

Standardization of Type 2 Diabetes Outpatient Expenditure with Bundled Payment Method in China

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Abstract

Background: In recent years, the prevalence of type 2 diabetes among Chinese population has been increasing by years, directly leading to an average annual growth rate of 19.90% of medical expenditure. Therefore, it is urgent to work on strategies to control the growth of medical expenditure on type 2 diabetes on the basis of the reality of China. Therefore, in this study, we explored the feasibility of implementing bundled payment in China through analyzing bundled payment standards of type 2 diabetes outpatient services.

Methods: This study analyzed the outpatient expenditure on type 2 diabetes with Beijing Urban Employee's Basic Medical Insurance from 2010 to 2012. Based on the analysis of outpatient expenditure and its influential factors, we adopted decision tree approach to conduct a case-mix analysis. In the end, we built a case-mix model to calculate the standard expenditure and the upper limit of each combination.

Results: We found that age, job status, and whether with complication were significant factors that influence outpatient expenditure for type 2 diabetes. Through the analysis of the decision tree, we used six variables (complication, age, diabetic foot, diabetic nephropathy, cardiac-cerebrovascular disease, and neuropathy) to group the cases, and obtained 11 case-mix groups.

Conclusions: We argued that it is feasible to implement bundled payment on type 2 diabetes outpatient services. Bundled payment is effective to control the increase of outpatient expenditure. Further improvements are needed for the implementation of bundled payment reimbursement standards, together with relevant policies and measures.

Key words: Bundled Payment; Case-mix; Outpatient Expenditure; Type 2 Diabetes

INTRODUCTION

In 2010, Chinese Center for Disease Control and Prevention investigated and found that the prevalence rate of diabetes in Chinese people >18 years old reached 9.7%,^[1] among whom, over 90% were type 2 diabetes.^[2] The average annual growth rate of direct medical expenditure of diabetes in China is 19.90%, which exceeds the growth rate of gross domestic product (GDP) and national health expenditure contemporarily,^[3] and outpatient expenditure occupied 2/3 of the direct medical fees.^[4] The increase in the prevalence of type 2 diabetes not only consumed an enormous amount of money, but also induced tremendous disease burden to both the patient and the society;^[5] therefore, it is necessary to research on how to control the outpatient expenditure of type 2 diabetes. In this study, we analyzed new patterns of medical insurance payment for type 2 diabetes outpatient services, combined with the consideration of features of

type 2 diabetes outpatient expenditure and advantages of bundled payment system. We studied the feasibility of implementing bundled payment for type 2 diabetes outpatient services in the Urban Employee Basic Medical Insurance (UEBMI) in Beijing, so as to come up with suitable payment standards for type 2 diabetes outpatient services.

“Bundled payment” is an approach in which payments to health care providers are related to the predetermined expected costs of a grouping, or “bundle”, of a certain health

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Received: 07-12-2015 **Edited by:** Xin Chen

How to cite this article: Xu GC, Luo Y, Li Q, Wu MF, Zhou ZJ. Standardization of Type 2 Diabetes Outpatient Expenditure with Bundled Payment Method in China. Chin Med J 2016;129:953-9.

Access this article online

Quick Response Code:



Website:
www.cmj.org

DOI:
10.4103/0366-6999.179796

care service.^[6] The intent of bundled payment systems is to decrease health care expenditure while improving or maintaining the quality of care. In 2009, the US Congress passed the affordable care act (ACA).^[7] As an important part of the ACA, “bundled payment” was implemented rapidly across the United States under the guidance of the Centers for Medicare and Medicaid Services.^[8,9] In recent years, bundled payment has already become an important strategy for the United States government to control the increase of medical fees.^[10,11]

Compared to other medical insurance payment modes, such as fee-for-service (FFS), diagnosis-related groups, fee for unit, capitation, etc., bundled payment stands out in several perspectives.^[12-15] It can improve the medical service efficiency and decrease unnecessary medical services (for instance, add abundant nursing after the operation and reduce duplicated check and unnecessary care), control the medical expenditure effectively and reduce the cost of medical insurance, promote the coordination between the medical service providers, and improve the medical care quality. Furthermore, it can greatly decrease the occurrence of decomposed hospitalization, repeated hospitalization, and shuffling patients in severe conditions.^[16-19]

However, there are also some disadvantages in bundled payment: (1) researchers said that adoption of the bundled payments approach was slowed by both technical and cultural difficulties. Technical issues included deciding what health problems should be subject to bundled payment and providing health providers with the information needed to improve medical care. Cultural issues included convincing providers that cost-cutting measures will not reduce the quality of medical care. (2) In order to maximize the profits, hospitals may decrease the patients’ opportunities to be diagnosed and treated by the experts.^[20] (3) As a medical service provider can outsource one part of the patients’ medical services to another provider, it will be difficult to identify financial responsibility for a specific pay package.^[21] (4) Since some kinds of diseases are not suitable for packaging, some patients may have more than one package, among which exists overlapping.

