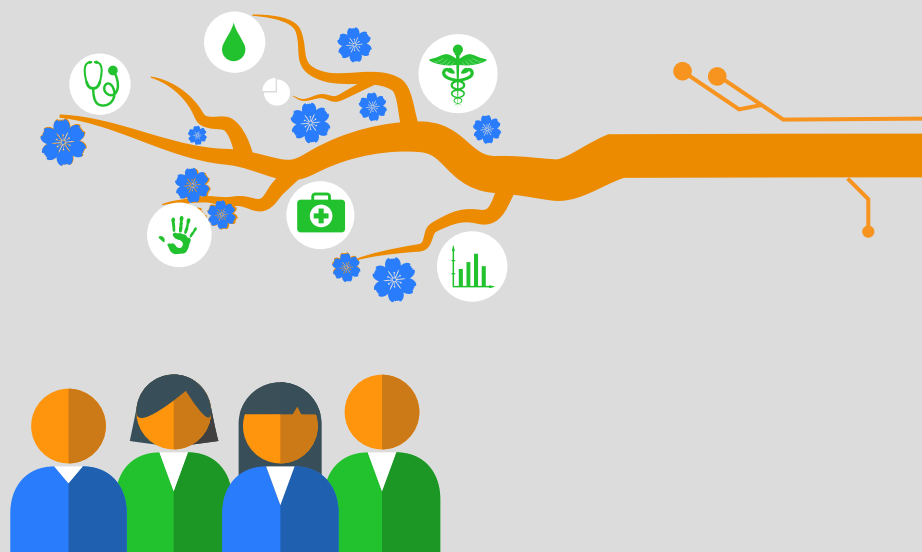


June 2017

Economic Implications of Improving Type 2 Diabetes Management in China

From Current Standards towards Optimized Scenarios



Introduction

Type 2 diabetes (T2D) is considered a worldwide epidemic. As the prevalence of type 2 diabetes increases globally, the condition and its associated complications are generating a considerable economic burden within healthcare systems. China reflects this trend, with 110 million people suffering from T2D in 2015, and this number is expected to grow to 151 million by 2040. Despite improved diagnosis and advances in treatment options for individuals with T2D, sub-optimal management of the disease and limited access to healthcare limit the benefits derived from these and contribute to avoidable economic and social burden in China.

This study aims to quantify the possible benefits and cost savings that may be achieved by the effects of public measures and strategies to improve T2D management in China. It assesses both the current and future economic burden of the disease and quantifies possible cost savings and clinical improvements that can be expected from policy changes that improve the quality of diabetes management.

This study is based on research and analysis undertaken by the QuintilesIMS Core Diabetes Model team led by Volker Foos with support from Lilly China. The contributions to this work by Mark Lamotte, Phil McEwan, Raf De Moor, Malfalda Ramos, Tengbin Xiong and Shuli Qu at QuintilesIMS are gratefully acknowledged.

We would further like to acknowledge the contributions from our local clinical expert panel, Linong Ji, Dajin Zou, Juming Lu, Yongde Peng and Dalong Zhu who supported this study with their clinical insights to the standards of T2D Management in China.

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Executive summary

The number of people suffering from type 2 diabetes (T2D) in China is expected to rise from 110 million in 2015 — approximately 10.6% of the total population—to 151 million in 2040, posing a significant challenge to the Chinese healthcare system. Undiagnosed diabetes in China is associated with preventable complications and mortality as well as considerable costs. The current “status quo” (SQ) management of T2D in China appears to be far from optimal, with only 26% of patients receiving treatment, and of those, only 40% attaining adequate glycemic control. Limited cardiovascular risk factor management and adherence also contributes to disease burden. At a national level, T2D-related direct annual costs are estimated at ¥621Bn (\$90.5Bn) under current patient management conditions. These annual national T2D costs include ¥593Bn in diabetes related complication costs and ¥28Bn attributable to glucose lowering and CV risk factor regulating medications (treatment costs).

To formulate effective healthcare resource allocation plans, it is necessary to determine both the current and future expected economic burden of T2D across a spectrum of potential management strategies. The objective of our study was to employ a modeling approach to estimate the annual cost burden reflecting the current standard of T2D management in China and compare this to a series of hypothetical improved management strategies. The CORE Diabetes Model was used to quantify the possible benefits and cost savings that may be achieved by multiple strategies to improve T2D management in China in comparison to current T2D patient management standards. Findings from our modeling analysis indicate that optimal management can yield significant benefits to the Chinese health system.

As much as ¥212Bn (\$30.9Bn) of annual complication costs could be saved under optimal T2D management conditions, i.e., assuming immediate diagnosis after disease onset, glucose lowering treatment escalation at guideline recommended target levels (HbA1c \geq 7%), perfect patient adherence and cardiovascular risk factor control alongside guideline recommendations. These savings are offset in part by increased treatment costs of ¥107Bn with optimal treatment versus the current management, but still result in an overall net savings of ¥106Bn.

With T2D prevalence forecasted to increase to 150.7 million cases by 2040, the future cumulative cost burden of T2D to the Chinese healthcare system would be ¥19,198Bn under the current (status quo) management and could be reduced to ¥15,939Bn with optimized patient treatment, yielding a total savings of ¥3,259Bn over 25 years.

The total annual indirect costs of lost productivity in China among T2D patients is estimated at ¥173Bn, and could be reduced to ¥149Bn with optimal management of diagnosed patients, or more than halved to ¥77Bn if both diagnosed and undiagnosed patients were optimally managed.

From the patient perspective, the model also predicted considerable relief in disease burden which is reflected by reduced complication rates and extended life expectancy. Under optimal management conditions, a total of 1.26 million microvascular complications (e.g., blindness, renal failure, amputations and neuropathy onset) and 1.33 million macrovascular complications (e.g., MI, stroke, HF, angina and PVD) could be avoided in China, annually, in comparison to current management. In addition, 2.01 million microvascular and 0.89 million macrovascular complications could be prevented annually if undiagnosed individuals could be diagnosed and treated in line with current SQ management.

Predictions from the CDM model demonstrated substantial reductions in mortality alongside improved scenario projections. In the general population, mortality risk could be reduced by 21.5%, 15.5% and 11.6% after 10, 20 and 30 years post-disease onset, respectively, if patients could be managed optimally rather than under current management. The findings from the modeling analysis suggest that China's 2030 Sustainable Development Goal of reducing non-communicable disease mortality by one-third can be achieved if overall T2D management is changed from current standards towards optimal management.

In the general population, including all age categories, life expectancy was improved by 3.21 years in individuals with optimal management. The highest life-year savings was among young onset individuals, amounting to 4.6 years. Savings declined with increasing age at disease onset, resulting in life-year savings of 3.64 and 1.97 years for intermediate and late-onset individuals, respectively.

Strategies to help address the challenge to the Chinese healthcare system of a growing population with T2D include improving access to diabetes screening to reduce the burden of under-diagnosis, multifactorial risk factor management including HbA1c and CV risk factor control according to local treatment guidelines and encouraging patient engagement to increase overall adherence to glucose lowering medications. Beyond these, a key strategy includes the use of data to monitor changes in epidemiology, patient education and economic outcomes to more appropriately design interventions and support a more effective allocation of healthcare efforts and resources.

Burden of T2D in China

Overview of T2D and its complications

Type 2 Diabetes (T2D) is a chronic disease characterized by both insulin resistance and the progressive dysfunction of insulin producing beta-cells; consequently, individuals with T2D suffer from elevated levels of blood glucose. Hypertension and dyslipidemia are common coexisting conditions and contribute to the risk of long-term complications of the disease. Diabetes related complications can be divided into microvascular (retinopathy, nephropathy, neuropathy and foot ulcerations) and macrovascular (myocardial infarction [MI], stroke, heart failure and peripheral vascular disease) complications. Macrovascular complications represent the more serious complication type and are associated with a considerable impact on cost, patient morbidity and a shortened life expectancy. Blood glucose levels tend to increase progressively as the disease duration increases. Lifestyle intervention is an important intervention for T2D treatment and is critical throughout the diabetes treatment process. When lifestyle change alone is unable to reach blood glucose targets, anti-hyperglycemic drug treatments are recommended.

For patients, undetected or poorly managed T2D with persistently elevated levels of blood glucose increases the risk of acute complication such as hypoglycemia, hyperglycemia, hyperosmolar state and diabetic ketoacidosis, and in the long term, increases the risk of debilitating and life-threatening complications due to macrovascular and microvascular damage. These complications can vastly decrease quality of life, productivity and life expectancy of diseased individuals.

The burden of T2D

Diabetes mellitus represents a serious challenge to the healthcare system of the People's Republic of China. Since 2000, the total number of people with diabetes mellitus has continuously increased from 20.8 million people, to 92.4 million in 2008 and further to 109.6 million in 2015, which represents approximately 10.6% of the total population.^{1,2,3} The main form of diabetes in China is type 2, with type 1 diabetes (T1D) accounting for approximately 5.0% of the total diabetes population.⁴ The rapid increase in prevalence of diabetes is in part related to China's sustained economic growth experienced since the economic reforms of the 1980's, which has been accompanied by rapid urbanization and a transfer of labour resources from the countryside to the cities. In addition, dramatic changes in national lifestyle and food consumption patterns have also contributed to an increased prevalence of T2D. China now has one of the largest populations of patients with diabetes globally and may not be adequately prepared to deal with the rapidly increasing prevalence. A number of published studies have aimed to assess the economic burden of diabetes in China and quantified the annual expenditures for diabetes across a wide range of expectations.^{3,5,6} One systematic review of the direct economic burden of T2D estimated the direct medical costs incurred by type 2 diabetes at \$0.25Bn, \$2.27Bn, \$8.66Bn and \$9.1Bn in the years of 1998, 2000, 2007 and 2008, respectively.⁵ The increasing annual cost burden was reported to not only be related to the epidemic growth in the number of patients with diabetes but also due to increases in outpatient and inpatient costs. Another cross-sectional study investigated patients at selected hospital clinics in four major cities and derived a much larger estimate of \$26.0Bn in 2007.⁶ More recent estimates from the International Diabetes Federation (IDF) Diabetes Atlas has reported annual diabetes expenditures between \$51.1 and \$88.4Bn in 2015.³ These and other

estimates of the diabetes related cost burden do not account for the considerable proportion of people in China with undiagnosed diabetes. A major component of diabetes related costs arise from the long-term complications of the disease, which are primarily associated with sub-optimal glucose management, increased blood pressure and elevated lipid profiles. In contrast to western countries, alternative use of traditional Chinese medicines may also represent a contributing dynamic to poor risk factor control in diabetes patients. Although certain plant-based compounds have demonstrated a reduction in hyperglycemia, the relative inaccuracy of dosing with traditional Chinese medicine may lead to sub-optimal glycemic control. The beneficial effect of intensive glucose lowering on diabetes related complication risks has been extensively described in the literature.^{7,8} The United Kingdom Prospective Diabetes Study in Type 2 diabetes recorded a 37% reduction in microvascular complications for an 11 mmol/mol (1% point) reduction in HbA1c level.⁹ The same study reported reductions of 14%, 12%, 16%, 43% and 14% associated with 1% point HbA1c reductions for non-fatal ME, non-fatal stroke, heart failure and all-cause mortality, respectively. Further, hypertension and dyslipidemia, which represent established risk factors for cardiovascular disease (CVD), are common coexisting conditions in T2D and management with blood pressure lowering and lipid lowering agents represents a central component of T2D practice guidelines.

What are HbA1c levels?

HbA1c levels are used to diagnose diabetes and refer to glycated haemoglobin (HbA1c), otherwise known as estimated average plasma glucose concentration. HbA1c develops when haemoglobin, an oxygen-carrying red blood cell protein, combines with glucose in the blood, thus becoming glycated.

