

Performance of the Adapted Diabetes Complications Severity Index Translated to ICD-10

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Diabetes is among the top 10 causes of death worldwide, and its global prevalence is increasing.¹⁻³ Healthcare expenditures for a patient with diabetes are more than twice as high as they are for an average patient, with costs mainly driven by inpatient care and medications used to treat diabetes-related complications.^{4,5} Risks of hospitalization, mortality, and healthcare costs are associated with the number and severity of diabetes-related complications.⁶⁻⁸ There is an urgent need for a validated diabetes-specific severity score for comorbidities to adjust for differences in diabetes-specific morbidity in a large array of studies. To enable epidemiological studies of large claims databases, such a score would ideally not include clinical data.

To systematically quantify diabetes complications, Young and colleagues developed the Diabetes Complications Severity Index (DCSI).⁶ The DCSI uses 7 categories of diabetes complications (ophthalmic, renal, neurologic, cerebrovascular, cardiovascular, peripheral vascular, and metabolic). Each category is scored with either 0 (no complication), 1 (nonsevere complication), or 2 (severe complication), except for neurologic complications, which score a maximum of 1. The highest possible DCSI score is therefore 13. As the DCSI needs laboratory values to calculate scores, Chang et al developed the adapted DCSI (aDCSI) specifically for use with claims data, which rarely contain laboratory results.⁹ The DCSI and aDCSI were validated with regard to hospitalization risk, mortality risk, and healthcare costs in patients with diabetes.⁶⁻⁹ Different approaches exist for the validation and use of the aDCSI, including correlative use to reflect current severity of diabetes complications and predictive use to reflect future risk of hospitalization, mortality, or costs. For example, Chang and colleagues⁹ correlated aDCSI scores over a 4-year period with hospitalizations during the same period, whereas Chen and Hsiao⁷ additionally reported on predictive performance. The development of both DCSI and aDCSI was based on *International Classification of Diseases, Ninth Revision (ICD-9)* codes. Although Glasheen et al¹⁰ translated the DCSI to *International Classification of Diseases, Tenth Revision (ICD-10)* and Wilke et al⁸ used the aDCSI with *ICD-10* data, no systematic validation of the aDCSI

ABSTRACT

OBJECTIVES: To assess the performance of the adapted Diabetes Complications Severity Index (aDCSI) translated to *International Classification of Diseases, Tenth Revision (ICD-10)* in predicting hospitalizations, mortality, and healthcare-associated costs.

STUDY DESIGN: Retrospective closed cohort study based on secondary data analysis.

METHODS: We translated the aDCSI to *ICD-10* and calculated aDCSI scores based on health insurance claims data. To assess predictive performance, we used multivariate regression models to calculate risk ratios (RRs) of hospitalizations and mortality and linear predictors of cost.

RESULTS: We analyzed a sample of 157,115 patients with diabetes mellitus. RRs of hospitalizations (total and cause specific) rose with increasing aDCSI scores. Predicting total hospitalizations over a 4-year period, unadjusted RRs were 1.22 for an aDCSI score of 1 (compared with a score of 0), 1.55 for a score of 2, 1.77 for a score of 3, 2.11 for a score of 4, and 2.72 for scores of 5 and higher. Cause-specific hospitalizations and mortality showed similar results. Costs clearly increased in each successive score category.

CONCLUSIONS: Our study supports the validity of the aDCSI as a severity measure for complications of diabetes, as it correlates to and predicts total and cause-specific hospitalizations, mortality, and costs. The aDCSI's performance in *ICD-10*-coded data is comparable with that in *International Classification of Diseases, Ninth Revision*-coded data.