Since 2009, the Chinese government has launched a new round of health care reform. Although some reforms took place in the medical insurance payment patterns, the rapid growth of medical expenditure has not slowed down significantly.^[22] At present, in most areas of China, the dominant payment pattern is still FFS.^[23] Disadvantages of this approach have been revealed during the long-term operation because of the information imbalance, the medical institution has the motivation to provide excessive or expensive medical services, which easily results in supplier-induced demand and excessive medical care.^[24,25] For this reason, Chinese medical insurance management department has to make various medical insurance lists and detailed health regulations. In 2011, the Chinese government proposed reform objectives of payment patterns. The main objectives were: (1) to study

the reform of global budget; (2) to explore the reform of capitation payment based on the risk pooling of outpatient services; and (3) to investigate the reform of diagnosis related groups payment on the basis of the inpatient and outpatient critical illness insurance program. Since then, the payment method in China began to change from single pattern (FFS) to a compound multilevel medical insurance payment system, which consists of global budget, diagnosis related groups payment, and capitation payment. In recent years, many of the Medical Insurance Institutions in China have done numerous studies on how to conduct a more effective payment method. Some of the cities and areas, represented by Beijing, have set up a compound multilevel medical insurance payment system. We can expect the generalization of a compound multilevel medical insurance payment system in the future.

Although many studies have been conducted on the reform of medical insurance payment patterns in China, rare can be found on bundled payment. Therefore, in this study, we explored the feasibility of implementing bundled payment in China through the analysis bundled payment standards of type 2 diabetes outpatient services.

METHODS

Data collection

This study collected the data of the basic medical insurance for an urban employee from January 1, 2010 to December 31, 2012, in Beijing’s secondary and tertiary public general hospitals. Based on these data, we set up the database system for UEBMI. The selected data included the basic information of patients diagnosed with type 2 diabetes (ICD-10 code: E11.2–E11.9), the diagnosis information and relevant settlement information of outpatient expenditure of medical institutions. Meanwhile, patients whose treatment time span <1 year and who have been hospitalized were excluded. Hence, we obtained the cases of 308,500 patients, accounting for 2,396,576 person-times. Then, we randomly selected 10% of the cases each year as the sample. In order to ensure the data’s independence between the years, we excluded those who were selected in any of the two years. Finally, we obtained a sample of 29,374 patients and 225,786 person-times.

Statistical analysis

All information was searched and gathered by year through SQL Server 2008 (Microsoft Corporation Inc., Redmond, WA, USA), and individually summarized data were imported into SPSS 13.0 (SPSS Inc., Chicago, IL, USA). We conducted a descriptive analysis and a single factor analysis on characteristic variables of the patients and the outpatient expenditure, wherein single factor analysis was performed with a rank-sum test of the nonparametric test. We compared data between two groups with Mann–Whitney *U* test and made a comparison of multiple groups with Kruskal–Wallis *H* test. Because the outpatient expenditure related to the disease which took place within

5 months after the first outpatient visit accounted for 75.14% of the total amount of the outpatient expenditure, showing a strong representativeness, it was regarded as the bundled fees.

We used fitting multiple linear regression models to analyze influential factors of outpatient expenditure of type 2 diabetes. Chi-square Automatic Interaction Detector (CHAID) in the decision-making tree was conducted to make case-mix analysis on outpatient expenditure. The statistical analysis was completed with Clementine 12.0 (SPSS Inc., Chicago, IL, USA). Finally, we established a case-mix model to calculate the standard expenditure and upper limit expenditure of each combination.