Measurement of HbA1c reflects average plasma glucose levels over a period of 8-12 weeks. It can be performed at any time of the day and does not require any special preparation such as fasting. These properties have made it the preferred test for both diagnosing diabetes and assessing glycemic control in patients with diabetes. The higher the HbA1c level, the higher the increase in risk of diabetes related complications, as demonstrated below:

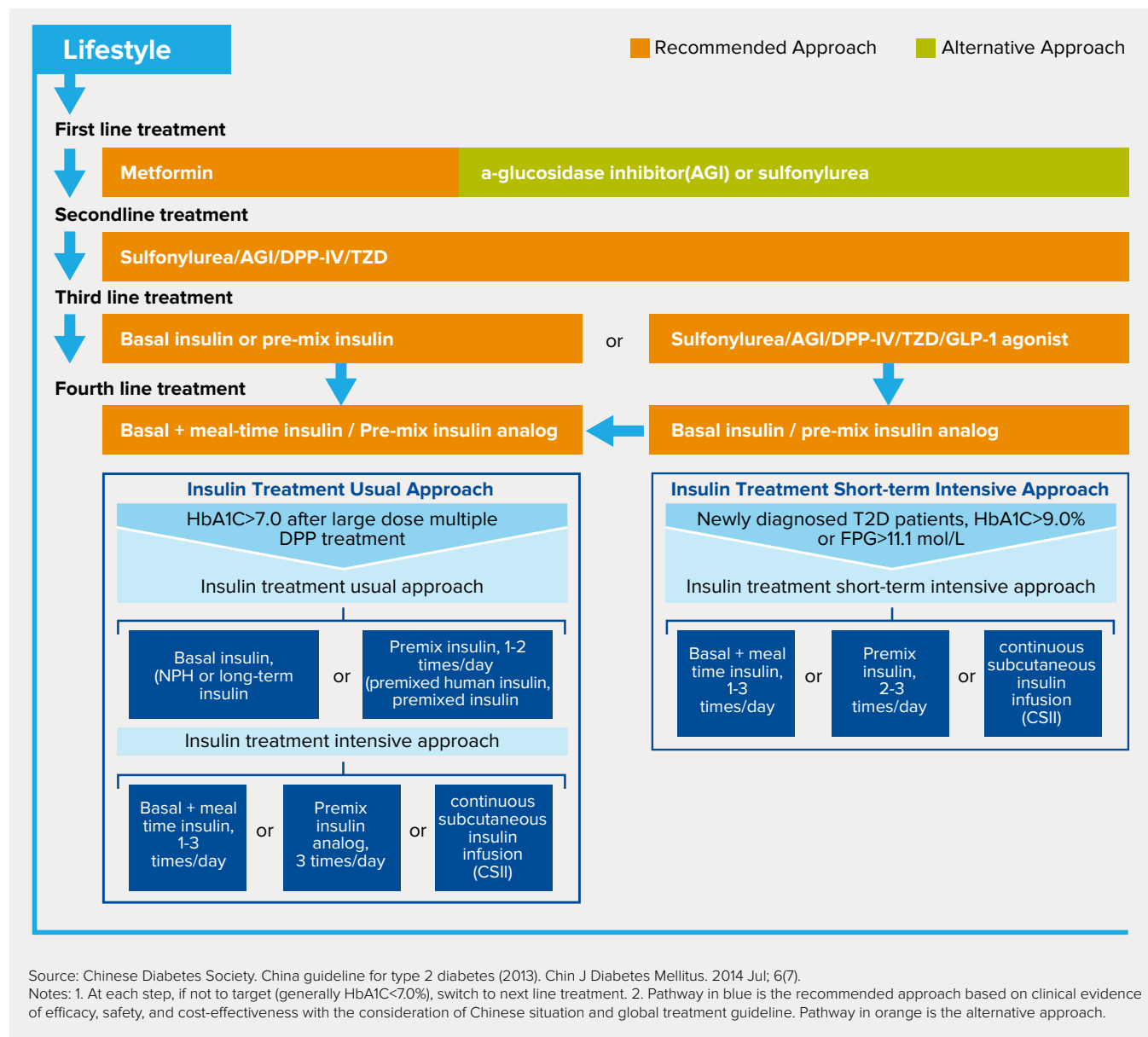
<6%	Normal range
6%–6.4%	Pre-diabetes
>6.5%	Diabetes

Current management of type 2 diabetes

T2D represents a disease requiring multifactorial management that should be initiated as early as possible. The importance of early glucose control was confirmed by a number of landmark trials in diabetes including the Diabetes Control and Complications Trial (DCCT) in type 1 diabetes, the United Kingdom Prospective Diabetes Study (UKPDS), and the Kumamoto Study in Japan, in type 2 diabetes, all of which found that intensive glucose control in the early stage of diabetes can significantly reduce the risk of diabetes related complications.^{7,8,10}

The Chinese Diabetes Society (CDS) has published a guideline on the management of T2D recommending a number of alternative treatment escalation algorithms that aim to maintain HbA1c below 7.0% (see Exhibit 1).¹¹

Exhibit 1: Chinese Treatment Guidelines for Type 2 Diabetes



However, this guideline is often not followed in clinical practice and therapy escalations currently take place at higher HbA1c thresholds than recommended (i.e., above 7%).¹² In fact, evidence shows that the current “status quo” (SQ) management of T2D in China appears to be far from optimal. Among all T2D cases in China, only 26% receive treatment, and of those, only 40% attain adequate glycemic control.^{13, 14}

Diagnosis is commonly delayed, and a large proportion of people with diabetes therefore remain undiagnosed. This represents a particular problem in rural areas where resources to screen and treat diabetes and its complications are limited.¹⁵⁻¹⁷ A review conducted to inform the prevalence of diagnosed and undiagnosed diabetes in China comprising 35 epidemiological studies from Mainland China, Hong Kong, and Taiwan, showed that the proportion of undiagnosed diabetes ranged approximately from 50% to 55% in Hong Kong and Taiwan and up to 70% in Mainland China.¹⁸ In those who are eventually diagnosed, the diagnostic delay is considerable. It is not uncommon in China that T2D individuals are only diagnosed at the time they present signs of severe hyperglycemia and dehydration (i.e., nonketotic hyperglycemic coma).

In addition, cardiovascular (CV) risk factor management is only applied in a minority of the T2D population. Over 75% of patients with diabetes have systolic blood pressure (SBP) levels of >140/80 mmHg or are taking antihypertensive medications simultaneously, and 72% of patients reported either comorbid hypertension, dyslipidemia or both.^{19,20} Finally, treatment related adverse events, such as hypoglycaemia and weight gain, contribute to reduced medication adherence thereby reducing the overall effectiveness of glucose lowering treatments through suboptimal dosing habits, all of which increases the risks of diabetes related complications and associated costs.²¹ In order to address these issues, China has established a number of health policy approaches to improve diabetes management.

What is treatment adherence?

Adherence to therapy is defined as the extent to which a person's behavior in taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a healthcare provider.

National programs and policy approaches to improve T2D in China

Healthcare reform

In order to reduce the burden of chronic diseases, such as diabetes, China committed to healthcare reform with the overall goal of establishing a universal, basic healthcare system to provide effective and safe healthcare at low cost.²² The healthcare reform was initiated in 2009 and is expected to be fully implemented by 2020. The reform comprises five priority areas: improving the public healthcare system, improving the medical service system and medical insurance, guaranteeing the drug supply and modernizing public hospitals through reforms (see Exhibit 2).

Exhibit 2: Strategic Health Care Reform Priorities



Since reform initiation, considerable progress has been made to increase insurance coverage of patients. Other important priorities focus on improving the quality of healthcare provisions to patients and building a primary care infrastructure that includes the development of community health centers (CHCs) and community health stations (CHSs), combined with a three-tier rural medical network comprising of county hospitals, township healthcare centers and village clinics.²² Further, service's standards and the quality of primary care institutions are proposed to be improved via education and training of general practitioners in CHC/CHS, as well as physicians in rural hospitals.²²

Diabetes specific programs

Since 2003, the CDS has promoted a nationwide guideline project to support the widespread adoption of the “Chinese Guidelines of Diabetes Prevention and Treatment”, which is one of two units of the China National Diabetes Management Program (CNDMP). The primary goal of the CNDMP is to establish an effective model for the prevention, detection and treatment of diabetes across different regions in China.²³ Further, China started a five-year initiative, as part of the “Guideline Promotions”, to train 11,128 healthcare professionals.^{23, 24}

The purpose of the study within this report is to quantify the possible benefits and cost savings that may be achieved by the effects of public measures and strategies to improve T2D management in China, i.e., improvements in risk factor levels via alternative approaches that may include: early screening to achieve timely diagnosis, HCP training to optimize secondary or tertiary prevention, patient based measures to increase treatment adherence, or others.

Using the CORE Diabetes Model to assess the economic burden of sub-optimal T2D management

Elements of economic burden explored

In order to formulate effective plans for resource allocation to finance national programs, it is necessary to determine both the current and future economic burden of diabetes and to quantify possible cost savings and clinical improvements that can be expected from policy changes that improve the quality of diabetes management in China. With this background, the QuintilesIMS CORE Diabetes Model (CDM) was customized to the Chinese setting to quantify the economic burden of T2D in China reflecting current clinical practice (status quo management) of the disease.²⁵

The QuintilesIMS CORE Diabetes Model

The QuintilesIMS CORE Diabetes Model (CDM) is a validated, peer-reviewed model, which simulates clinical outcomes and costs for cohorts of people with either type 1 or type 2 diabetes.²⁵ The model has been customized to the Chinese setting to calculate the possible cost-savings and benefits that are associated with optimized T2D management scenarios in comparison to the current management standard in China.

In order to collect all of the information required for the modeling analysis, a number of pragmatic literature reviews were conducted to follow up data on the current clinical practice of T2D management in China, local T2D treatment modalities to inform the most likely choices of glucose lowering agents, health care costs and population characteristics. The information collected in the literature reviews were complemented by data collected from interviews with five local experts in the field.¹ The interviews were carried out in the period between July 1 and July 26, 2016. Information on the local model adaptation can be provided by the authors on request.

Model projections reflecting the SQ management standards were further compared to a series of scenarios describing improvements in T2D management across four domains:

- **Reduced time to diagnosis** – Diagnosis is commonly delayed and a large proportion of people with diabetes remain undiagnosed. A number of scenarios were conducted to explore the impact of reduced time to diagnosis and associated timely treatment and the associated beneficial effects on patient outcomes.
- **Improved HbA1c target values to maintain glucose control** – T2D commonly requires stepwise intensification of treatment to maintain good glycemic control. The Chinese Diabetes Society guideline on T2D specified a number of alternative treatment escalation algorithms that aim to maintain HbA1c below 7.0%.¹¹ However, in clinical practice, therapy escalations commonly take place at higher HbA1c thresholds than detailed in the

algorithm, which is associated with increasing delays of treatment intensification. Modeled scenarios explored a stepwise reduction of HbA1c thresholds from levels assumed to represent current clinical practice down to guideline recommended targets.

- **Improved adherence to glucose lowering medications** – It is well recognized that impaired medication adherence is associated with sub-optimally controlled diabetes and a decline in medication efficacy on HbA1c levels. This was taken into account by considering an adherence-rate-dependent weighted (reduced) HbA1c effect size of glucose lowering medications that were considered in the analyses. We thereby explored step-wise improvements in adherence from rates reflecting the current SQ towards optimal adherence (100%).
- **Improved cardiovascular risk factor control** – Hypertension and dyslipidemia are common coexisting chronic illnesses that accompany T2D, and Chinese guidelines have specified target values for blood pressure and lipid values. Despite these recommendations, large segments of the Chinese T2D population remain above these targets. Our analysis explored stepwise improvements of the percentage of all T2D individuals that reach recommended guideline target values from percentages representing the current SQ towards 100%.

Population characteristics considered

In order to capture the implication of management changes in the entire population, the model was applied to project the clinical course and associated lifetime costs of newly diseased T2D individuals in three age categories:

1. Young disease onset (age \leq 45 years)
2. Intermediate disease onset (age between 46 and 64)
3. Late disease onset (age 65 or older)

Treatment paradigms applied

What is a treatment paradigm?

