 (>=0.0006751 &<0.0019423)	0.87	0.001	0.81	0.95
Quartile 4 (>=0.0019423)	0.92	0.043	0.85	1.00
Model 3				
HbA1c Adjusted Standard Deviation (ref=Quartile 1: <0.30%)				
Quartile 2 (>=0.30 &<0.48)	1.03	0.559	0.94	1.11
Quartile 3 (>=0.48 &<0.80)	1.10	0.039	1.00	1.20
Quartile 4 (>=0.80)	1.11	0.060	1.00	1.23
HbA1c levels (ref=<7% (<53 mmol/mol))				
>7% (>=53 mmol/mol) &<8% (<64 mmol/mol)	0.96	0.159	0.90	1.02
>=8% (>=64 mmol/mol)&<9% (<75 mmol/mol)	1.11	0.054	1.00	1.22
>=9% (>=75 mmol/mol)	1.12	0.128	0.97	1.30
HbA1c slope (ref=Quartile 1: <-0.000368%)				
Quartile 2 (>=-0.000368 &<0.0006751)	0.92	0.041	0.85	1.00
Quartile 3 (>=0.0006751 &<0.0019423)	0.87	<0.001	0.80	0.94
Quartile 4 (>=0.0019423)	0.93	0.089	0.86	1.01

*Models include baseline demographics, Elixhauser comorbidities, Young severity index, BMI, microalbumin, serum creatinine, blood pressure, LDL, starting a thiazolidinedione or insulin compared to sulfonylurea, provider quality controls, year fixed effects and Veterans Affairs Medical Center random effects.

The first model included **HbA1c standard deviation, **HbA1c** levels, **HbA1c** slope and all the covariates above. A second model replaced **HbA1c** standard deviation with **HbA1c** coefficient of variation and a third model replaced **HbA1c** standard deviation with **HbA1c** adjusted standard deviation.