Original Article

The Prognosis and Healthcare Expenditure of Newly Diagnosed Diabetic Patients – Are There Differences Between Family Physicians and the Internists?

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Objective: Diabetes has become a global epidemic and its related complications also contribute to staggering medical expenditure. This is a longitudinal cohort study utilizing the National Health Insurance Research Database of Taiwan. The aim of this study is to analyze the probability of family physicians and internists in the primary healthcare system in encountering diabetic acute emergencies and chronic cormobidities as well as the difference in medical expenditure.

Methods: Subjects aged 18 or above visiting local clinics with initial diagnosis of diabetes mellitus between November 2002 and December 2004 as well as at least two visits with diabetes diagnoses within 12 months were included. The primary healthcare system should cover at least 50% of their diabetes-related clinical visits. Exclusion criteria included diabetes-related diagnosis prior to the initial diagnosis and/or the concomitant diagnosis of serious illnesses. The whole study period included years being followed until December 31, 2007.

Results: Kaplan-Meier survival analysis was conducted to evaluate the risk of developing acute as well as chronic complications between two cohorts (SAS 9.2). Totally 1,273 and 989 patients aged between 18 and 75 were recruited for the family medicine cohort and internal medicine cohort, respectively.

Conclusions: Our study revealed no differences in the reported incidences of most diabetes-associated complications between the family physicians and internists, the average cost of outpatient care by family physicians was significantly lower than that by internists. The results, therefore, underscore the capability of primary care family physicians to provide cost-effective care for diabetic patients.

Key words: diabetes mellitus, longitudinal health insurance database, acute complications , chronic cormobidities, medical expenditure

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Introduction

Diabetes has become a global epidemic with its prevalence substantially increased three folds from 153 million in 1980 to 347 million in 2008 in less than three decades.[1] The incidence in Taiwan is 4.7% – 6.5% and 5.3% – 6.6% for males and females, respectively.[2] Diabetes-related complications not only include the life-threatening situations such as diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic state (HHS), and hypoglycemia, but also comprise a wide range of chronic and debilitating morbidities that contribute to the subsequent mortalities and staggering medical expenditure.[3-5]

Since chronic care of diabetes patients requires neither special diagnostic equipment nor complicated therapeutic measures, the responsibility usually fell into the hands of physicians in the primary healthcare system (i.e., primary care physicians) who are the gatekeepers responsible for providing accessible, continuous, comprehensive, coordinative, and accountable service and act as sentinels of the medical system.

Of all the specialties of primary care physicians with different training backgrounds, internists and family physicians are those mainly responsible for chronic diabetic care. While the internists (i.e., endocrinologists) serve as the principal councilor, the family physicians focus on primary care including the prevention of diseases, interactions with patients, and treatment of disease complications as well as playing a crucial role in following the progression of chronic diseases.

Utilizing the Longitudinal Health Insurance Database, this study analyzed the probability of family physicians and internists in the primary healthcare system in encountering diabetic emergencies including DKA, HHS, and hypoglycemia as well as the difference in medical expenditure generated through the two medical specialties. The aims of the present study are to provide a practical reference for the public, government, and the medical boards in terms of the choice of medical specialty, policy-making, and modification of physician training.

Methods

Utilization of National Health Insurance Research Database

One million subjects were randomly selected from the National Health Insurance Research Database between the years 2001 and 2007. Of the population of one million, subjects of age over 18 with newly diagnosed diabetes mellitus type 1 and type 2 were included in the current study. The inclusion criteria for the study subjects included those visited local clinics with an age of 18 or over and an initial diagnosis of diabetes mellitus in the medical record between the period of January 2002 and December 2004 as well as at least two subsequent visits with diabetes being included as one of the five diagnoses submitted to the National Health Insurance Company within 12 months of the initial diagnosis. The primary healthcare system should cover at least 50% of their diabetes-related clinical visits. Exclusion criteria included the appearance of diabetes-related diagnosis within 12 months prior to the initial diagnosis of diabetes and/or the concomitant diagnosis of serious illnesses as defined by the Ministry of Health, Taiwan, that were supposed to contribute significantly to the individual's medical expenditure. According to the event-free probability of diabetes-related clinical visits in the first year, patients were divided into family medicine and internal medicine groups. The definition of diabetes-related diseases was in accordance with that of ICD-9-CM (Table 1).