A treatment paradigm describes the cascade of treatment approaches over time that are applied to treat T2D individuals. Because diabetes is a progressive disease, initial therapy (1st line therapy) approaches to maintain glucose control eventually fail. At this point, most patients need one or more oral anti-diabetes drug, or insulin, added to the current treatment (2nd line therapy). If, after time, second-line therapy fails, most patients will need one or more additional drugs added as a third, fourth or fifth-line therapy to achieve target glycemic levels.

To account for the variety of most commonly applied treatment approaches in Chinese clinical practice, each scenario was projected across four alternative T2D treatment paradigms, P1-P4. In summary:

1. Four treatment paradigms, representing a cascade of glucose lowering agents applied from 1st to 5th line therapy, were defined based on data from the literature review and suggestions from local experts.
2. Model projections in each age category and for each scenario considered (SQ and respective improvements) were applied for each paradigm separately.
3. Outcomes from the individual paradigm projections were averaged to yield the overall outcomes.

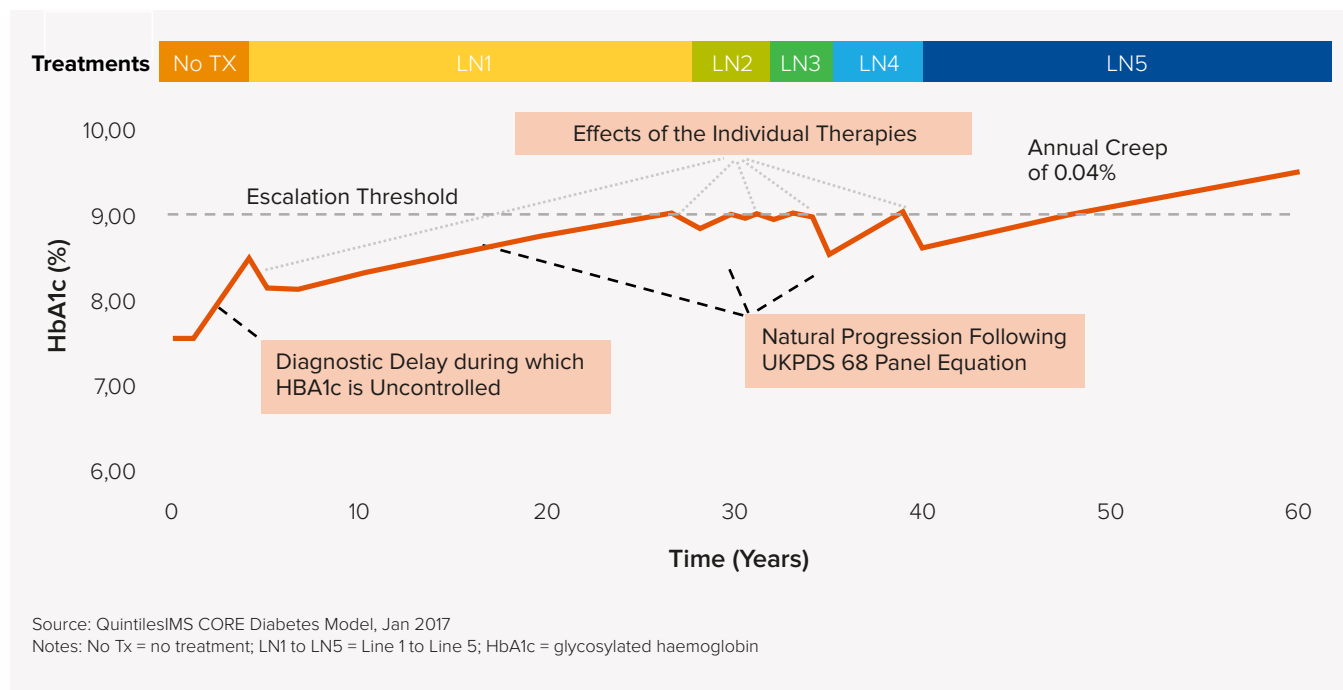
Treatment escalation from 1st to 5th line therapy was assumed whenever the time-updated HbA1c level of simulated patients in the modeling exceeded predefined threshold values that were considered to represent the glucose management standard (2nd domain of T2D management outlined above) in the particular scenario explored.

In fact, HbA1c represented the main driver characterizing improvements over the first three domains of T2D management considered in the modeling analysis (reduced time to diagnosis, improved HbA1c target values and adherence improvements).

HbA1c progression in the modeled scenarios

HbA1c progression over time was determined by the effects of individual glucose lowering agents alongside the foreseen therapy modifications from 1st to 5th line in each treatment paradigm. Between therapy escalations, HbA1c trajectory was considered to follow a natural progression pattern reflected by a random effects panel equation derived from UKPDS data.²⁶ Post escalation to 5th line therapy, we considered a linear HbA1c increase of 0.04% points per year in all scenarios, based on mean HbA1c progression patterns in 238,639 treated outpatient Chinese T2D individuals over 10 years of diabetes duration.²⁷ Annual HbA1c progression in uncontrolled conditions (i.e., in untreated or during diagnostic delay) was assumed following consensus agreement from local experts. An example of HbA1c progression according to the above specification and determined by an escalation threshold at 9.0% is presented in Exhibit 3.

Exhibit 3: Model of an HbA1c Trajectory at an Escalation Threshold of 9.0%



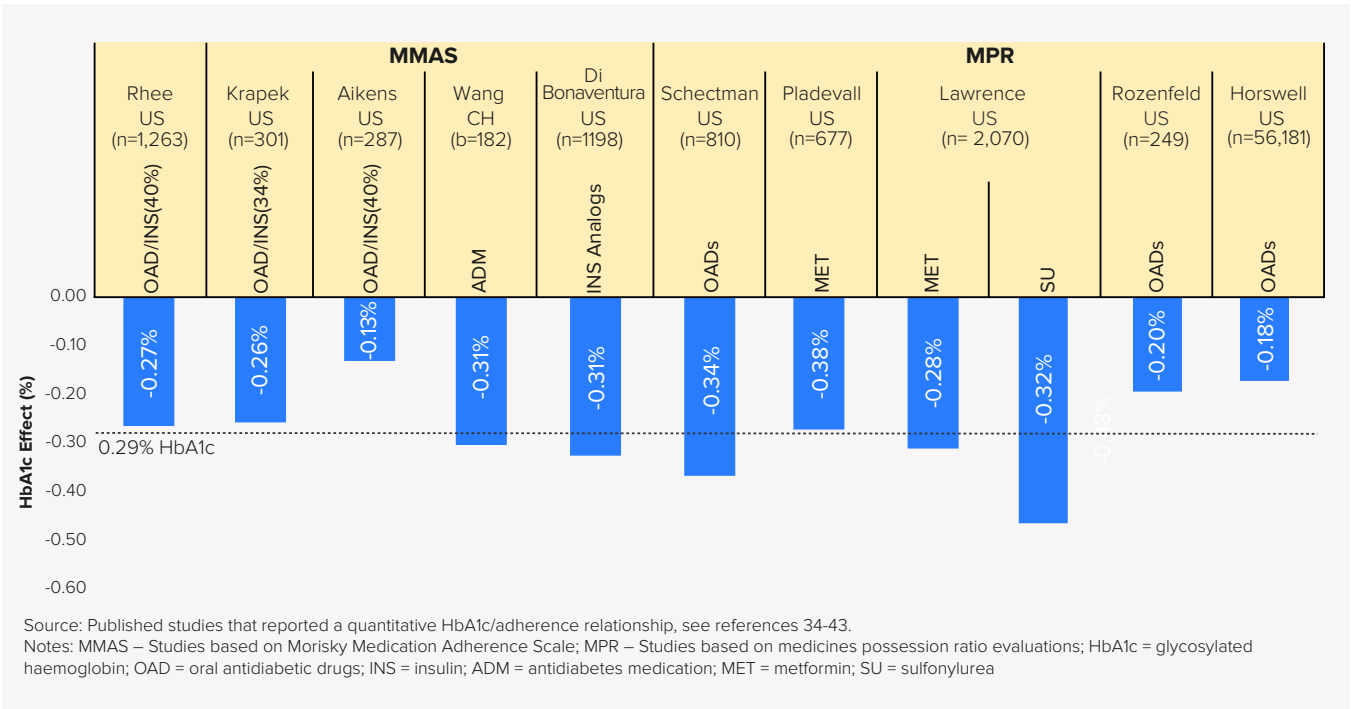
Other considerations and assumptions

Improvements in treatment adherence

Improvements in adherence rates were reflected in the model through increased HbA1c effect sizes of glucose lowering agents that were considered in the explored treatment paradigms. The full HbA1c effect size (as reported in published sources) was assumed in scenarios where a 100% adherent population was considered and reduced HbA1c effect sizes in population with impaired adherence.

The association between reduced HbA1c effect size and impaired adherence was derived from a systematic review that reported data from a number of studies that assessed the association between adherence to antidiabetic medicines and glycemic control.²⁸ From this review, data from ten studies were extracted that reported the change in HbA1c size reflecting various adherence rates.²⁹⁻³⁸ The data from these ten studies reflected an average HbA1c decline of 0.29% being equivalent to a 20% increase in adherence rate (see Exhibit 4). The literature finding was finally combined with the average estimate from the local expert committee (0.35% HbA1c reduction per 20% adherence increase) which averaged to a 0.32% HbA1c reduction per 20% adherence rate increase that was applied in the modeling analysis.

Exhibit 4: Reduction in HbA1c Levels Associated with a 20% Improvement in Adherence rate



HbA1c effect size (and other treatment characteristics) of the various glucose lowering interventions considered in treatment paradigms P1 to P4 were sourced from one published randomized clinical trial (RCT) and two systematic reviews comprising data from multiple randomized controlled trials (RCTs).^{39, 40, 41} Due to the controlled scenarios commonly established within RCTs, it was hypothesized that the drug specific HbA1c effect sizes from these sources represented drug effects in a 100% adherent population.

Improvements in cardiovascular risk factor management

Status quo of cardiovascular risk factor management (CV-RFM) was reflected by the assumption that 22.9% and 35.9% of treated T2D individuals with hypertension (occurring in 75% of the population) reach guideline recommended target values for systolic blood pressure (SBP) and diastolic blood pressure (DBP), respectively, and 11.6% of treated T2D individuals with dyslipidemia reach lipid targets.⁴² Iterative improvements from SQ until optimal CV-RFM considered three percentage level improvements from the SQ percentages until 100% (L1 to L3) in each category.

Based on these proportions and a number of additional considerations (i.e., the prevalence of hypertension and dyslipidemia in the Chinese T2D population, guidelines recommending target levels and elevated levels representing uncontrolled cases of hypertension and dyslipidemia, which were informed by local experts) we calculated overall CV risk factor levels in the Chinese general T2D population and applied these in the model projections to represent SQ and improved CV-RFM levels L1 to L3 (see Exhibit 5).