Am J Manag Care. 2019;25(2):e45-e49

TAKEAWAY POINTS

- ▶ The adapted Diabetes Complications Severity Index (aDCSI) (translated to *International Classification of Diseases, Tenth Revision [ICD-10]*) correlates to and predicts hospitalizations (total and cause specific), mortality, and healthcare-associated costs.
- ▶ Planned use of the aDCSI should consider that the performance differs for correlation and prediction and that results of correlative studies cannot necessarily be transferred to predictive applications and vice versa.
- ▶ We provide further evidence that the aDCSI can be used with *ICD-10*-coded data.

with *ICD-10* data has been performed with long-term follow-up. Because most healthcare systems use *ICD-10*-based diagnostic coding, studies on the performance of the aDCSI with *ICD-10* data are urgently needed, especially after the switch from *ICD-9* to *ICD-10* in the United States in 2015.

Based on an analysis of health insurance claims data, the aims of this study are to translate and adapt the aDCSI to *ICD-10* and show its performance for correlation with and prediction of hospitalizations, mortality, and healthcare costs over 4 years.

METHODS

Study Design and Setting

We conducted a retrospective closed cohort study based on secondary data analysis. The study is based on claims data from a large statutory health insurance fund in southern Germany (AOK Baden-Württemberg). This insurer covers 4 million inhabitants of the state of Baden-Württemberg (almost half the state's population). Our data set contains data on all continuously insured persons 18 years and older living in Baden-Württemberg (see [eAppendix Table 1](#) [eAppendix available at [ajmc.com](#)] for the complete list of inclusion criteria). The data include comprehensive information on ambulatory care, drug prescriptions, and hospital care. The analysis was carried out as part of an evaluation of general practitioner-centered healthcare and was fully approved by the Ethics Committee of Frankfurt University Hospital.

Participants

Individuals who had a diagnosis of diabetes mellitus in 2010 (*ICD-10* codes E10-E14) and were receiving antidiabetic medication were included in the study cohort. To further increase diagnostic specificity, we required a diagnosis of diabetes to be coded in at least 3 calendar quarters per year. This should exclude cases of gestational diabetes.

Translation

On the basis of expert consensus, the *ICD-9* version of the aDCSI⁹ was translated to *ICD-10* by the Institute of General Practice (University of Frankfurt) and the PMV Research Group at the Department of Child and Adolescent Psychiatry, Psychosomatics, and Psychotherapy (University of Cologne). The suggestions made by Wilke and colleagues⁸ were taken into consideration in

the translation. Because our translation was undertaken prior to the translation of the DCSI by Glasheen and colleagues,¹⁰ their work was not considered. Our primary translation was to *ICD-10-GM* (German Modification, 2013¹¹), and our analysis is based on this translation. We also present a translation to the CDC's *ICD-10, Clinical Modification (ICD-10-CM)*¹² for comparison. The detailed translation can be found in [eAppendix Table 2](#).

Predictive Performance

Based on our translation, we calculated aDCSI scores for all patients in our study cohort depending on their status in 2010. We assessed outcomes during the observation period from the beginning of 2011 to the end of 2014. Clinical outcomes included overall hospitalizations; hospitalizations due to stroke, coronary heart disease (CHD), and acute renal failure; and mortality. To predict cost, we calculated total costs of inpatient care and costs of prescription medication per patient from 2011 to 2014. Costs are those that insurance reimbursed and do not include private costs (eg, over-the-counter medications).

Performance in Correlative Use

To facilitate comparison with previous results, we also calculated aDCSI scores based on all coded diagnoses in the entire observation period (2011-2014). We calculated models based on this "cumulative" aDCSI for overall hospitalizations during the observation period.