Data Processing and Definitions

The calculation of the event of acute

Table 1. DM complications

Complications	ICD-9
ACUTE	
Hypoglycemic acute complications	
Hypoglycemia	250.3, 251.1-251.2, 250.8
Hyperglycemic acute complications	
Hyperosmolar hyperglycemic state (HHS)	250.2
Dabetic ketoacidosis (DKA)	250.1
CHRONIC	
Large-vessel complications	430-438, 410-414
Renal manifestations	250.4, 585.1-585.9, 583.81, 581.81
Ophthalmic manifestations	250.5, 369.00-369.9, 366.41, 365.44, 362.01-362.07
Neurological manifestations	250.6, 353.5, 536.3, 536.3, 354.0-355.9, 713.5, 337.1, 357.2
Peripheral circulatory disorders	250.7, 785.4, 443.81, 707.10-707.9, 731.8

complications was based on their appearance as one of top five diagnoses for either hospitalization or visits to the emergency department from the date of initial diagnosis to December 31, 2007. On the other hand, the calculation of the event of chronic complications was based on their appearance as one of top five diagnoses during hospitalization or visits to either the outpatient clinic or emergency department after excluding the patients with the diagnosis code of diabetes-related chronic complications on their first outpatient clinic visits during the same study period. Censoring was considered for patients who were complication-free during the whole study period (i.e., till December 31, 2007). Data including the timing of occurrence of acute and chronic diabetes-related complications (i.e., time to event) as well as medical expenditures were analyzed.

Medical expenditure was defined as the expenditure derived from outpatient clinic visits, including co-payment, because of diabetes-related diagnoses per person-year.

Statistical Analysis

All data were processed with statistical software SAS 9.2 according to the set conditions. Relevant data were presented as survival curve using Kaplan-Meier estimator. The significance of difference in event probability between the two groups was determined with Log-Rank Test. Significance of difference between the two groups was determined using Student t-test with a p value less than 0.05 being considered statistically significant.

Results

Totally 1,273 and 989 patients were recruited for the family medicine group and internal medicine group, respectively. Analysis of the demographic data showed that the male/female ratio was 0.96 and 1.12 and the age was 56.7 ± 12.4 and 56.3 ± 12.6 for the former and latter, respectively, with the family medicine group slightly female-predominant and older compared with those in the internal medicine group. However, no statistical significance was noted (Table 2).

Similarly, although Kaplan-Meier survival analysis demonstrated no significant difference in the incidence of hypoglycemia after initial

Table 2. Intergroup comparison of the demographic data of newly diagnosed diabetic patients between family medicine group and internal medicine group.

	Family physician (n = 1,273)	Internist (n = 989)	p
Male/female ratio	0.96	1.12	0.08
Age (SD)	56.7 (12.4)	56.3 (12.6)	0.42

diagnosis of diabetes between the two groups, different trends were discernible in the two groups. While the episodes of hypoglycemia continued to increase after 3 years of initial diagnosis and leveled off only after the fifth year in the internal medicine group, the occurrence became relatively stable after the third year in the family medicine group (Fig. 1). On the other hand, the incidences of acute hyperglycemic complications (i.e., HHS and DKA) (Fig. 2) as well as overall acute complications (Fig. 3) were higher in the internal medicine group than those in the family medicine group throughout the study period, despite the lack of statistical significance.