Exhibit 5: Levels of Cardiovascular Risk Factors Applied in the CDM Analysis of the Chinese T2D Population						
	Controlled Level ^{\$}	Uncontrolled Level ^{\$\$}	Base Case (SQ) ^{\$\$\$}	L1 ^{\$\$\$}	L2 ^{\$\$\$}	L3 ^{\$\$\$}
SBP (mmHg)	125.00	154.30	138.00	133.67	129.33	125.00
DBP (mmHg)	80.00	87.00	81.95	80.97	79.98	79.00
TCHOL (mg/dl)	174.00	255.20	217.09	202.73	188.37	174.02
HDL (mg/dl)	61.90	34.80	47.51	52.30	57.09	61.87
LDL (mg/dl)	88.90	139.20	115.60	106.72	97.83	88.94
TG (mg/dl)	106.30	221.40	167.35	147.00	126.64	106.28

Source: QuintilesIMS CORE Diabetes Model, Jan 2017

Notes: \$ = Local expert consensus estimate on risk factor levels in controlled patients or guideline target⁴¹, whatever is lower ; \$\$ = Local expert consensus estimate on risk factor levels in uncontrolled patients; \$\$\$ = Calculated risk factor levels; CV risk factor levels displayed represent level 1, 2 and 3 of CV-RFM. SBP = systolic blood pressure; DBP = diastolic blood pressure; TCHOL = total cholesterol; LDL = low-density-lipoprotein; HDL = high-density-lipoprotein; TG = triglycerides; SQ = status quo; L1 through L3 = line 1 through line 3; CDM = QuintilesIMS CORE Diabetes Model

Individuals that remain untreated

Health implications and costs incurred for the 55% of the Chinese T2D population that were assumed to remain undiagnosed and untreated over their lifetimes were likewise assessed. Due to the absence of any glucose lowering intervention for these individuals, we assumed a more rapid HbA1c increase, aiming to reflect the proliferation of hyperglycemia in uncontrolled T2D individuals. Following a consensus agreement of local experts, the annual HbA1c progression in untreated individuals was assumed at 0.32%, 0.24%, 0.2% and 0.13% per year for time intervals of 1 to 5 years, 6 to 10 years, 11 to 15 years and ≥16 years post disease onset, respectively.

Definition of current status quo management in China

Based on extensive literature searches, the SQ management of T2D in China was defined as a scenario in which 45% of the total population eventually receives a diagnosis and 55% remain undiagnosed. In those who are diagnosed:

- On average, diagnosis is delayed by 4 years following disease onset.
- Treatment escalation to maintain glucose control is most commonly considered at an HbA1c threshold of 9%.
- On average, individuals present a 60% adherence rate with glucose lowering medications.
- 22.9% and 35.9% of treated T2D individuals with hypertension reach guideline recommended target values of SBP and DBP, respectively.
- 11.6% of treated T2D individuals with dyslipidemia reach guideline recommended lipid targets.

Sensitivity analyses on status quo management in China

Alternative assumptions for the definition of SQ management were explored in a number of univariate sensitivity analyses. These were conducted to explore the uncertainty of the below categories:

- Diagnostic delay: The average delay of 4 years as assumed for the SQ scenario was based on multiple literature observations. However, this estimate may represent an underestimation since most sources report conditions in better managed populations while the average diagnostic delay in China, including rural areas, may be considerably longer. Therefore, durations of 6, 8 and 10 years were explored.
- The treatment escalation of HbA1c target of 9.0% in the SQ scenario was explored at 9.5% and 10.0%.
- The degree of HbA1c progression during diagnostic delay (base case assumed 0.32% point increase per year) was increased and reduced by 25% to 0.26% and 0.4% point increase per year, respectively.
- Further, the model was evaluated using cardiovascular risk equations from the Hong Kong Diabetes registry data.^{43, 44}

Projecting optimized management scenarios

A cascade of 15 step-wise improvements from the SQ were projected with the model considering improvements in the diagnostic delay (2 years and immediate diagnosis), HbA1c escalation threshold (8.5%, 8.0%, 7.5% and 7.0% ESC), adherence rate (80% and 100%) and a three level improvement in CV risk factor management (L1 to L3) where the percentage of the population reaching guideline recommended target values was linearly increased from the SQ assumption to 100%. The list of all scenarios projected including no treatment, SQ-management and step-wise improvements from SQ is presented in Exhibit 6.

Extrapolating model outcomes to national level

The QuintilesIMS CORE Diabetes model projects patient histories for a defined cohort population (e.g., comprising 1000 patients) and reports outcomes on a per capita level. In our study, the model was applied to project per capita lifetime outcomes for all explored treatment paradigms (P1 to P4) and across all age categories. In order to transfer the model outcomes to annual, population based figures, a number of computational steps were followed.

Outcomes from the individual paradigm projections (P1 to P4) were averaged and subsequently weighted according to the age distribution in the Chinese T2D population. Aggregated outcomes were further annualized via division of lifetime results through the mean number of years of life in each age category to yield the average annual per capita outcomes. Extrapolation to the national level was accomplished by multiplication of age specific annual per capita outcomes by the total number of diagnosed Chinese T2D individuals in each age category. Finally, total national outcomes representing all T2D individuals in China including young, intermediate and late onset were calculated as the sum of the individual age specific national estimates.

Exhibit 6: Current and Optimized Scenarios Projected in the CORE Diabetes Model Analysis					
	Scenarios	Delay of Treatment Onset (Years)	HbA1c Escalation Threshold (% Points)	Adherence Rate (%)	CV-Risk Factor Management (Level 0-4)
No Tx	No treatment over lifetime				
SQ	Status quo	4	9.0%	60%	0
S1	2-yr diagnostic delay	2	9.0%	60%	0
S2	2-yr diagnostic delay & 8.5% ESC	2	8.5%	60%	0
S3	2-yr diagnostic delay & 8.0% ESC	2	8.0%	60%	0
S4	2-yr diagnostic delay & 7.5% ESC	2	7.5%	60%	0
S5	2-yr diagnostic delay & 7.0% ESC	2	7.0%	60%	0
S6	Immediate treatment & 9.0% ESC	0	9.0%	60%	0
S7	Immediate treatment & 8.5% ESC	0	8.5%	60%	0
S8	Immediate treatment & 8.0% ESC	0	8.0%	60%	0
S9	Immediate treatment & 7.5% ESC	0	7.5%	60%	0
S10	Immediate treatment & 7.0% ESC	0	7.0%	60%	0
S11	Immediate treatment & 7.0% ESC & 80% AR	0	7.0%	80%	0
S12	Immediate treatment & 7.0% ESC & 100% AR	0	7.0%	100%	0
S13	Immediate treatment & 7.0% ESC & 100% AR & level 1 improved CV-RFM	0	7.0%	100%	1
S14	Immediate treatment & 7.0% ESC & 100% AR & level 2 CV-RFM	0	7.0%	100%	2
S15	Immediate treatment & 7.0% ESC & 100% AR & level 3 CV-RFM	0	7.0%	100%	3

Source: QuintilesIMS CORE Diabetes Model, Jan 2017

Notes: Shaded boxes indicate the iterative improvement (step improvement) vs. the previous scenario, and the stepwise improvement towards optimized management; No Tx = no treatment; SQ = status quo; ESC = escalation threshold; AR = adherence rate; CV-RFM = Cardiovascular risk factor management

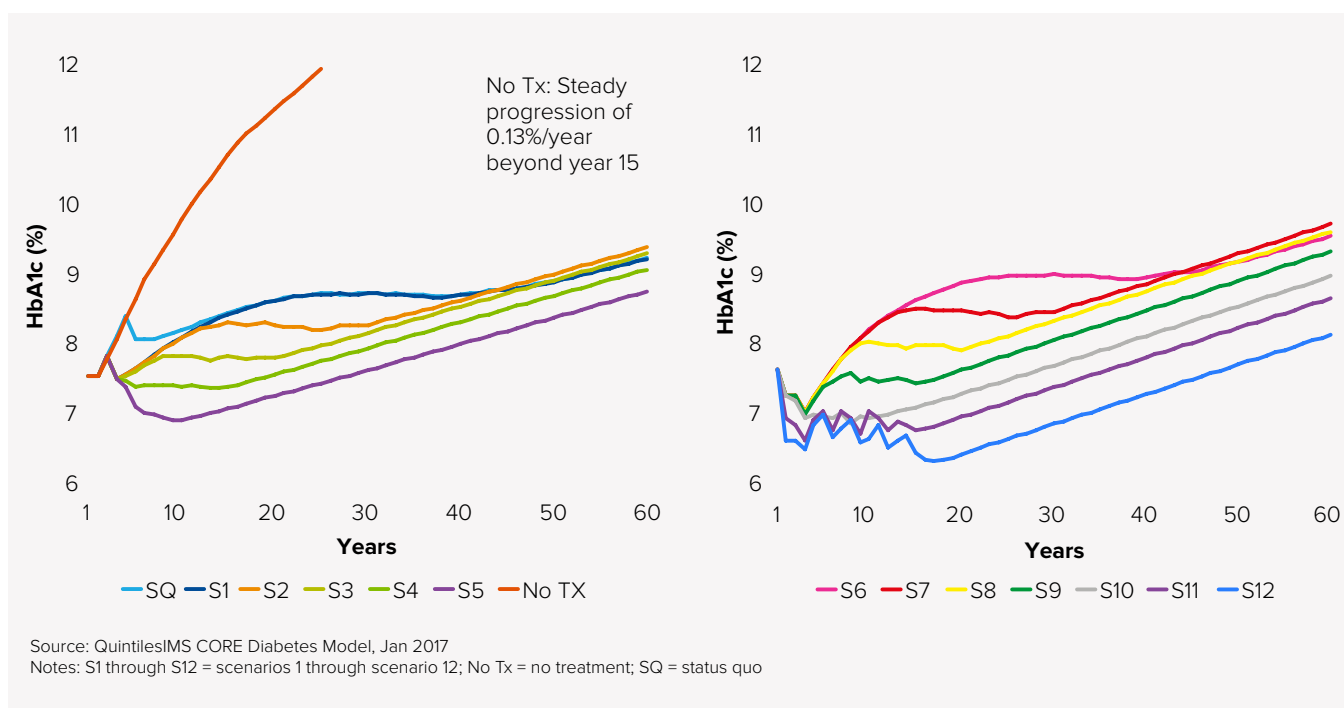
Cost and benefit estimates of improved T2D management

The CORE Diabetes model (CDM) was used to estimate the direct costs of medical care for all evaluated scenarios on an individual per capita basis as well as on national population level.

The progression of HbA1c in the evaluated scenarios

Exhibit 7 presents the resulting HbA1c trajectory curves as applied in the modeling analysis for all scenarios conducted including SQ, S1 to S12 and no treatment (no-TX). The curves represent the averages across all four projected treatment paradigms P1 to P4 that were explored.

Exhibit 7: Modeled HbA1c Increases Over a Patient Lifetime for All Scenarios in the CDM Analysis



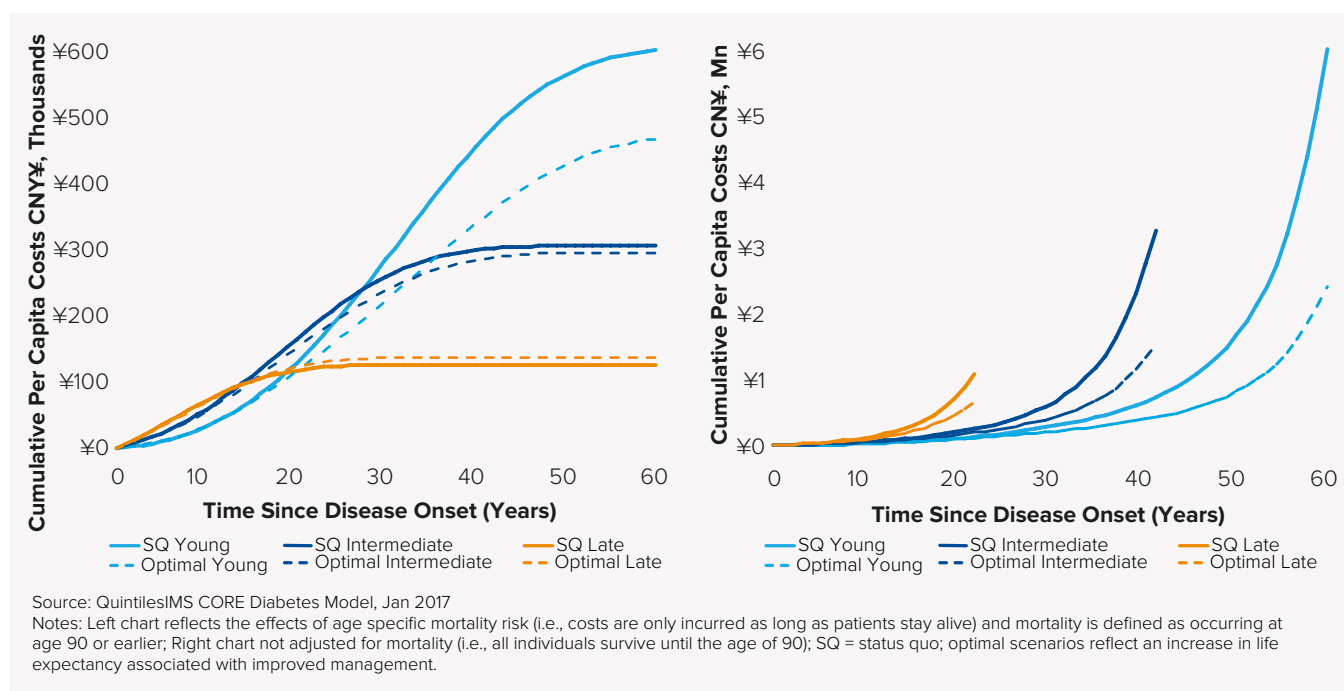
Economic burden of diabetes under improved scenarios

