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Cost-Minimization Analysis of Metformin and Acarbose in Treatment of Type 2 Diabetes

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ABSTRACT

Background: Metformin is the first-line oral hypoglycemic agent for type 2 diabetes mellitus (T2DM) per international guidelines with proven efficacy, safety, and cost-effectiveness. However, little information comparing it with acarbose exists. **Objective:** To study the cost-effectiveness of metformin and acarbose—two extensively adopted agents—in treating T2DM. **Methods:** Cost-minimization analysis was conducted on the assumption that metformin and acarbose have equivalent clinical effectiveness. The cost of treatment was detected and evaluated from a payer's perspective. In sensitivity analyses, several clinical scenarios were developed according to clinical practices and physicians' prescribing behaviors in China. **Results:** Metformin can save annual treatment costs by 39.87% to 40.97% compared with acarbose. Under a wide range of assumptions on utilization profile and physician prescribing behavior, it saves costs by 19.83% to 40.97% in patients whose weight is 60 kg or less and by 39.87% to 70.49% in patients whose weight is more than 60 kg, which corroborates the results that metformin is more cost-effective than acarbose. **Conclusions:** Metformin appears to provide better value for money than does acarbose. Findings from this study are consistent with those from previous studies that metformin is undoubtedly the first choice in the management of T2DM, with significant glucose-lowering effects and low treatment costs.

Keywords: acarbose, cost-minimization, metformin, type 2 diabetes.

Introduction

Diabetes is one of the common chronic diseases worldwide [1]. China leads among the countries with the highest prevalence of diabetes. In 2010, the prevalence of diabetes in Chinese adults 18 years and older was 11.6% (113.9 million) [2]. Because of the long duration and expensive treatment, diabetes not only affects patients' quality of life but also brings a heavy economic burden to both the family and the society. A study on the epidemic and economic burden of diabetes in China [3] indicates that the average annual growth rate of direct medical cost of diabetes was 19.9% in recent years, which was higher than the gross domestic product and national health care expenditure growth over the same period, ranking the second in all surveyed chronic diseases.

Type 2 diabetes mellitus (T2DM) accounts for at least 90% of all cases of diabetes [4]. It has brought great burden in terms of health care cost and socioeconomic consequences, reaching $26.0 billion in 2007 in direct medical costs and predicted to be $47.2 billion by 2030 in China [5]. Glycemic control in patients with T2DM is directly related to the occurrence of diabetes-related complications and the extent of damage to target organs, and it is the key point in treating T2DM. When lifestyle interventions can no longer bring about glycemic control, oral hypoglycemic agents are the main methods used for the treatment of T2DM. Owing to the advances in T2DM treatment, there are many kinds of oral hypoglycemic agents available in the market. Each agent has its peculiarity in mechanism and site of action; thus, their glucose-lowering effects and treatment costs for patients vary significantly.

As a biguanide drug, metformin is the first-line oral hypoglycemic agent for T2DM in compliance with international guidelines with proven efficacy, safety, and cost-effectiveness [6–8], whereas acarbose, one of the α-glucosidase inhibitors, is recommended as one of the second-line drugs in the treatment of diabetes in China [7]. In use of oral antidiabetic drugs in China, metformin (53.7%) and α-glucosidase inhibitors (including acarbose, 35.9%), however, are both widely accepted and used either as monotherapy or in combination with other antidiabetic agents [9]. A possible reason for the popular use of acarbose may be its effect, which is superior in patients eating a relatively high

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carbohydrate diet, such as Chinese [10]. Little information exists, however, comparing metformin with acarbose in both clinical effectiveness and cost-effectiveness.

After a meta-analysis, it was found that glucose-lowering effects of metformin monotherapy and acarbose monotherapy are the same by direct comparison, while metformin monotherapy is a little better by indirect comparison [11]. This means that glucose-lowering effects of metformin monotherapy are at least as good as those of acarbose monotherapy. Thus, this study aimed to make an economic evaluation by using a cost-minimization analysis technique to see which drug is more cost-effective.

Methods

Estimation of the Cost

The perspective of the payer was used in this study because both drugs are covered by the payer. Cost was estimated on the basis of treatment schedules from the literature [12–19] and prices of both drugs in China; only direct medical costs were included. For metformin (brand name Glucophage, specification 500 mg × 20 tablets), the highest price set by the government is ¥29.2 and the lowest set by the market is ¥24.82; for acarbose (brand name Glucobay, specification 50 mg × 30 tablets), the highest and the lowest price is ¥74.2 and ¥61.92, respectively [20–23]. Both the lowest and highest prices were used to estimate the annual average treatment cost. Because both drugs are common oral hypoglycemic agents and tolerated well and have similar treatment efficacy and gastrointestinal adverse reactions, which can be alleviated by starting at a low dose and escalating the dose gradually [7,11,24–26], we, therefore, assume that patients taking both drugs have the similar frequency of doctor visits. Thus, we assume that the relevant costs in treating T2DM, such as doctor visit, diagnostic, inspection, and hospitalization cost, and so forth [27], can be set to be equivalent and not included in this study. All costs were based on 2014 prices and expressed in Renminbi (¥). No cost discounting was applied because all costs were measured by a period of 1 year.