Statistical Analysis

We used univariate and multivariate regression models to calculate risk ratios (RRs) for overall hospitalizations and specific hospitalizations due to stroke, CHD, and acute renal failure. The aDCSI was included as a categorical variable (0, 1, 2, 3, 4, and ≥ 5) in our regression models. Because of overdispersion in Poisson models (as previously reported⁹), we used negative binomial models to calculate RRs. Negative binomial models did not show overdispersion, and results were very similar to those in the Poisson model. We therefore show them in comparison with the results of Young and colleagues⁶ and Chang and colleagues.⁹ For direct medical cost, a linear regression model was used to estimate incremental increase in cost per unit of the aDCSI score. We used Cox's proportional hazards models to estimate hazard ratios for all-cause mortality. Adjusted and unadjusted models were calculated for age, sex, and insulin use. For a comparison of the aDCSI's performance in predictive and correlative use, we calculated the area under the curve (AUC) of the receiver operating characteristic (ROC) curve. Descriptive analyses and modeling were performed in SAS version 9.3 (SAS Institute Inc; Cary, North Carolina) and ROC analysis in SPSS version 22 (IBM Corp; Armonk, New York).

RESULTS

Baseline Characteristics

Our study cohort included 157,115 patients with diabetes. The mean age was 69.5 years and 52.7% of patients were female. A total of 134,163 (85.4%) patients were alive at the end of our observation period. Further characteristics are summarized in [Table 1](#).

Patients with higher aDCSI scores tended to be older and have higher general comorbidity, as assessed using the Charlson Comorbidity Index. Insulin use and mortality rose with increasing aDCSI score.

End Points

Adjusted and unadjusted multiple regression models showed increasing RRs of hospitalization with increasing aDCSI scores compared with those without complications ([Table 2](#)^{6,9} and [Table 3](#)⁶). Correlative use showed larger increases in RRs with increasing aDCSI score. Adjusted and unadjusted RRs showed an approximately linear increase for aDCSI scores of 1 to 5 and above. Hospitalization for ischemic stroke, CHD, and acute renal failure showed similar increases in RRs ([Table 4](#)). RRs were lower in the adjusted models, suggesting that part of the increased risk in higher aDCSI score categories is related to covariates, and mainly to older age in these groups. Relative risk of hospitalization was higher in men than women. Assessed using the AUC, the performance of the aDCSI in predictive use (to predict overall hospitalizations) was 0.642 (95% CI, 0.639-0.644). The AUC for correlative use (correlation with overall hospitalizations) was 0.735 (95% CI, 0.732-0.737). The ROC curve is shown in the [Figure](#).

Mortality

A total of 22,952 deaths occurred during the 4-year observation period from 2011 to 2014. The hazard ratios for mortality increased with a rise in aDCSI score compared with those without complications ([eAppendix Table 3](#)). The adjusted model showed the same trend, but adjustment led to a decrease in hazard ratios compared with the unadjusted model. The risk of dying was higher in men than women.

Costs

Higher aDCSI scores were related to increased costs of inpatient care and prescription medications. Compared with a score of 0,

medication costs roughly doubled and inpatient costs tripled for patients with aDCSI scores of 5 or greater ([eAppendix Table 4](#)).

DISCUSSION

Based on a large and representative cohort, our results show that scores on the *ICD-10* translation of the aDCSI reliably stratify risk of hospitalization and mortality and can be used for healthcare cost prediction. In addition, we show for the first time that the aDCSI

TABLE 1. Baseline Characteristics of Patients With Type 1 or Type 2 Diabetes and Characteristics Stratified by aDCSI Score at Baseline