RESULTS

The descriptive analysis and single factor analysis of outpatient expenditure of type 2 diabetes

The result indicated that: (1) the number of male patients was slightly higher than female patients. Ages concentrated to 51–70 years, which occupied 58.52% of the total amount. The 86.56% of patients were retired; no more than 15.00% were in-service. (2) More than 90.00% patients had complications, among which, proportions of patients with cardiac-cerebrovascular diseases, neuropathy, and arteriosclerosis in lower extremity were all more than 50.00%; arteriosclerosis in lower extremity even reached 61.79%. Proportions of retinopathy, nephropathy, and diabetic foot were <40%; diabetic foot was the least (9.84%). (3) The average outpatient expenditure in 3 years was RMB 8397.16 Yuan; 50% patients spent less than RMB 8866.18 Yuan. (4) Except gender, all of the distribution variance of each characteristic variable at different levels was statistically significant. For all of the complications, the distribution difference of outpatient expenditure of type 2 diabetes was statistically significant [Tables 1 and 2].

Influential factors of outpatient expenditure of type 2 diabetes

We used a multiple linear regression according to the results of the descriptive analysis and the single factor analysis to analyze the influential factors of outpatient expenditure. This step was to make preparation for case-mix analysis through decision-making tree. Influential factors of outpatient expenditure will be used as the grouping node (predict variables).

We conducted a multiple linear regression, with outpatient expenditure as the dependent variable and relevant factors as independent variables. Since all of the variance inflation factors in the equation were <5, no serious co-linearity existed in the equation. Factors in the equation were: gender, age, job status (in service or not), and whether with complications. The results indicated, except gender, the age, job status, and severity of the disease significantly influenced the outpatient expenditure of type 2 diabetes [Table 3].

A further multiple linear regression analysis was conducted on cases with complications (mostly clinical chronic complication of type 2 diabetes). A multiple linear regression model was introduced with the outpatient expenditure as the dependent factor and whether with various complications as the independent factor. From the model, it can be seen that among patients with complications, as to any complication, after controlling other variables (complications), the outpatient expenditure of patients with this complication was higher than that of patients without this complication [Table 4].

The significant of the influential factors on the total outpatient expenditure were subsequently (from high to low): whether with complication, age, and job status [Table 3]. As to various complications, the significances on outpatient expenditure were subsequently (from high to low): diabetic foot, diabetic nephropathy, cardiac-cerebrovascular disease,

Table 1: Univariate analysis of patients' outpatient expenditures

Variables	Number	Outpatient expenditures (RBM, Yuan)			Statistical values	P
		Median	P ₂₅	P ₇₅		
Gender					-1.001*	0.070
Men	17,663	8896.14	5189.47	13,427.56		
Female	11,711	8849.56	5073.16	13,394.06		
Age					18.341†	0.000
≤40 years	3125	7431.58	4625.78	13,279.46		
41–50 years	4423	7955.67	4838.86	13,978.84		
51–60 years	10,079	8879.83	5322.99	12,873.98		
61–70 years	7110	9091.05	5588.70	12,442.55		
71–80 years	4075	9523.26	5845.84	14,744.42		
>80 years	562	9107.36	6081.30	13,788.55		
In-service or not					9.163*	0.000
In-service	25,426	9093.51	5732.12	13,882.15		
Out of service	3948	6746.59	4379.60	12,280.04		
Whether with complication or not					125.395*	0.000
With complication	26,551	9485.32	6034.32	14,347.92		
Without complication	2823	4507.83	3050.14	6354.58		

*U values; †H values.

Table 2: Univariate analysis of outpatient expenditures of patients with or without complications

Variable	Number	Outpatient expenditures (RBM, Yuan)			U	P
		Median	P ₂₅	P ₇₅		
Retinopathy					19.271	0.004
With	8330	9037.10	5981.36	13,018.93		
Without	21,044	8732.40	5655.17	12,984.49		
Diabetic nephropathy					4.383	0.000
With	10,510	10,839.00	7529.43	15,894.37		
Without	18,864	7085.60	4589.25	11,726.18		
Diabetic foot					13.685	0.000
With	2890	12,013.00	9138.05	17,947.83		
Without	26,484	7981.20	5156.27	12,041.93		
Cardiac cerebrovascular disease					7.436	0.000
With	16,884	10,753.00	7431.65	15,482.17		
Without	12,490	6891.80	4164.73	11,472.28		
Neuropathy					5.692	0.012
With	17,372	9448.60	6538.28	14,461.79		
Without	12,002	7995.80	5073.21	12,046.92		
Arteriosclerosis in lower extremity					5.469	0.022
With	18,150	9408.70	6497.86	14,673.58		
Without	11,224	7956.70	4998.62	11,985.24		

Table 3: Multivariate linear regression analysis of the influential factors of outpatient expenditure