Direct Costs

The CORE Diabetes model was used to estimate the direct costs of medical care for all evaluated scenarios on an individual per capita basis as well as on national population level. Exhibit 8 shows the cumulative growth of direct per capita lifetime costs comparing optimized management conditions (S15) vs. the SQ across age categories. The top chart shows the cumulative growth of lifetime per capita costs adjusted for the increasing age specific mortality risk (i.e., costs are only incurred as long as patients stay alive) that leads to a flattening of the cost curves over time. For average individuals with young-, intermediate- and late-onset of diabetes, the model predicted that under standard SQ management conditions, overall lifetime direct per capita costs add up to ¥588,724, ¥300,976 and

¥123,959, respectively. Those costs could be reduced by ¥131,419 and ¥9,500 down to ¥457,305 and ¥291,476 for young- and intermediate-onset individuals but for late onset individuals would be increased by ¥11,512 up to ¥135,470 if patients were managed optimally (S15). At this stage, it has to be stressed that this cost reflection includes excess costs in the optimized scenarios that are associated with an increase in life expectancy, being associated with the improved management, which ultimately leads to a survival paradox. The paradox arises as during the time the better managed patients stay alive and incur costs, patients in the SQ scenario have deceased and consequently incur zero costs. In order to illustrate the cost developments under both management conditions in the absence of the survival paradox, the bottom chart in Exhibit 8 presents the cumulative cost growth for hypothetical scenarios in which individuals survive until the age of 90, irrespective of the management strategy applied. This mortality adjusted per capita cost reflection (while hypothetical since an age of 90 represents an unlikely scenario in T2D) illustrates more clearly the considerable potential for cost savings under optimized vs. SQ conditions on individual basis. Under these hypothetical assumptions, per capita savings would add up ¥3,746,019, ¥1,812,508 and ¥459,506 for young, intermediate and late onset individuals at the age of 90 years.

Exhibit 8: Cumulative Direct per Capita Lifetime Costs of T2D, Adjusted and Not Adjusted for Mortality



Annualization of per capita lifetime costs and extrapolation to the national level yielded a T2D-related total direct annual cost of ¥621Bn (\$90.5Bn) for 2015 under current SQ management conditions. These costs include ¥593Bn attributable to the treatment of diabetes related complications (i.e., complication costs) and ¥28Bn attributable to glucose lowering and CV risk factor regulating medications (i.e., treatment costs). The validity of these findings is supported by the most recent estimates from the International Diabetes Federation (IDF), which rated the annual Chinese expenditures for T2D to lie between ¥351 and ¥607Bn (\$51.1 to \$88.4Bn).⁴⁵

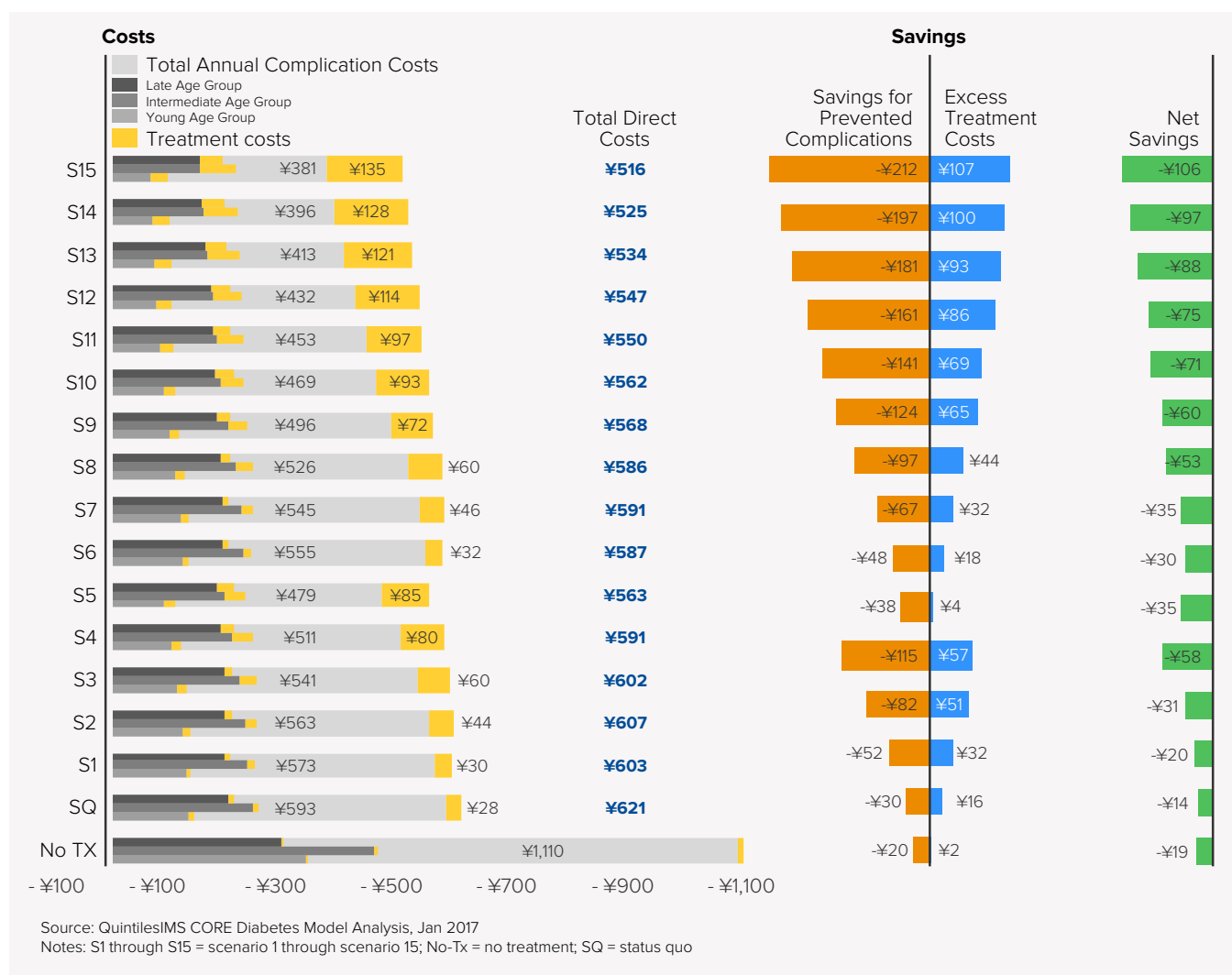
By customizing the CDM to consider improvements in T2D management according to optimized scenarios from S1 to S15, it was estimated that as much as ¥212Bn of annual complication costs could be saved if patients were optimally treated according to scenario S15. In contrast to these savings, optimized management in S15 was associated with excess treatment costs of ¥107Bn vs. SQ, which overall resulted in net savings of ¥106Bn for SQ vs. S15. The annual costs for patients that remain undiagnosed and untreated (which represent 55% of the total Chinese T2D population) were predicted at ¥1,122Bn. The cost estimation for untreated patients hypothesized

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that those individuals generate healthcare costs in a similar way as diagnosed and treated individuals, however, it has to be acknowledged that this may represent an overestimation due to the likely lack of healthcare access for undiagnosed and untreated cases in China.

Exhibit 9 presents the projected population based annual costs for all scenarios including no treatment (no-TX), SQ and S1 to S15.

Exhibit 9: Population Based Annual Complication, Treatment and Total Costs; Incremental Expenses and Savings and Net Savings (CN¥Bn)

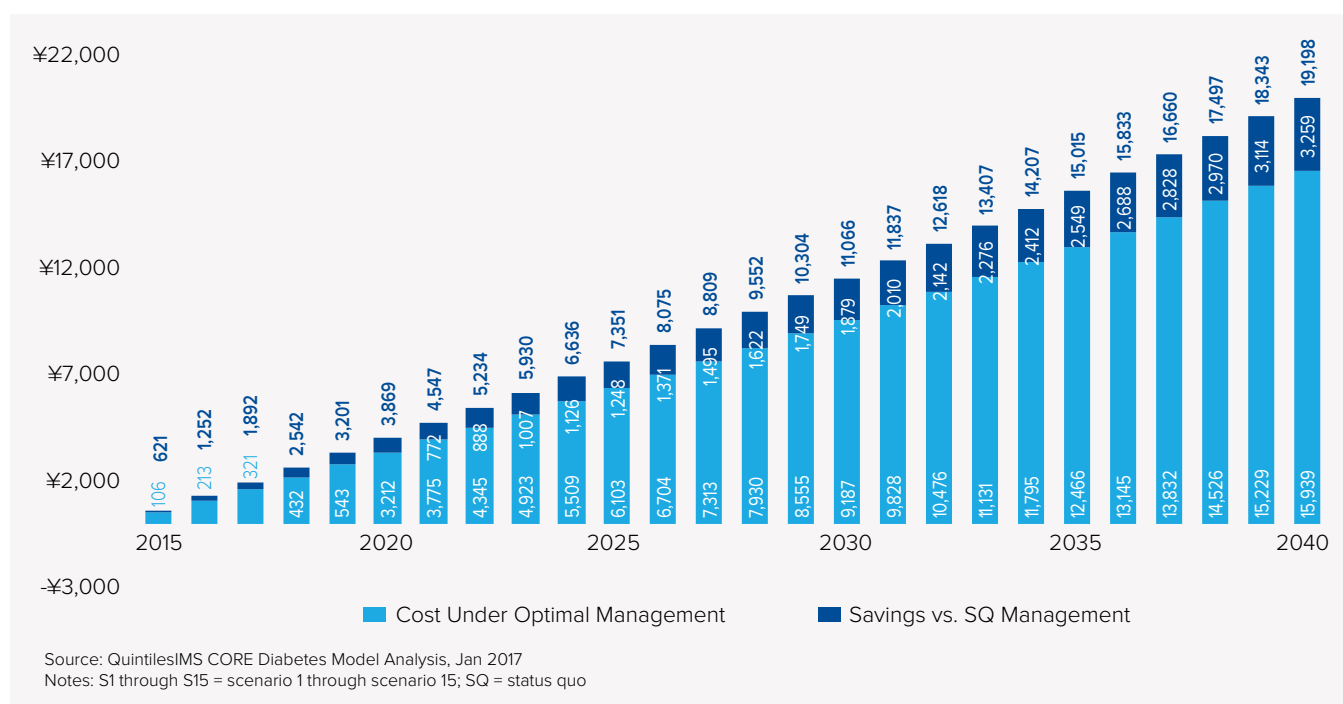


Section A of Exhibit 9 illustrates the increasing population based total direct annual cost burden of T2D across all explored scenarios and age categories separately for treatment associated costs and costs incurred to treat diabetes related complications. Section B presents the incremental population based costs in all scenarios (S1 to S15) vs. SQ. The tornado shaped appearance illustrates the competing situation between increasing treatment costs (i.e., expenses) alongside improved management scenarios and decreasing complication costs (i.e., savings), corresponding to the savings for avoided complications. Finally, Section C presents the net saving in each scenario vs. SQ as the sum of treatment expenses and complication cost savings.