Characteristics	All	aDCSI					
		0	1	2	3	4	≥5
n	157,115	28,023	28,625	29,072	22,159	17,892	31,344
Age, years, mean (SD)	69.5 (11.7)	63.2 (12.6)	66.2 (11.6)	69.3 (11.2)	71.2 (10.4)	73.2 (9.9)	75.2 (9.1)
Sex							
Male	47.3%	45.7%	44.7%	45.6%	47.8%	48.5%	51.6%
Female	52.7%	54.3%	55.3%	54.4%	52.2%	51.5%	48.4%
German citizenship	88.1%	83.8%	85.6%	87.4%	89.2%	90.6%	92.5%
CCI score, mean (SD)	3.35 (2.28)	1.47 (0.97)	2.33 (1.37)	2.74 (1.50)	3.49 (1.72)	4.25 (1.91)	5.94 (2.37)
Type 1 diabetes	9.5%	7.5%	9.2%	8.5%	10.0%	10.0%	11.7%
Insulin use	27.1%	17.8%	21.4%	22.7%	26.8%	30.6%	43.0%
Hospitalizations in 2011-2014 per patient, mean (SD)							
Total	2.27 (3.21)	1.23 (2.28)	1.47 (2.45)	1.93 (2.70)	2.31 (3.02)	2.82 (3.39)	3.90 (4.16)
Stroke	1.42 (2.33)	0.77 (1.53)	0.91 (1.68)	1.18 (1.82)	1.43 (2.04)	1.77 (2.37)	2.50 (3.40)
Coronary heart disease	1.10 (1.95)	0.62 (1.33)	0.76 (1.56)	0.96 (1.66)	1.15 (1.88)	1.35 (2.05)	1.77 (2.66)
Acute renal failure	1.44 (2.38)	0.76 (1.53)	0.91 (1.68)	1.17 (1.81)	1.35 (2.05)	1.79 (2.41)	2.57 (3.50)
Mortality in 2011-2014	14.6%	5.5%	6.1%	10.9%	12.5%	19.9%	32.4%

aDCSI indicates adapted Diabetes Complications Severity Index; CCI, Charlson Comorbidity Index.

TABLE 2. Unadjusted Risk Ratios for All-Cause Hospitalization by Main Predictor (predictive aDCSI for 2010, correlative aDCSI for 2010-2014)

	Risk Ratio (95% CI) for Overall Hospitalization			
	Our Study (n = 157,115)		Young et al ⁶ DCSI (n = 4229)	Chang et al ⁹ aDCSI (n = 138,615)
	Predictive	Correlative		
aDCSI or DCSI (ref, 0)				
1	1.22 (1.20-1.25)	1.19 (1.15-1.24)	1.40 (1.14-1.72)	1.39 (1.36-1.42)
2	1.55 (1.52-1.58)	1.70 (1.64-1.76)	2.25 (1.84-2.76)	2.24 (2.19-2.29)
3	1.77 (1.73-1.81)	2.15 (2.08-2.23)	3.36 (2.72-4.14)	3.13 (3.03-3.23)
4	2.11 (2.06-2.16)	2.89 (2.80-2.99)	5.05 (4.07-6.26)	4.21 (4.05-4.37)
≥5	2.72 (2.67-2.78)	4.93 (4.78-5.07)	7.70 (6.41-9.24)	6.10 (5.86-6.36)

aDCSI indicates adapted Diabetes Complications Severity Index; DCSI, Diabetes Complications Severity Index; ref, reference.

METHODS

TABLE 3. Comparison of Adjusted Risk Ratios for All-Cause Hospitalizations by Main Predictor (predictive aDCSI for 2010, correlative aDCSI for 2010-2014)

	Risk Ratio (95% CI) for Overall Hospitalization		
	Our Study ^a (n = 157,115)		Young et al ^{6,b} DCSI (n = 4229)
	Predictive	Correlative	
aDCSI or DCSI (ref, 0)			
1	1.16 (1.13-1.18)	1.18 (1.14-1.22)	1.05 (0.67-1.62)
2	1.40 (1.37-1.43)	1.65 (1.59-1.70)	1.19 (0.77-1.86)
3	1.54 (1.50-1.57)	2.06 (1.99-2.13)	1.95 (1.25-3.04)
4	1.77 (1.72-1.82)	2.72 (2.64-2.82)	3.11 (2.01-4.81)
≥5	2.18 (2.14-2.24)	4.48 (4.34-4.62)	5.13 (3.45-7.64)

aDCSI indicates adapted Diabetes Complications Severity Index; DCSI, Diabetes Complications Severity Index; ref, reference.

^aAdjusted for sex, age, and insulin use.