Factors	Partial regression coefficient	Standardized partial regression coefficient	t	P	Variance inflation factors
Constant term	7.924		238.500	0.000	
Gender	0.009	0.014	-1.003	0.066	1.146
Age	0.001	0.014	-4.108	0.012	2.312
Job status (in-service or not)	-0.049	-0.013	-6.846	0.008	1.478
Whether with complication	0.598	0.778	118.560	0.000	1.374

Table 4: Multivariate linear regression analysis of outpatient expenditures of patients with complications

Factors	Partial regression coefficient	Standardized partial regression coefficient	t	P	Variance inflation factor
Constant term	8.412		374.580	0.000	
Retinopathy	0.366	0.142	22.650	0.000	1.578
Diabetic nephropathy	0.525	0.257	5.322	0.000	2.478
Diabetic foot	0.736	0.384	15.986	0.000	2.439
Cardiac-cerebrovascular disease	0.562	0.229	8.487	0.000	1.617
Neuropathy	0.469	0.215	6.473	0.000	2.378
Arteriosclerosis in lower extremity	0.475	0.219	6.837	0.000	1.925

arteriosclerosis in lower extremity, neuropathy, and retinopathy successively [Table 4].

Grouping result of outpatient cases

We used Chi-square Automatic Interaction method to build a decision-making tree. Primary decision-making tree analysis was made with the influential factors as the grouping node (predict variables) according to the multiple linear regression analysis on the influential factors of outpatient expenditure [Table 5].

Then, a decision-making tree case grouping was conducted on the outpatient expenditure of patients with complications. We obtained the results of the case grouping using type 2 diabetes outpatient expenditure as the target variable and whether

with complications as the predicted variable [Table 6]. Considering the stability of the classification, the weakened reference value of the standard due to too many grouping, and suitable sample volume in each group, we set up five grouping nodes and ten layers at most to cease the tree every time we made decision-making tree analysis.

Reimbursement standard of outpatient expenditure

The standard value of outpatient expenditure per year in each case group can be calculated according to the grouping result of outpatient expenditure. Combining the consultation opinion of experts, we set the median of the outpatient expenditure in each group as the standard bundled expenditure, and 3/4 of the interior expenditure of

each group as the upper limit of the bundled expenditure. In practice, medical insurance management organizations can refer to this to work out reasonable reimbursement standards for type 2 diabetes outpatient expenditure. It can also utilize to discover the record of excessive expenditure in time, which can provide a reference for identifying further expenditure risk.

The reimbursement standard of type 2 diabetes outpatient expenditure is listed in Table 7. We can see: (1) the first grouping node was whether with complications, which divided the patients into with complication group and without complication group. The outpatient expenditure of patients with complication group was higher. (2) The second grouping node was age, classifying patients with complications into

groups: ≤ 50 years old, 51–70 years old, and > 70 years old. (3) In the group of patients with complications, diabetic foot showed the highest correlation with the outpatient expenditure. The outpatient expenditure of patients with diabetic foot was higher than that of patients without diabetic foot. Among patients without diabetic foot, the outpatient expenditure of patients with cardiac-cerebrovascular disease was higher than that of patients without cardiac-cerebrovascular disease. Among patients without diabetic nephropathy, the outpatient expenditure of patients with cardiac-cerebrovascular disease was higher than that of patients without cardiac-cerebrovascular disease. Among patients without cardiac-cerebrovascular disease, the most significant variable was age. Outpatient expenditure of patients > 70 years old was the highest and that of patients < 50 years old was the lowest. (4) In all the characteristic variables, whether with complications was the best predictive variable. With or without diabetic foot, with or without cardiac-cerebrovascular disease, with or without diabetic nephropathy, age, and with or without neuropathy were in the secondary place. The outpatient expenditure of patients without complication and ≤ 50 years old was the lowest, while that of patients complicated with the diabetic foot was the highest.

Table 5: Primary case grouping of outpatient expenditures of type 2 diabetes

Grouping node 1	Grouping node 2	Cases (n)
With complication		26,551
Without complication	Age ≤ 50 years	1142
	50 years $<$ age ≤ 70 years	1012
	Age > 70 years	669
Total		29,374

Table 6: Grouping of outpatient expenditure cases of patients with complication

Grouping node 1	Grouping node 2	Grouping node 3	Grouping node 4	Grouping node 5	Cases (n)	
With diabetic foot					2890	
Without diabetic foot	With diabetic nephropathy	With cardiac-cerebrovascular disease			14,236	
		Without cardiac-cerebrovascular disease			3580	
	Without diabetic nephropathy	Without cardiac-cerebrovascular disease	Age > 70 years			1414
			50 years $<$ age ≤ 70 years	With neuropathy		1436
		Age ≤ 50 years	Without neuropathy			1128
			With neuropathy			1003
		Without neuropathy			864	
Total					26,551	