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These predictions of the national Chinese annual cost burden are based on population estimates of 109.6 million diagnosed cases in 2015. However, the International Diabetes Federation forecasted a prevalence increase to 150.7 million cases by 2040. In line with these estimates, Exhibit 10 presents an outlook of the future cumulative cost burden of T2D to the Chinese healthcare system. The exhibit compares the expected cost development reflecting the current SQ management standards and compares these to possible savings that would be associated with an optimized management approach (S15). By 2040 the future cumulative cost burden of T2D to the Chinese healthcare system would be ¥15,939Bn under optimized treatment compared with the current status quo management ¥19,198Bn, yielding a total savings of ¥3,259Bn.

Exhibit 10: Future Outlook of Cumulative National Direct Costs and Savings Under Current vs. Optimized Management of Type 2 Diabetes, CN¥Bn



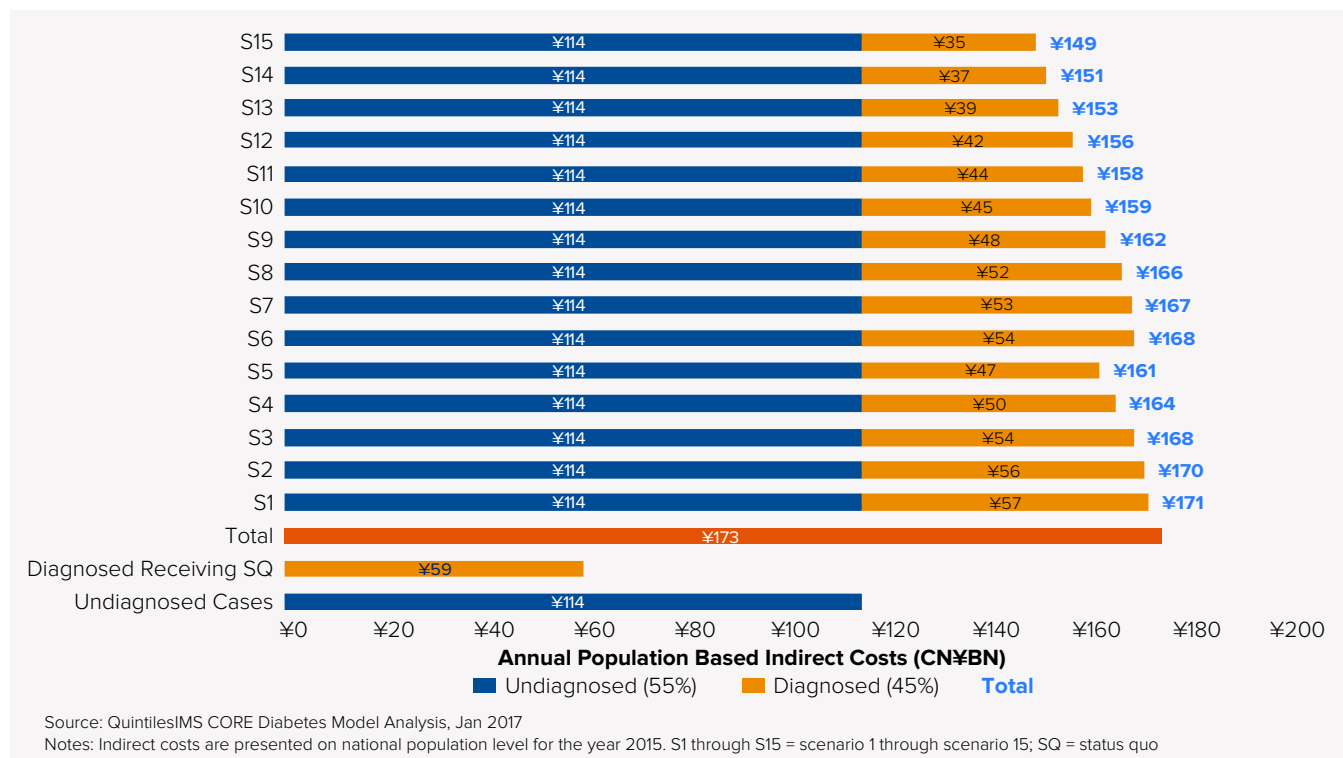
Indirect Costs

The CDM model was also used to estimate the annual indirect costs associated with lost productivity for all evaluated scenarios including no treatment (no-TX), SQ and S1 to S15 (see Exhibit 11). Indirect costs are presented on national population level for the year 2015. The exhibit presents indirect costs separately for the undiagnosed individuals that do not receive treatment (¥114Bn), representing 55% of the population and diagnosed cases that are or will be eventually recognized by the healthcare system and receive SQ management (¥59Bn), representing the remaining 45% of the population. Adding both together yields the total annual indirect costs of T2D in China of ¥173Bn.

Scenarios representing improvement in T2D management considered that only diagnosed individuals (i.e., 45% of the Chinese T2D population) would be subjected to improved management at a constant indirect cost burden of ¥114Bn CNY from the undiagnosed population. Under this assumption, it was estimated that indirect costs could be reduced to ¥149Bn for optimal management according to S15.

Under the hypothetical assumption that the entire Chinese T2D population, including the 55% undiagnosed cases and 45% diagnosed cases, would be subjected to improved management scenarios, the CDM model predicted a possible reduction of indirect costs down to ¥77Bn for scenario S15.

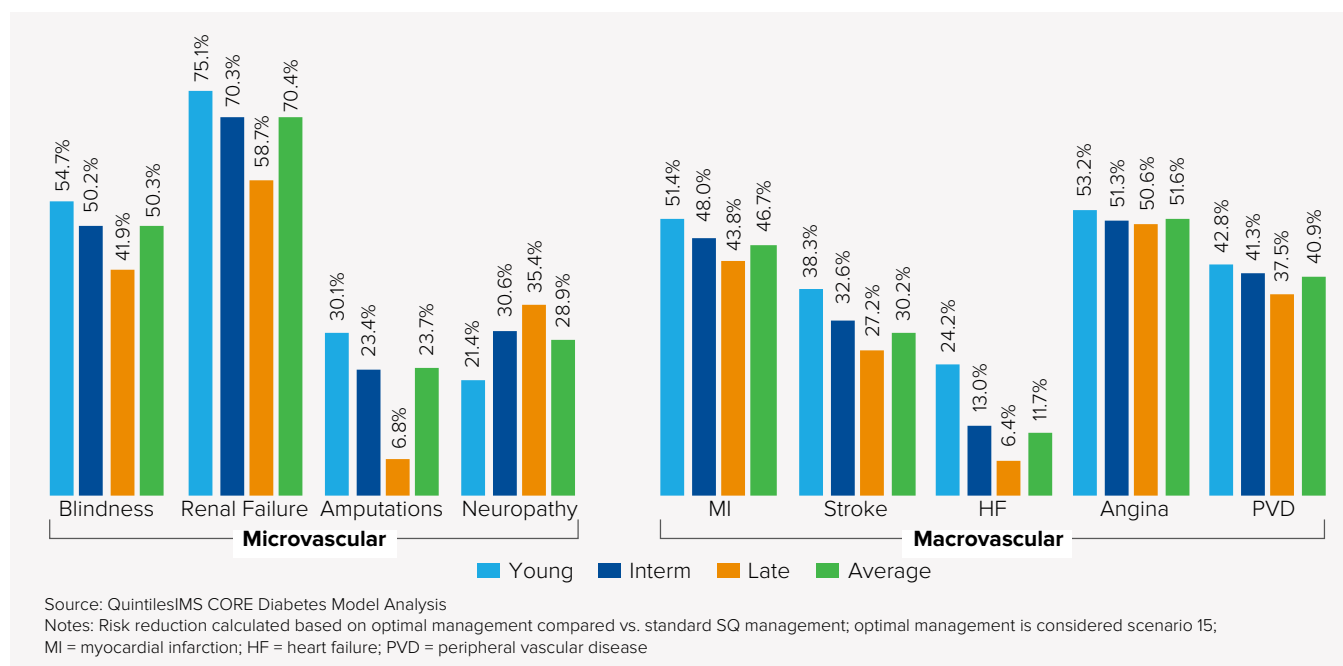
Exhibit 11: Annual Indirect Costs Associated with Lost Productivity, CN¥Bn



Reducing the burden of diabetes related complications

Diabetes requires continued medical management to prevent acute complications and to reduce the risk of long-term complications. The CORE Diabetes Model has estimated the risk reductions of preventable microvascular and macrovascular complications such as renal failure, blindness, peripheral neuropathy and lower limb amputations (microvascular) as well as myocardial infarction, stroke, heart failure, ischemic heart disease and peripheral vascular disease (macrovascular). Exhibit 12 illustrates the possible individual lifetime complication risk reductions associated with optimal (S15) vs. SQ management.

Exhibit 12: Relative Lifetime Complication Risk Reductions for Optimally Managed Individuals vs. Those That Receive Standard SQ Management

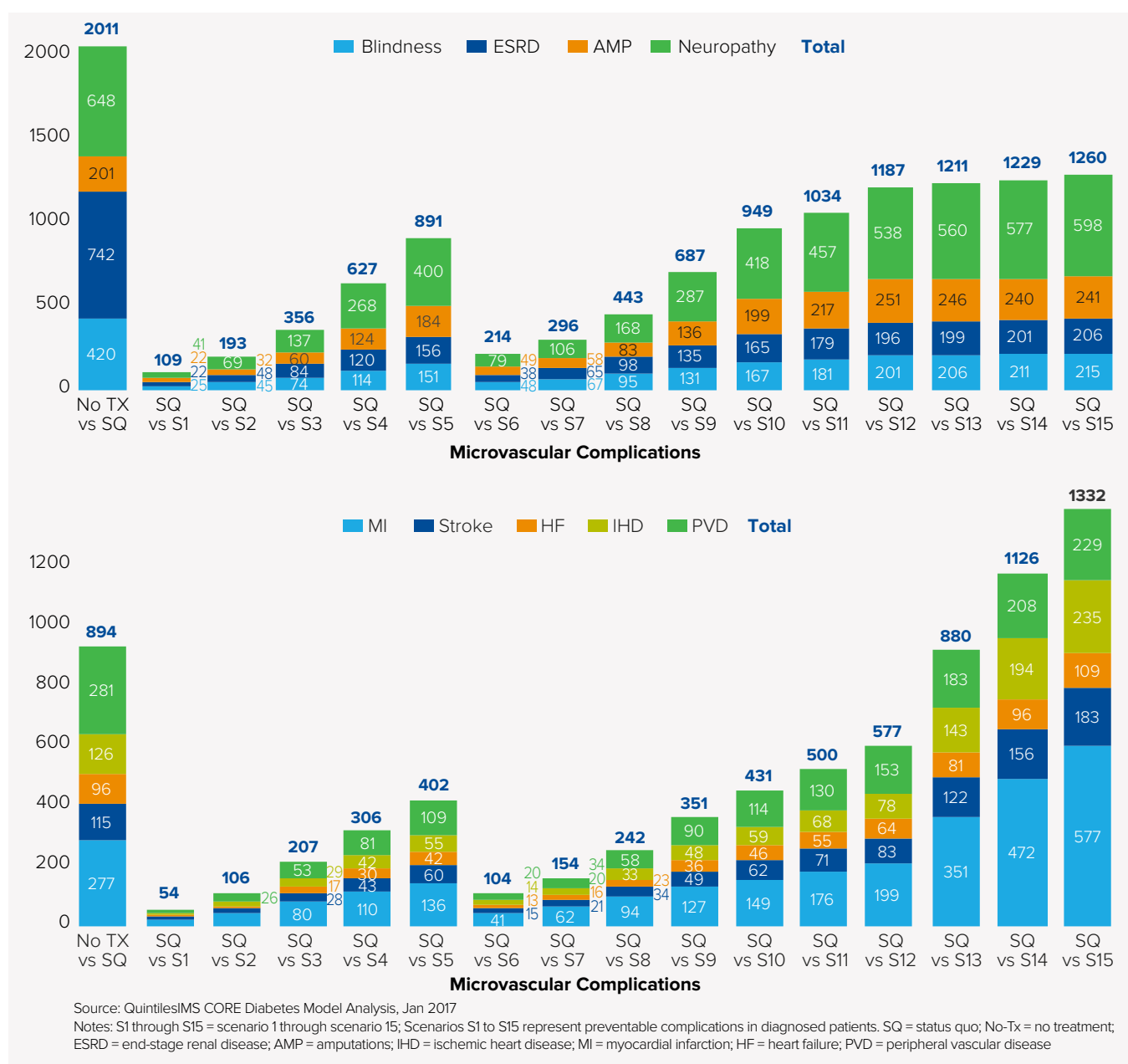


Reductions in Complication Risks

Findings from the CDM demonstrated considerable relative reductions in the lifetime risk of diabetes related complications ranging from 11.7% (heart failure) up to 70.4% (renal failure) in optimal vs. SQ management.