^bAdjusted for age, sex, race, diabetes duration, glycosylated hemoglobin level, body mass index, current smoking, and insulin use.

predicts specific patient-relevant outcomes related to diabetes (hospitalization for ischemic stroke, CHD, and acute renal failure). This is the first validation study of the aDCSI based on a patient cohort from Germany, adding to the external validity of the score.

Correlative use of the aDCSI reveals higher RRs and AUCs than predictive use. This is to be expected, because patients with acute complications, reflected in a higher aDCSI, are more likely to be hospitalized. This is also true when the aDCSI increases following a hospitalization during which complications were diagnosed. Depending on the intended use of the aDCSI, the distinction between correlative use and predictive use should be taken into consideration.

We observed somewhat lower RRs in higher score categories than were described in previous studies, even in correlative analysis.^{6,7,9} One possible explanation is the relatively high hospitalization rate in Germany (a mean of 2.3 hospitalizations per patient over 4 years

in our sample compared with 0.94 hospitalizations over 4 years in the study by Chang et al⁹).

Disease severity scores based on claims data (and sometimes additional laboratory data) rely on the documentation and validity of coded diagnoses, which in turn depend on national systems of patient care and reimbursement. Claims data often include a certain degree of simultaneous under- and overcoding. Undercoding can occur when clinicians consider diagnoses to be clinically irrelevant (which should barely affect diseases used to calculate the aDCSI), when diseases are not detected (this may be relevant, such as for chronic renal failure, which is asymptomatic in early stages), and when diseases are not reimbursable (this largely depends on the specificities of the respective healthcare system). Overcoding can result when codes of acute diseases are not removed from electronic management systems when the acute disease has subsided. In Germany, previous studies have shown that the average number of diagnoses per patient is high compared with other countries.¹³ Country-specific modalities like these are likely to contribute to observed differences in the performance of severity scores.

Limitations

Most diagnostic codes are quite specific for diabetes-related complications, but some are not (this limitation applies to the aDCSI and similar scores in general). Stroke or renal failure, for instance, are common complications of diabetes, but they can have other causes (eg, atrial fibrillation for stroke). Although not specific to diabetes, these factors can still be of prognostic relevance. The accuracy of the documentation of a patient's diagnosis is important in all applications of the aDCSI.

Besides this general limitation, although our data set covers a broad population, some selection effects are possible, as we were able to analyze only the data from the AOK insurance fund, and this fund has a slightly larger proportion of insured persons without employment and with chronic diseases than other insurers in the

TABLE 4. Risk Ratios for Hospitalization (2011-2014) Due to Stroke, CHD, and Acute Renal Failure by Main Predictor (aDCSI score of 2010) and Adjusted by Age, Sex, and Insulin Use (n = 157,115)

Predictors	Risk Ratio (95% CI) for Hospitalization					
	Stroke		CHD		Acute Renal Failure	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
aDCSI (ref, 0)						
1	1.21 (1.19-1.24)	1.16 (1.13-1.18)	1.24 (1.21-1.27)	1.19 (1.16-1.22)	1.20 (1.18-1.23)	1.15 (1.12-1.17)
2	1.52 (1.49-1.55)	1.40 (1.37-1.43)	1.62 (1.58-1.66)	1.50 (1.46-1.54)	1.53 (1.50-1.57)	1.41 (1.38-1.44)
3	1.76 (1.72-1.81)	1.57 (1.53-1.61)	1.79 (1.74-1.84)	1.61 (1.57-1.67)	1.77 (1.73-1.82)	1.58 (1.54-1.62)
4	2.08 (2.02-2.13)	1.80 (1.75-1.85)	2.10 (2.04-2.17)	1.84 (1.78-1.90)	2.12 (2.07-2.18)	1.83 (1.78-1.88)
≥5	2.71 (2.65-2.79)	2.24 (2.19-2.29)	2.60 (2.53-2.68)	2.18 (2.12-2.25)	2.83 (2.76-2.89)	2.32 (2.26-2.38)
Sex (ref, female)	–	1.13 (1.11-1.14)	–	1.19 (1.17-1.21)	–	1.13 (1.15-1.15)
Age	–	1.10 (1.09-1.11)	–	1.10 (1.09-1.11)	–	1.10 (1.09-1.10)
Insulin use	–	1.26 (1.24-1.28)	–	1.20 (1.18-1.20)	–	1.28 (1.26-1.30)