In terms of diabetes-related chronic complications, there was no significant difference in the occurrence of large vessel disease (Fig. 4) and peripheral circulatory disorders (Fig. 5) as well as neurological (Fig. 6) and ophthalmic manifestations (Fig. 7) on Kaplan-Meier survival analysis. However, substantially higher incidence of renal manifestations was noted in the internal medicine group compared with that in the family medicine group with statistical significance (p = 0.028) (Fig. 8). Overall chronic complications also showed a trend of lower incidence in family medicine group despite the lack of statistical significance (p = 0.091) (Fig. 9).

Moreover, the medical expenditure for the internal medicine and family medicine groups was US$302.53 and US$244.14 per person-year, respectively, with the latter being 23.9% lower than that of the former (p < 0.001).

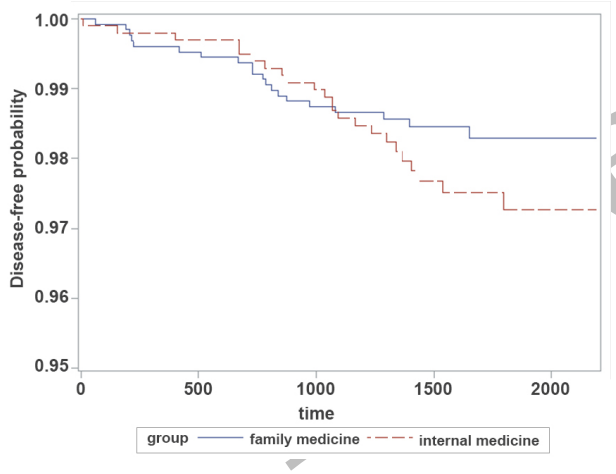

Fig 1. Hypoglycemic acute complications (Hypoglycemia)

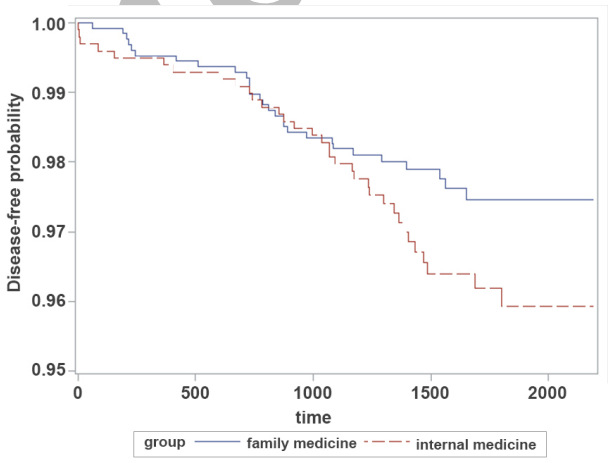

Fig 3. Overall acute complications

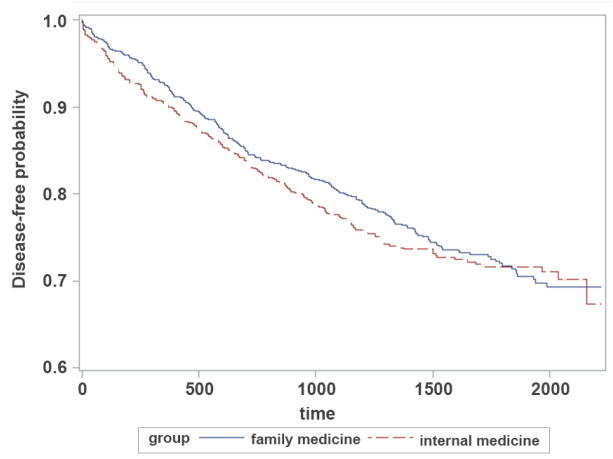

*Fig 2. Hyperglycemic acute complications (*Diabetic ketoacidosis+Hyperosmolar hyperglycemic state*)*