Mapping these results on the population level, the model predicted that under optimal management conditions (S15) a total of 1.26 million microvascular complications (comprising blindness, renal failure, amputations and neuropathy onset) and 1.33 million macrovascular complication (comprising MI, stroke, HF, angina and PVD) could be avoided annually in China in comparison to current SQ management. Exhibit 13 illustrates the national number of preventable microvascular and macrovascular complications alongside all scenario improvements vs. SQ that were considered.

Exhibit 13: Number of Preventable Microvascular and Macrovascular Complications on a National Level per Year in Thousands



Evaluating the 55% of the population that remain undiagnosed and untreated over lifetime, the model predicted a number of 2.01 million microvascular and 0.89 million macrovascular complications that could be prevented annually if those individuals would be diagnosed and treated in line with current SQ management.

Expected improvements in life expectancy

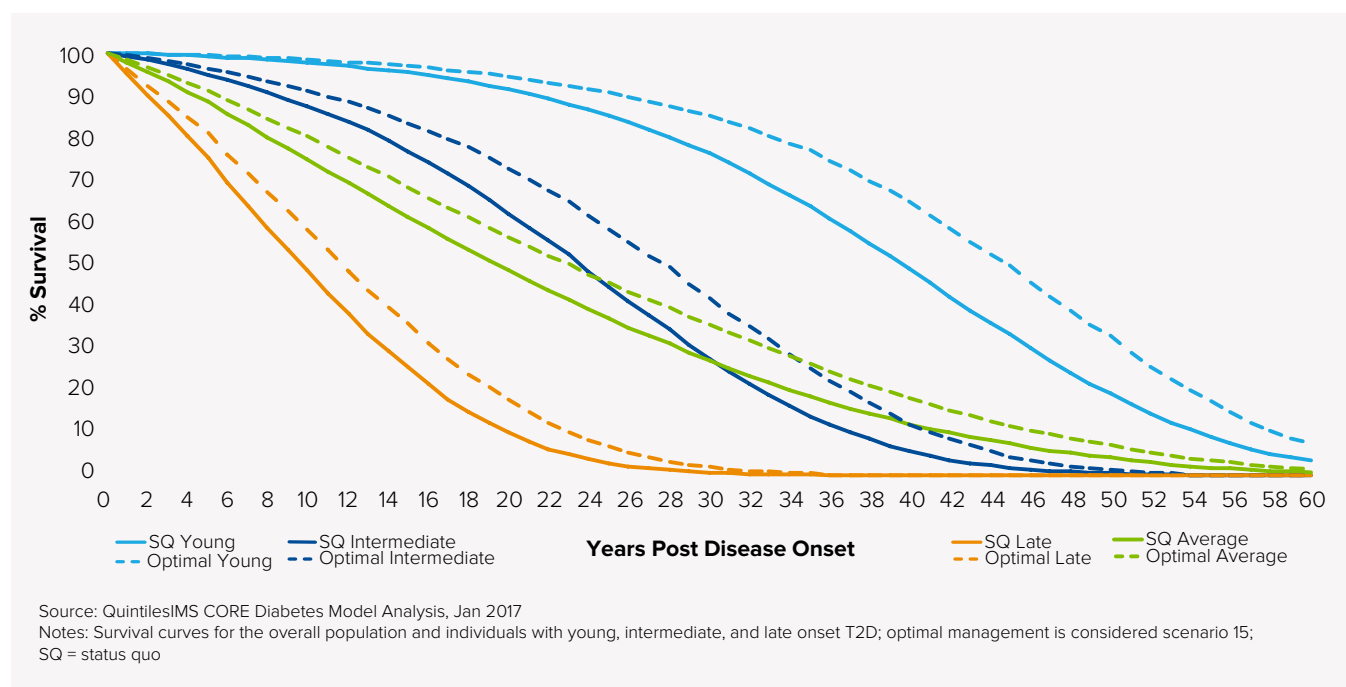
Diabetes is associated with a significant increase in mortality risk from a wide range of complications as outlined in the previous section. There are a paucity of studies describing the relevance of diabetes for total and cause-specific mortality.⁴⁶⁻⁴⁸

China's Sustainable Development Goals

China's 2030 Sustainable Development Goals include reducing non-communicable disease mortality by one-third, and monitoring the changes over time. As supported by the findings from our modeling analysis, these goals can be achieved if overall T2D management is changed from SQ standards towards optimal management.

Predictions from the CDM model demonstrated substantial reductions in mortality alongside improved scenario projections. Exhibit 14 presents the survival curves projected for young, intermediate and late onset T2D individuals as well as for the general population (weighted average) separately for SQ vs. optimized management (S15).

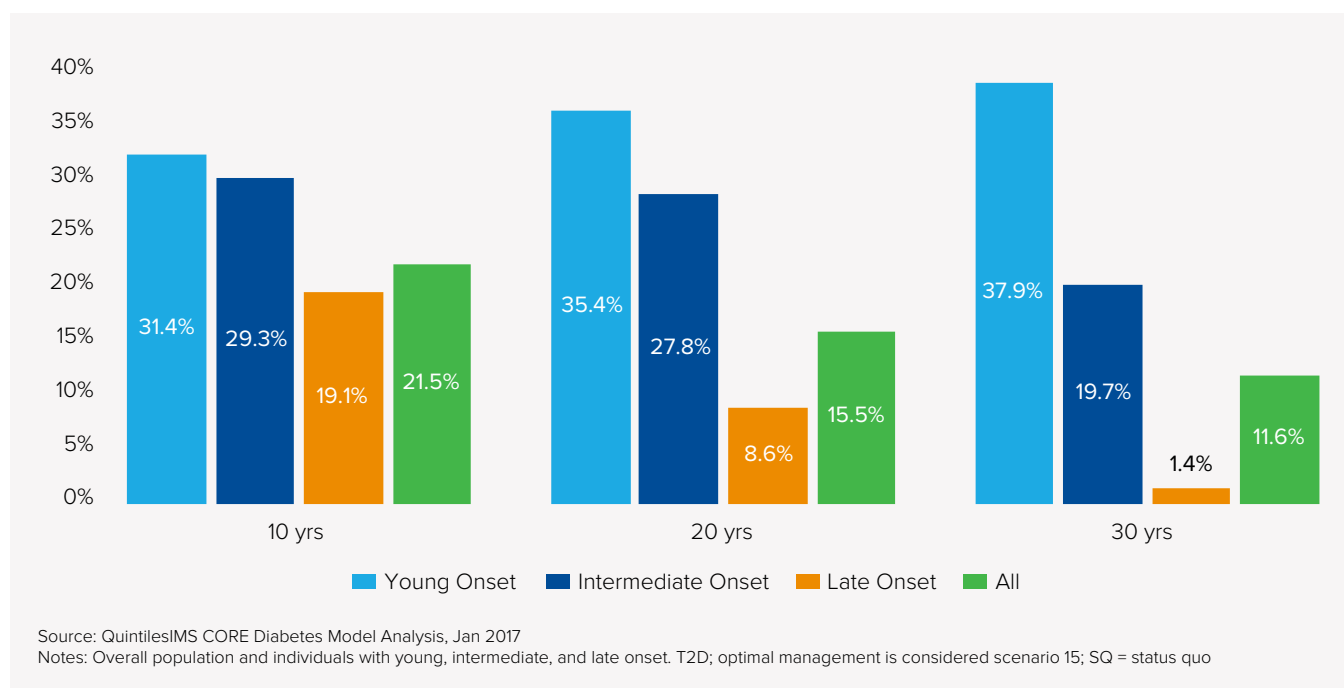
Exhibit 14: Population Survival with Status Quo and Optimized Management of Type 2 Diabetes



Reductions in mortality risk

Analysis of the modeled survival data demonstrated that in the general population, mortality risk could be reduced by 21.5%, 15.5% and 11.6% after 10, 20 and 30 years post disease onset, respectively, if patients would be managed optimally (S15) vs. SQ management (see Exhibit 15). As can be expected, the highest potential for mortality risk reductions was predicted in young onset individuals with 31.4%, 35.4% and 37.9% reductions after 10, 20 and 30 years post disease onset, followed by intermediate onset (29.3%, 27.8% and 19.7%) and late onset individuals (19.1%, 8.6% and 1.4%).

Exhibit 15: Reduction in Mortality Risk at Various Times Post Disease Onset

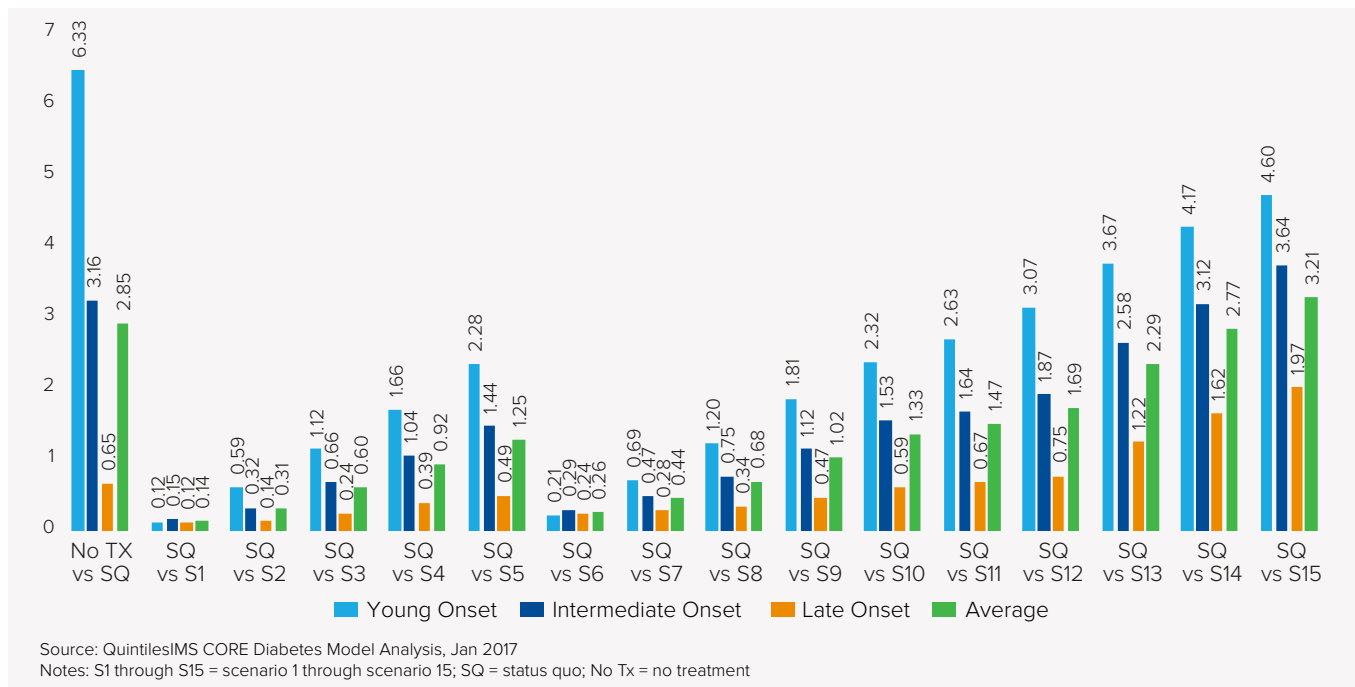


Per capita life year savings

Exhibit 16 presents potential savings in life expectancy for the general population and separately for age categories alongside all projected scenario improvements vs. SQ.