aDCSI indicates adapted Diabetes Complications Severity Index; CHD, coronary heart disease; ref, reference.

state. Nevertheless, AOK Baden-Württemberg covers almost half the state's population. The population analyzed should therefore be fairly representative for insurance-covered individuals of industrialized societies. However, for the United States, the uninsured constitute a major challenge facing healthcare today, with many experiencing more severe diabetes and related complications.^{14,15} A limitation in the methods used in this study is that we did not take person-time at risk into account (ie, those that die early on during the observation period are no longer at risk of hospitalization) when calculating risk of hospitalization and costs. To ensure comparability with previous studies, we decided against the use of more sensitive statistical methods.

Besides prediction, we believe that the main use of the aDCSI is to adjust multivariate models in health service research to reflect the severity of diabetes complications. In this regard, a standardized translation to *ICD-10* facilitates the comparability of studies. There are minor differences between the *ICD-10-GM* used in this study and the CDC's *ICD-10-CM* that may limit direct comparison, but we believe that the effects are small. However, when using the aDCSI, coding conventions for the population under review should be taken into account.

CONCLUSIONS

Our study supports the overall validity of the aDCSI and its translation to *ICD-10* as a severity measure for diabetes complications, as it correlates to and predicts overall and cause-specific hospitalizations, mortality, and cost. ■

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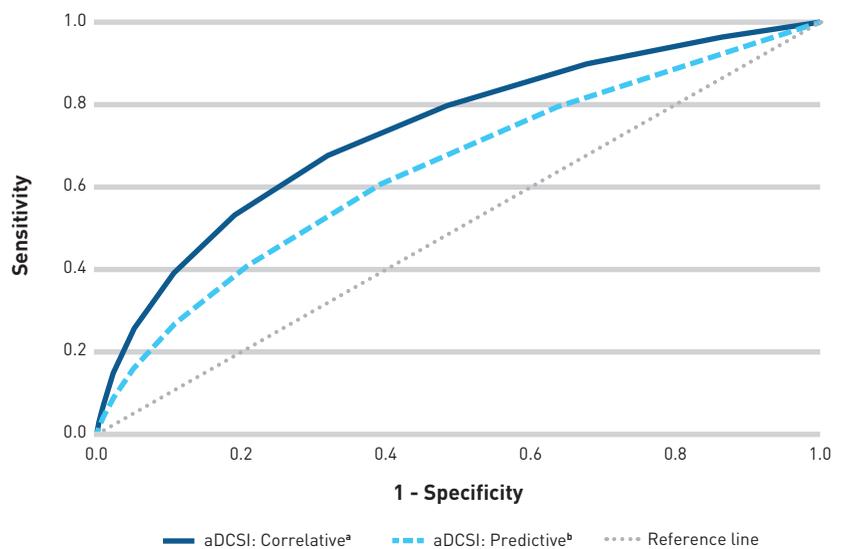
Source of Funding: The statutory health insurer AOK Baden-Württemberg supported our study and provided the administrative data sources/claims data. The funder had no role in the analysis, interpretation, or publication of the data.

Author Disclosures: The authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (FSW, AG, IS, IK, RL, MH, MB, KK); acquisition of data (RL); analysis and interpretation of data (FSW, AG, MH, MB, KK); drafting of the manuscript (FSW, KK); critical revision of the manuscript for important intellectual content (AG, IS, IK, MB, KK); statistical analysis (AG); administrative, technical, or logistic support (AG, RL, MH, MB, KK); supervision (IS, IK, MB, KK); and correcting translation of adapted Diabetes Complications Severity Index (IS).