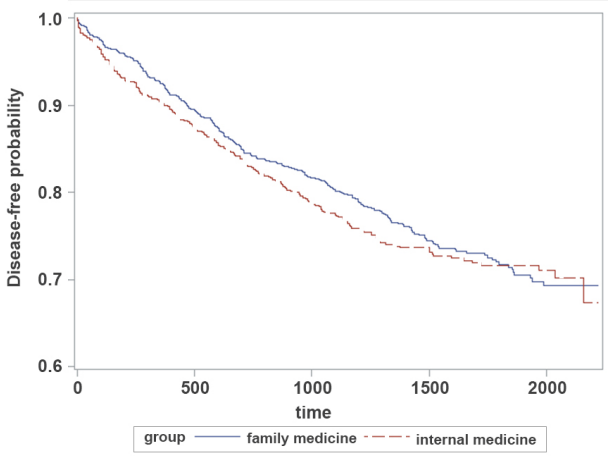

Fig 4. Large vessel disease

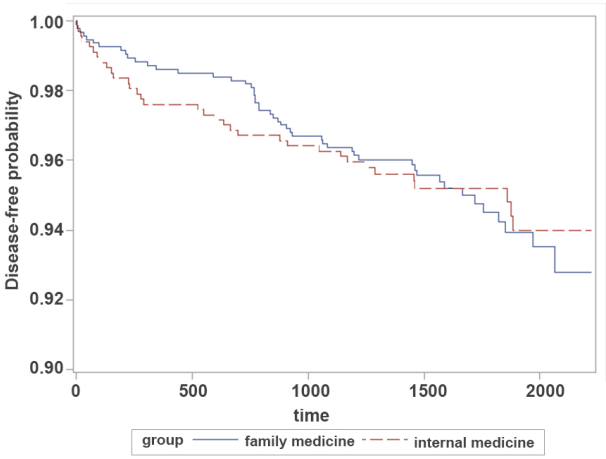

Fig 5. Peripheral circulatory disorders

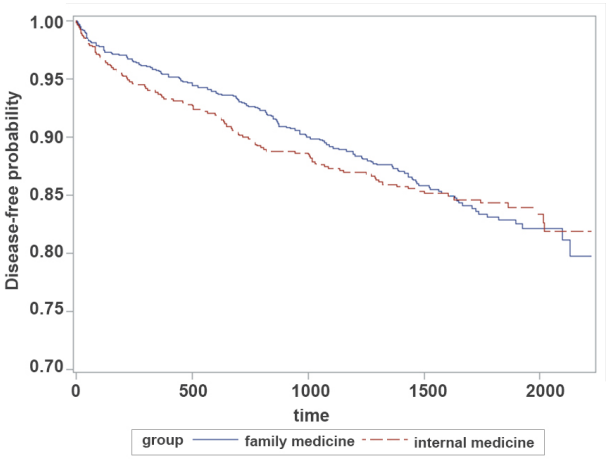

Fig 6. Neurological manifestations

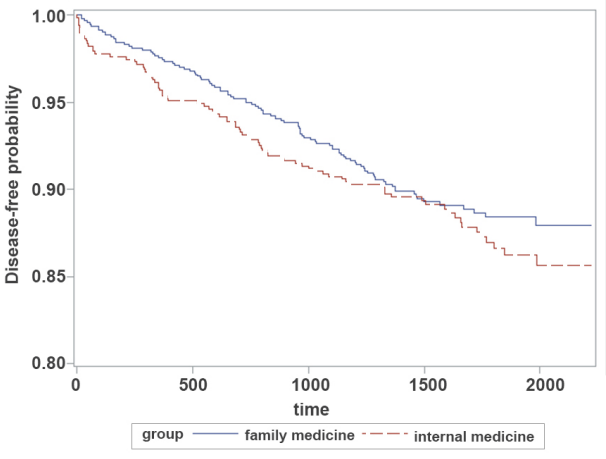

Fig 7. Ophthalmic manifestations

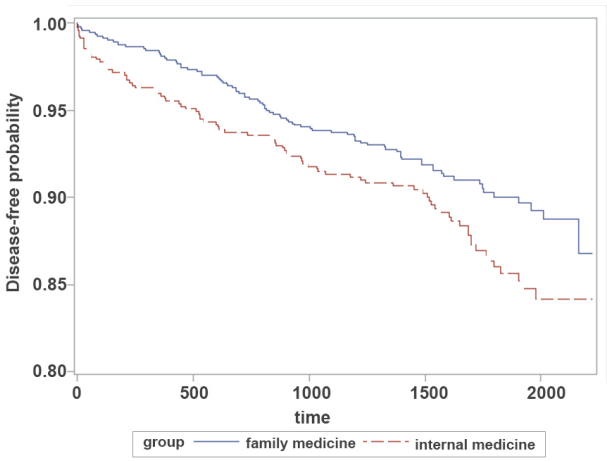

Fig 8. Renal manifestations

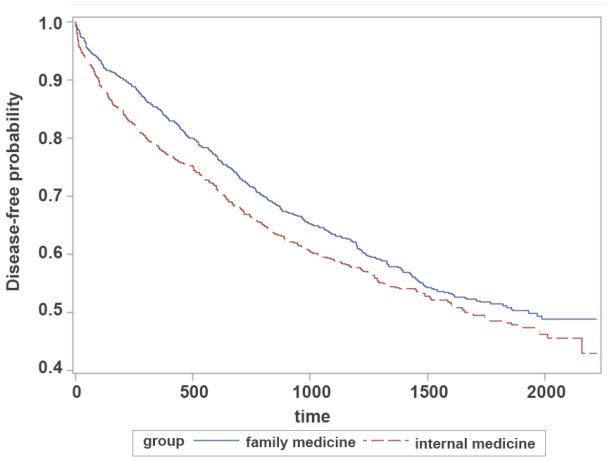

Fig 9. Overall chronic complications

Discussion

The present study compared the management of patients with newly diagnosed diabetes by primary care physicians in two medical disciplines, namely the family physicians and internists, in terms of the incidences of subsequent development of acute and chronic complications in the patients as well as the medical expenditure involved over a 5-year period. The aim of this study is primarily to investigate the cost-effectiveness of diabetes management in a medical system that puts specialists on the frontiers of primary care such as that in Taiwan and United States compared to that in United Kingdom that involves mainly the general practitioners.

According to the statistics of Taiwan Medical Association (www.tma.tw/stats/files/2016_stats.pdf) in 2016, the number of family physicians practicing primary care was 2,101 that was 13% less than that of primary

Table 3. Comparison of incidence of diabetes-related complications between internal medicine and family medicine clinics

Complications	Chi-Square	*p* value