Table 7: Analysis results of the solvency standard of outpatient expenditure

Rules of grouping	Standard fees (RBM, Yuan)	Upper limit of fees exceeding standard (RBM, Yuan)
Without complication, age ≤ 50 years	3498.19	6354.58
Without complication, 51 years $<$ age ≤ 70 years	4536.90	7627.65
Without complication, age > 70 years	5377.61	8236.78
With diabetic foot	12,012.84	15,894.37
Without diabetic foot, with diabetic nephropathy	10,275.37	13,922.94
Without diabetic foot, without diabetic nephropathy, with cardiac-cerebrovascular disease	8521.80	10,046.28
Other complications besides diabetic foot, diabetic nephropathy, cardiac-cerebrovascular disease, age > 70	7480.09	9148.56
Without diabetic foot, without diabetic nephropathy, without cardiac-cerebrovascular disease, with neuropathy, 50 $<$ age ≤ 70	6700.92	8843.92
Other complications except diabetic foot, diabetic nephropathy, cardiac-cerebrovascular disease, neuropathy, 50 $<$ age ≤ 70	6438.17	8257.19
Without diabetic foot, without diabetic nephropathy, without cardiac-cerebrovascular disease, with neuropathy, age ≤ 50	6124.18	7543.26
Other complications except diabetic foot, diabetic nephropathy, cardiac-cerebrovascular disease, neuropathy, age ≤ 50	5710.18	7026.30

DISCUSSION

Bundled payment was in favor of controlling the increase of medical fees. First, in the analysis of the influential factors of type 2 diabetes outpatient expenditure, standardized partial regression coefficients of whether with complication and age were 0.778 and 0.014, ranking top two among all of the influential factors with statistical significance. Second, in the grouping result of outpatient expenditure, whether with complications and age were the first and second grouping nodes of decision-making tree grouping. After recalculation, the group with the highest standard expenditure was the group complicated with diabetic foot. As a whole, the older the patient was, the higher the outpatient expenditure would be. All these indicated that age and whether with complications were the most important factors that influenced the bundled payment for type 2 diabetes outpatient services.

Therefore, relying on the research on medical insurance big data, when bundling type 2 diabetes outpatient expenditure, this study defined the outpatient expenditure related to the disease within 5 months after the first outpatient visit of patients as the bundled payment. We fully considered the influence of whether with complications and age and regarded whether with complications and age as the important variables for cases grouping as far as possible. In this way, we took the individualized difference of the disease into consideration and made it more reasonable to decrease excessive clinical medical service and control the rapid increase of outpatient expenditure.

Selection of bundled node of type 2 diabetes outpatient expenditure should take realistic feasibility into consideration. In this study, cases were grouped through the CHAID. It is noteworthy that one key point to establish CHAID decision-making tree is to choose the quantity of grouping nodes and set up the conditions of ceasing the growth of the tree. If there are too few grouping nodes, it will be invalid to group the patients according to differentiated characteristics, and the within-group variance will be too large. If there are too many nodes, it will lead to particularly complex grouping result and over-fitting phenomenon, which will weaken the reference value of the standard. Therefore, considering the realistic feasibility, this study set up five grouping nodes and ten layers at most to cease growth of the decision-making tree. In this way, we obtained 11 case groups at last. The result was acceptable for the clinical doctors and medical insurance institutions. Within the group, clinical features were similar, within-group variances were small, and between-group variances were significant.

Further verification is needed for reimbursement standard of type 2 diabetes outpatient expenditure. It is reasonable reimbursement standard for the bundled payment of outpatient services that can coordinate the interests among doctors, patients, and the medical insurance organizations as well as control the excessively rapid growth of medical fees. In this study, we set the median of the expenditure of each group as the reference and 3/4 of the intra-group

expenditure as the upper limit. Although we could not prove its reasonability theoretically, the result showed the outpatient expenditure in the lowest in patients without complication and the age ≤ 50 years, but highest in patients with diabetic foot, which was consistent with the results of other researchers.^[26] In addition, the reimbursement standard of bundled payment can also be modified with the combination of clinical context pathway and advice from medical institutions, medical insurance management institutions, and experts. We believed that in the future, the reimbursement standard of bundled payment can be more than more precise.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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