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FIGURE. ROC Curve of the aDCSI's Performance [AUC (95% CI)]



aDCSI indicates adapted Diabetes Complications Severity Index; AUC, area under the curve; ROC, receiver operating characteristic.

*AUC, 0.735; 95% CI, 0.732-0.737.

*AUC, 0.642; 95% CI, 0.639-0.644.

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eAppendix Table 1. Detailed Exclusion Criteria

- Patient changed insurance fund during study period
- Age less than 18 years
- Patient or physician is part of a special innovative or exploratory insurance program, not reflecting usual care in the German health system.
- Patients place of residence outside of the state of Baden-Wuerttemberg
- Patients who registered with the insurance fund within the two years prior to study start (2012-2013)

eAppendix Table 2. aDCSI translation to ICD-10

Complications	ICD-10-GM (Germany)	ICD-10-CM (USA)	aDCSI Points	Diagnosis label
Ocular	E10.3, E11.3, E12.3, E13.3, E14.3; H28.0, H36.0	E08.3, E09.3, E10.3, E11.3, E13.3	1	diabetes mellitus with ophthalmic complications
	H35.0	n.a. *	1	background retinopathy and retinal vascular changes
	H35.8	n.a.	1	other specified retinal disorders
	H35.3	n.a.	1	degeneration of macula and posterior pole
	H35.6	n.a.	1	retinal hemorrhage
	H35.2	n.a.	2	other proliferative retinopathy
	H33.0	H33.0	2	retinal detachments and breaks
	H54.0; H54.4	H54.0; H54.4	2	blindness, both eyes and blindness one eye
	H43.1	H43.1	2	vitreous hemorrhage
Renal	E10.2, E11.2, E12.2, E13.2, E14.2	E08.2, E09.2, E10.2, E11.2, E13.2	1	diabetes mellitus with kidney complications
	N08.3	n.a.	1	glomerular disorders in diseases classified elsewhere
	N04	N04	1	nephrotic syndrome
	N03	N03	1	chronic nephritic syndrome
	N05	N05	1	unspecified nephritic syndrome
	N18	N18	2	chronic kidney disease
	N17	N17	2	acute kidney failure
	N19	N19	2	unspecified kidney failure
	T82.4	T82.4	2	mechanical complication of vascular dialysis catheter
	Z49	Z49	2	renal dialysis
	Z99.2	Z99.2	2	dependence on renal dialysis
Neurological	E10.4, E11.4, E12.4, E13.4, E14.4	E08.4, E09.4, E10.4, E11.4, E13.4	1	diabetes mellitus with neurological complications
	G60.9	G60.9	1	hereditary and idiopathic neuropathy, unspecified
	G73.0	G73.3	1	myasthenic syndromes in other diseases classified elsewhere
	H49.0, H49.1, H49.2	H49.0, H49.1, H49.2	1	oculomotor nerve palsy; trochlear nerve palsy; abducent nerve mononeuropathy in diseases classified elsewhere
	G59.0	n.a.	1	mononeuropathy in diseases classified elsewhere
	M14.6, M14.2	n.a.	1	neuropathic arthropathy
	G63.2	n.a.	1	polyneuropathy in diseases classified elsewhere
	G99.0	n.a.	1	autonomic neuropathy in diseases classified elsewhere
Cerebrovascular	G45	G45	1	transient cerebral ischemic attacks and related syndromes
	I61, I63; I64, I69	I61, I63, I69		intracranial hemorrhage; ischemic stroke; sequelae of those
Cardiovascular	I70	I70	1	atherosclerosis
	I24	I24	1	other acute ischemic heart diseases
	I20	I20	1	angina pectoris
	I25	I25	1	chronic ischemic heart disease
	I21, I23	I21, I23	2	myocardial infarction and complications of MI
	I49.0, I46	I49.0, I46	2	ventricular fibrillation and flutter, cardiac arrest
	I48	I48	2	atrial fibrillation and flutter
	I22	I22	2	subsequent myocardial infarction
	I50, I11.0, I13.0	I50, I11.0, I13.0	2	heart failure, hypertensive heart disease with heart failure, hypertensive heart and chronic kidney disease with heart failure
	I71	I71	2	aortic aneurysm and dissection
Peripheral vascular	E10.5, E11.5, E12.5, E13.5, E14.5	E08.5, E09.5, E10.5, E11.5, E13.5	1	diabetes mellitus with circulatory complications
	I79.2	n.a.	1	other disorders of arteries, arterioles and capillaries in diseases classified elsewhere
	I72.4	I72.4	1	aneurysm of artery of lower extremity
	I73.9	I73.9	1	peripheral vascular disease, unspecified
	I74.3	I74.3	2	embolism and thrombosis of arteries of the lower extremities
	R02, I70.24	I70.23, I70.24, I70.25, I70.26, E08.52, E09.52, E10.52, E11.52, E13.52	2	Atherosclerosis of native arteries of extremities with gangrene or ulceration; diabetic peripheral angiopathy with gangrene
	A48.0	A48.0	2	gas gangrene
	L97	L97	2	non-pressure chronic ulcer of lower limb, not elsewhere classified
	L98.4	L98.4	2	non-pressure chronic ulcer of skin, not elsewhere classified
	n.a.	E08.621, E08.622, E09.621, E09.622, E10.621, E10.622, E11.621, E11.622, E13.621, E13.622	2	diabetes mellitus with other skin or foot ulcer
Metabolic	E10.1, E11.1, E12.1, E13.1, E14.1	E08.1, E09.1, E10.1, E11.1, E13.1	2	diabetes mellitus with ketoacidosis
	E10.0, E11.0, E12.0, E13.0, E14.0	n.a.	2	diabetes mellitus with coma
	n.a.	E08.641, E09.641, E10.641, E11.641, E13.641	2	diabetes mellitus with hypoglycemia with coma