Hypoglycemic acute complications (Hypoglycemia)	1.587	0.208
Hyperglycemic acute complications (Dabetic ketoacidosis + Hyperosmolar hyperglycemic state)	2.053	0.152
Overall acute complications	2.613	0.106
Large vessel disease	0.257	0.612
Renal manifestations	4.793	0.029*
Neurological manifestations	0.021	0.885
Ophthalmic manifestations	0.714	0.398
Peripheral circulatory disorders	0.038	0.846
Overall chronic complications	2.887	0.089

care internists (i.e., 2,371). In contrast, the former reported more patients with initial diagnosis of diabetes compared with the latter (1,273 vs. 989). The results may suggest the preference of diabetic patients to seek medical assistance from family physicians and/or the possibility of emphasized holistic care in family medicine that enables more effective screening for diabetes.

Despite the lack of statistical significance, the incidences of hypoglycemic and hyperglycemic complications (e.g., HHS and DKA) as well as overall acute complications on Kaplan-Meier analysis were all lower in the family medicine group than those in the internal medicine group. The relatively lower incidences may indicate adequate disease control and timely prevention of complications. On the other hand, although HHS and DKA are relatively uncommon acute hyperglycemic complications of different etiologies, they were grouped into a single category in the current study because of their similar risk factors, symptoms, severity, urgency, and management strategies.[6]