Base-Case Identification

There is no fixed dosage regimen for the management of hyperglycemia in patients with T2DM with metformin or acarbose or any other pharmacologic agents [24,25]. Data on medication use and average dosage were derived from the direct comparison section of the meta-analysis [11–19], which directly compared the treatment effect of metformin and acarbose and showed their comparable efficacy in the Chinese population (1500 mg/d for metformin and 150 mg/d for acarbose).

Sensitivity Analysis

Because physicians' compliance with drug's instruction recommendations or national guidelines with regard to the initiation and monitoring of drug dosage in treating T2DM is unknown, in sensitivity analysis, several different clinical scenarios were developed after interviews with physicians treating diabetic patients, to illustrate potential clinical situations as well as to analyze the difference in annual average treatment costs with metformin and acarbose.

Based on physicians' prescribing behaviors in China and the potential increased risk for elevated serum transaminases in patients with low body weight [25], the usual maximum dose of acarbose is slightly different in different weight groups (150 mg/d for weight $\leq$ 60 kg and 300 mg/d for weight $>$ 60 kg) [28–30]. Meanwhile, because of the difference in clinical prescribing habits and cognition of physicians in China, metformin also has two usual maximum doses (1500 and 2000 mg/d) in clinical practice, which is not strongly associated with patients' weight. Eight clinical scenarios, therefore, were developed according to different therapeutic regimens for patients with T2DM with different body weights to model different clinical conditions that may reflect real-world usage patterns of patients with T2DM. Scenario 1 considered all patients treated using only one oral drug (metformin or acarbose) at the initial dose. Scenarios 2, 5, and 6 involved patients who received only one oral drug (metformin or acarbose) at the usual maximum dose. Scenarios 3, 4, 7, and 8 simulated a situation that both drugs were titrated from the initial dose to the usual maximum dose gradually in patients with different body weights (Table 1). The common characteristics of scenarios 2 to 4 are that patients' weight is 60 kg or less and that of scenarios 5 to 8 is that patients' weight is more than 60 kg. Moreover, scenario 1 includes both weight groups (Table 1).

Results

Annual Average Treatment Cost of Metformin and Acarbose at Base Case

In base-case cost analysis, the annual treatment cost of metformin was ¥1358.90 while that of acarbose was ¥2260.08 when referring to the lowest price; the annual treatment cost of metformin and acarbose was ¥1598.70 and ¥2708.30 referring to the highest price, respectively. Under the same level of glycemic control, metformin could achieve annual cost savings by 39.87% (lowest price) or 40.97% (highest price) compared with acarbose (Table 2).

Annual Average Treatment Cost of Metformin and Acarbose at Different Scenarios

The annual treatment cost of metformin ranged from ¥452.97 to ¥2131.60 whereas that of acarbose ranged from ¥753.36 to ¥2708.30 at the four different scenarios (scenarios 1–4) in which patients' weight is 60 kg or less. Under these assumptions, metformin also minimizes the cost in all the four scenarios regardless of changes in daily dosage or medication cost, remaining a cost-saving strategy of 19.83% to 40.97% (Table 2).

The annual treatment cost of metformin ranged from ¥452.97 to ¥2131.60 whereas that of acarbose ranged from ¥753.36 to ¥5416.60 at the five different scenarios (scenario 1, and 5–8) in which patients' weight is more than 60 kg. For all the five scenarios, metformin administration was the lower cost strategy compared with acarbose, for which savings ranged from 39.87% to 70.49% (Table 2).

Discussion

Economic evaluation refers to the comparative analysis of alternative projects in terms of their costs and consequences by using principles and methods of economics. In the context of current health policy, with more and more governments trying to limit the escalation in health expenditure, there is an increasing need to find medical treatment strategies that are as effective but less costly. A pharmacoeconomic approach is commonly used to evaluate the health benefit of drug treatments to gain good value for money. Economic evaluation of medical products is particularly important in a country such as China, where for the inclusion of a drug in the national essential drugs list, the call in and out of a drug in the National Reimbursement Drug List, and the pricing of new drugs, patent medicines, and other drugs,