In the general population, including all age categories, life expectancy was improved by 3.21 years in individuals with optimal (S15) vs. SQ management. Savings were highest in young onset individuals (4.6 years) and declined with increasing age at disease onset; 3.64 and 1.97 years for intermediate and late onset individuals, respectively. In contrast, the assumption of no treatment intervention over a lifetime resulted in a predicted average life year loss of 2.85 years vs. SQ. The average life expectancy savings attributable to a reduced time of diagnostic delay were relatively modest and ranged from 0.14 years to 0.26 years, respectively, in scenarios representing 2 year diagnostic delay (S1) and immediate diagnosis (S6) vs. SQ. Projections exploring reductions of the HbA1c treatment escalation threshold demonstrated substantially higher average life year savings, ranging from 0.31 years to 1.25 years for threshold value assumptions from 8.5% to 7.0% (S2 to S5), respectively, if T2D diagnosis was delayed by 2 years, and 0.44 years to 1.33 years if immediate diagnosis was assumed (S7 to S10). Scenarios reflecting improved adherence (S11 and S12) presented additional average life year savings of 0.14 years and 0.36 years over a lifetime if the overall adherence rate was assumed at 80% and 100% (vs. 60% in SQ), respectively. Finally, model projections reflecting improved CV-RFM predicted additional life year savings of 0.6 years, 1.08 years and 1.51 years in scenarios assuming level 1, 2 and 3 of improved CV-RFM (S13 to S15).

Exhibit 16: Per Capita Life Year Savings in SQ Managed Patients vs. Those Not Receiving Treatment and Patients Receiving Improved Management vs. SQ



Results from sensitivity analyses on status quo management in China

All outcomes from the sensitivity analysis on SQ management are presented in Exhibit 17.

Results demonstrated a remarkable increase of total population based costs (and respective savings in S15 vs. SQ) when diagnostic delay was assumed at 6, 8 and 10 years. Otherwise, outcomes supported the robustness of the base case results with direct population based annual costs not varying by more than 4% vs. BC in analyses SA4 to SA8.

Exhibit 17: Outcomes from Sensitivity Analyses						
A)	Total Outcomes	Population Based Annual Cost (BN CNY)				Life Expectancy LE
		Complication	Treatment	Direct	Indirect	
BC	SQ (4 yr diagnostic delay, 9% HbA1c escalation threshold)	¥594	¥28	¥622	¥59	21,03
SA 1	SQ modified to assume 6 year delay of diagnosis and treatment	¥621	¥26	¥647	¥62	20,83
SA 2	SQ modified to assume 8 year delay of diagnosis and treatment	¥660	¥48	¥708	¥66	20,63
SA 3	SQ modified to assume 10 year delay of diagnosis and treatment	¥720	¥50	¥770	¥72	20,09
SA 4	SQ modified to assume 9.5% HbA1c escalation threshold	¥595	¥23	¥618	¥59	20,98
SA 5	SQ modified to assume 10.0% HbA1c escalation threshold	¥596	¥23	¥618	¥59	20,98
SA 6	SQ modified to assume 25% reduced HbA1c creep (0.25% points/yr) during diagnostic delay	¥588	¥28	¥616	¥58	21,08
SA 7	ISQ modified to assume 25% increased HbA1c creep (0.4% points/yr) during diagnostic delay	¥602	¥28	¥630	¥60	20,96
SA 8	SQ (and all other scenarios from S1 to S15) evaluated with risk equations from HKDR	¥569	¥29	¥598	¥51	22,45

Source: QuintilesIMS CORE Diabetes Model Analysis, Jan 2017. Notes: BC = base case; SA = sensitivity analysis

Conclusion and recommendations

The above results provide an illuminating picture of the economic and societal implications of improving T2D management in China. Over the next 23 years, an additional 45 million adults will have T2D, which poses a considerable challenge to the Chinese healthcare system. In order to address this challenge, more effective allocation of resources may be required to develop strategies to reduce the T2D disease burden. In general, strategies to reduce the burden of diabetes can be classified in primary, secondary and tertiary prevention. While primary prevention aims to prevent the occurrence of T2D in individuals with pre-diabetes, secondary and tertiary prevention aim to prevent diabetic complications, or if present (tertiary), delay the progression of complications to reduce morbidity and mortality.

Diabetes screening

Individuals at high risk of diabetes or those that have already developed diabetes may be identified through diabetes screening. The study has demonstrated that undiagnosed diabetes is associated with considerable costs, preventable complications and mortality, which suggests that a policy of early identification of prediabetes or recent diabetes onset through systematic or opportunistic screening is advisable. Therefore, opportunistic screening strategies have to be adopted where high risk patients may be identified during routine physical examinations or during treatment of other diseases. In the further course, once identified, those high risk subjects should be targeted for diabetes screening.

Secondary and tertiary prevention strategies

The ultimate approach to achieve effective secondary prevention (i.e., prevention of complication onset) is represented by multifactorial risk factor management that should be initiated as early as possible. This includes intensive glucose control at guideline recommended HbA1c targets (7%) but also blood pressure control, lipid control and aspirin use as appropriate for the prevention of CVD. Likewise to the measures applied in secondary prevention, tertiary prevention also includes intensified glucose control as well as CV risk factor control, as described above, to delay the progression of complications. Findings from the analysis have demonstrated the significant potential of achieving guideline recommended targets of glucose and CV risk factor control to improve health outcomes and reduce expenditure.

The Chinese Diabetes Society has compiled and published four editions of standards of care for T2D management as clinical guidance for practice in China in the last 12 years.⁴⁹ These guidelines represent evidence-based documents to guide primary to tertiary prevention of diabetes in China, which should assist to help clinicians (diabetes specialists or other HCP) in the management of patients with T2D or subjects at risk for diabetes. In order to achieve the goals of secondary and tertiary prevention strategies, it is important to increase the awareness of T2D treatment guidelines among healthcare practitioners in China. This approach requires the training of primary healthcare doctors and nurses to support their patients to manage their T2DM. As part of the China National Diabetes Management Program (CNDMP), the country has started a five year program to train HCPs to support the integration of diabetes treatment guidelines. Despite the efforts already undertaken, additional training and skill development of HCPs is advisable to increase guideline awareness and adherence across China, in particular in rural areas, where the resources for diabetes screening and treatment are limited.

Access to healthcare

Ultimately, a natural prerequisite for primary to tertiary prevention represents appropriate healthcare access. This includes access to the measures outlined above but also and in particular the access to current effective treatments that will have to be improved, as should the path for innovative future treatments.

Patient engagement

There is a growing awareness that patients should be more active and manage their health and healthcare more effectively. Patient engagement is defined as how well a person understands his or her role in the care process, and whether that person has the knowledge, skills, capacity, and confidence to follow through with this role.⁵⁰ It also includes the awareness of modifiable risk factors such as unhealthy food, physical inactivity and alcohol and tobacco consumption, as well as appropriate changes in lifestyle behavior to avoid these risks as needed to prevent or delay the onset T2D. As such, patient engagement relates to an individual's willingness and ability to take independent actions to manage their health and care. Recent studies have found that having the knowledge, skills, and confidence to manage one's own health translates into improved health-related outcomes.⁵¹⁻⁵³

Data utilization

It also will be particularly important to utilize available data to monitor changes in epidemiology, patient education and economic outcomes. The analysis of available data sources can help to improve the design of interventions (such as developing current risk algorithms) and quantify the success of attempted interventions. As health data gathering accelerates in China, the bank of information (e.g., electronic medical records [EMR]) could be leveraged to support a more effective allocation of healthcare efforts and resources. Examples represent the early identification of patients that are at risk of diabetes to support systematic screening efforts or alternatively, for patients that have already developed diabetes, the identification of individuals with low adherence profiles that may be specifically subjected to patient engagement measures. In another example, data could be used to perform “predictive analytics”, a process whereby software algorithms mine compiled data based on set criteria. This would make identification quick and accurate thus narrowing down the pool of patients for further profiling and intervention.

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Acknowledgements

- i. Five local clinical experts in the field were interviewed in the period between July 01 and July 26, 2016 to gather information on the standard of T2D management in China:
- Linong Ji, endocrine department director of Peking Remin Hospital in Beijing, CDS Committee member and American Diabetes Association Committee member
 - Dajin Zou, endocrine department director of Shanghai Changhai Hospital and CDS Deputy Director
 - Juming Lu, endocrine department director of 301 Hospital in Beijing, CDS Committee member and Chief Editor of Chinese Journal of Diabetes
 - Yongde Peng, endocrine department director of Shanghai General Hospital, CDS Committee member and President of China Diabetes Mellitus Association
 - Dalong Zhu, endocrine department director of Nanjing Gulou Hospital in Nanjing, CDS Committee member and Chief Editor of China Journal of Diabetes

This report makes references to and leverages the 2016 QuintilesIMS Institute series, “Improving Type 2 Diabetes Therapy Adherence and Persistence: How to Address Avoidable Economic and Societal Burden.” As such, the authors of the 2016 series, namely, Dr. Srikanth Rajagopal, Gaelle Marinoni, Daniel Houslay and Peter Thomas are gratefully acknowledged.

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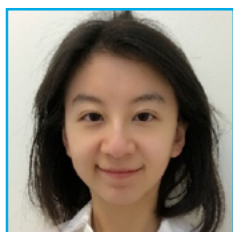
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About the QuintilesIMS Institute

The QuintilesIMS Institute leverages collaborative relationships in the public and private sectors to strengthen the vital role of information in advancing healthcare globally. Its mission is to provide key policy setters and decision-makers in the global health sector with unique and transformational insights into healthcare dynamics derived from granular analysis of information.

Fulfilling an essential need within healthcare, the Institute delivers objective, relevant insights and research that accelerate understanding and innovation critical to sound decision-making and improved patient care. With access to QuintilesIMS's extensive global data assets and analytics, the Institute works in tandem with a broad set of healthcare stakeholders, including government agencies, academic institutions, the life sciences industry and payers, to drive a research agenda dedicated to addressing today's healthcare challenges.

By collaborating on research of common interest, it builds on a long-standing and extensive tradition of using QuintilesIMS information and expertise to support the advancement of evidence-based healthcare around the world.

Research Agenda

The research agenda for the Institute centers on five areas considered vital to the advancement of healthcare globally:

The effective use of information by healthcare stakeholders globally to improve health outcomes, reduce costs and increase access to available treatments.

Optimizing the performance of medical care through better understanding of disease causes, treatment consequences and measures to improve quality and cost of healthcare delivered to patients.

Understanding the future global role for biopharmaceuticals, the dynamics that shape the market and implications for manufacturers, public and private payers, providers, patients, pharmacists and distributors.

Researching the role of innovation in health system products, processes and delivery systems, and the business and policy systems that drive innovation.

Informing and advancing the healthcare agendas in developing nations through information and analysis.

Guiding Principles

The Institute operates from a set of Guiding Principles:

The advancement of healthcare globally is a vital, continuous process.

Timely, high-quality and relevant information is critical to sound healthcare decision-making.

Insights gained from information and analysis should be made widely available to healthcare stakeholders.

Effective use of information is often complex, requiring unique knowledge and expertise.

The ongoing innovation and reform in all aspects of healthcare require a dynamic approach to understanding the entire healthcare system.

Personal health information is confidential and patient privacy must be protected.

The private sector has a valuable role to play in collaborating with the public sector related to the use of healthcare data.



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