Unlike acute complications, diabetes-associated chronic complications usually develop only years or even decades after initial diagnosis of the disease. Early report of chronic complications, therefore, represents either a previously undetected disease or timely recognition. According to a study by Martin et al. that followed patients initially diagnosed with diabetes in Germany, the incidence of large vessel complications such as acute myocardial infarction and stroke increases linearly with the duration of diabetes, while chronic complications arising from small vessel diseases are unusual at early stage of the disease.[7] The results of Kaplan-Meier analysis in the present study showed that more diabetes-related chronic complications were reported by family physicians than by the internists, including large vessel disease, neuropathy, retinopathy, and peripheral vascular diseases despite a lack of statistical significance. On the other hand, internists reported the majority of renal complications with statistical significance. The results may indicate sensitive awareness of the early development of vascular, neurologic, and ophthalmological complications by family physicians, while internists are keen on treating complications that require long-term medical intervention such as renal manifestations. The other possibility to account for the finding is the referral to internists by other primary care physicians for the treatment of renal disorders that eventually found to be diabetes-related.

In terms of medical expenditure, the annual cost for an average outpatient in the family medicine group was 20% less than that in the internal medicine group (p <0.001). Taking into consideration the higher incidence of reported acute complications in the former, the finding may suggest a better cost-effectiveness in patient management in the former but may also be due to the costly pharmaceutical,

follow-up, and interventional strategies arising from the treatment of renal complications in the latter.[7]

Focusing on inpatients with pneumonia, Smith et al. demonstrated no significant difference in patient outcome despite a progressive elevation in the average cost of care for one patient from primary care family physician, family physician hospitalist, to critical care hospitalist.[8] The present study is the first to compare the number of patients initially diagnosed with diabetes, the incidences of complications, and the medical expenditure involved between family physicians and internists in the primary care setting. The study was designed to investigate the impact of difference in background training between the two disciplines of physicians on patient outcome and cost-effectiveness focusing on one category of patients who are likely to develop acute and/or chronic complications. While family medicine emphasizes on training in preventive medicine and the provision of holistic, family- and community-based care, internal medicine offers more professional training in the art of diabetes diagnosis and treatment. One of the critical factors that determines the success of transferring diabetic patients from specialist to primary care has been reported to be the patient's confidence in the capability of primary care physician which, in turn, affects the patient's compliance with primary care.[9] To address this issue, the current study demonstrated a significantly lower average cost of outpatient care by family physicians compared with that of internists in the absence of notable differences in the incidences of diabetes-associated acute and chronic complications between the two groups. The results of the present study, therefore, highlight the ability of primary care family physicians to provide effective and efficient care for diabetic patients.

Limitations

Since this retrospective cohort study was conducted based on the National Health Insurance Research Database, the accuracy of data analysis depends heavily on the discreetness of coding of diabetes-related disorders. Lin et al. have previously reported a coding accuracy of 74.6% for diabetes-associated diagnosis in the National Health Insurance Research Database. The accuracy, on the other hand, is substantially improved with the number of outpatient clinic visits and hospitalization.[10] To enhance the accuracy of data acquisition, the present study included only cases with three or more diabetes-related diagnoses during outpatient clinic visits and/or hospitalization within a year. Moreover, since data on glycated hemoglobin were not available in the current study, the status of diabetes control cannot be compared between the two groups. Instead, the incidences of diabetes-associated acute and chronic complications were analyzed. Furthermore, since the present study focused on patient care in the primary care setting, patients who chose to visit specialists in different areas according to the nature of their complications and those who received treatment at secondary care institutes because of the increased severity of their diseases were excluded from this study. Finally, since some diabetes-associated chronic complications may appear only after a decade or even a longer period of disease progression, a follow-up period of 3 to 5 years in the current study cannot accurately reflect the incidence of chronic complications on a long-term basis.

Conclusion

Despite the lack of notable differences in the reported incidences of most diabetes-associated complications between the family physicians and internists in the primary care setting, the average cost of outpatient care by family physicians was significantly lower than that by

internists. The results, therefore, underscore the capability of primary care family physicians to provide cost-effective care for diabetic patients.