* n.a.: not applicable as ICD-10-CM specifically codes these complications as suffix to the diabetes (E08-E13) codes

eAppendix Table 3. Cox Regression Model of Mortality in 2011-2014 by Main Predictor (aDCSI score of 2010), Unadjusted and Adjusted for Age, Sex, and Insulin Use (n = 157,115)

Predictors		Unadjusted HR (95% CI)	<i>P</i>	Adjusted HR (95% CI)	<i>P</i>
aDCSI (ref, 0)	1	1.16 (1.10-1.23)	<.0001	0.91 (0.86-0.96)	.0005
	2	2.10 (2.00-2.20)	<.0001	1.31 (1.25-1.37)	<.0001
	3	2.53 (2.41-2.66)	<.0001	1.36 (1.29-1.43)	<.0001
	4	3.72 (3.54-3.91)	<.0001	1.72 (1.64-1.81)	<.0001
	≥5	5.83 (5.58-6.10)	<.0001	2.33 (2.23-2.45)	<.0001
Age		-	-	2.39 (2.35-2.43)	<.0001
Sex (ref, female)		-	-	1.49 (1.45-1.54)	<.0001
Insulin use		-	-	1.58 (1.53-1.62)	<.0001

aDCSI indicates adapted Diabetes Complications Severity Index; ref, reference; HR, hazard ratio.

eAppendix Table 4. Costs of Inpatient Care and Prescription Medications in 2011-2014 per Patient Stratified by Main Predictor (aDCSI score of 2010)

aDCSI	Medication Costs (€)	Inpatient Costs (€)
0	4.312	4.747
1	5.229	5.963
2	5.856	7.924
3	6.709	9.208
4	7.468	11.078
≥5	8.930	15.296