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Supplementary Data

ICD-9	Diabetes mellitus related Complications
250.1	Diabetes with ketoacidosis
250.2	Diabetes with hyperosmolarity
250.3	Diabetes with other coma
250.4	Diabetes with renal manifestations
250.5	Diabetes with ophthalmic manifestations
250.6	Diabetes with neurological manifestations
250.7	Diabetes with peripheral circulatory disorders
250.8	Diabetes with other specified manifestations
251.1	Other specified hypoglycemia
251.2	Hypoglycemia, unspecified
337.1	Peripheral autonomic neuropathy in disorders classified elsewhere
353.5	Neuralgic amyotrophy
354.0	Carpal tunnel syndrome
354.1	Other lesion of median nerve
354.2	Lesion of ulnar nerve
354.3	Lesion of radial nerve
354.4	Causalgia of upper limb
354.5	Mononeuritis multiplex
354.8	Other mononeuritis of upper limb
354.9	Mononeuritis of upper limb, unspecified
355.0	Lesion of sciatic nerve
355.1	Meralgia paresthetica
355.2	Other lesion of femoral nerve
355.3	Lesion of lateral popliteal nerve
355.4	Lesion of medial popliteal nerve
355.5	Tarsal tunnel syndrome
355.6	Lesion of plantar nerve
355.7	Other mononeuritis of lower limb
355.8	Mononeuritis of lower limb, unspecified
355.9	Mononeuritis of unspecified site
357.2	Polyneuropathy in diabetes
362.01	Background diabetic retinopathy
362.02	Proliferative diabetic retinopathy
362.03	Nonproliferative diabetic retinopathy NOS
362.04	Mild nonproliferative diabetic retinopathy
362.05	Moderate nonproliferative diabetic retinopathy
362.06	Severe nonproliferative diabetic retinopathy
362.07	Diabetic macular edema
365.44	Glaucoma associated with systemic syndromes
366.41	Diabetic cataract
369.0	Profound impairment, both eyes
369.1	Moderate or severe impairment, better eye, profound impairment lesser eye
369.2	Moderate or severe impairment, both eyes
369.3	Unqualified visual loss, both eyes
369.4	Legal blindness, as defined in U.S.A.
369.6	Profound impairment, one eye
369.7	Moderate or severe impairment, one eye
369.8	Unqualified visual loss, one eye
369.9	Unspecified visual loss
410	Acute myocardial infarction
411	Other acute and subacute forms of ischemic heart disease
412	Old myocardial infarction
413	Angina pectoris
414	Other forms of chronic ischemic heart disease
430	Subarachnoid hemorrhage
431	Intracerebral hemorrhage
432	Other and unspecified intracranial hemorrhage
433	Occlusion and stenosis of precerebral arteries
434	Occlusion of cerebral arteries
435	Transient cerebral ischemia
436	Acute, but ill-defined, cerebrovascular disease
437	Other and ill-defined cerebrovascular disease
438	Late effects of cerebrovascular disease
443.81	Peripheral angiopathy in diseases classified elsewhere
581.81	Nephrotic syndrome in diseases classified elsewhere
583.81	Nephritis and nephropathy, not specified as acute or chronic, in diseases classified elsewhere
585.1	Chronic kidney disease, Stage I
585.2	Chronic kidney disease, Stage II (mild)
585.3	Chronic kidney disease, Stage III (moderate)
585.4	Chronic kidney disease, Stage IV (severe)
585.5	Chronic kidney disease, Stage V
585.6	End stage renal disease
585.9	Chronic kidney disease, unspecified
536.3	Gastroparesis
707.1	Ulcer of lower limbs, except pressure ulcer
707.2	Pressure ulcer stages
707.8	Chronic ulcer of other specified sites
707.9	Chronic ulcer of unspecified site
713.5	Arthropathy associated with neurological disorders
731.8	Other bone involvement in diseases classified elsewhere
785.4	Gangrene