An Evaluation of Cost Sharing to Finance a Diet and Physical Activity Intervention to Prevent Diabetes

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OBJECTIVE — The Diabetes Prevention Program (DPP) lifestyle intervention is a cost-effective strategy to prevent type 2 diabetes, but it is unclear how this intervention could be financed. We explored whether this intervention could be offered in a way that allows return on investment for private health insurers while remaining attractive for consumers, employers, and Medicare.

RESEARCH DESIGN AND METHODS — We used the DPP and other published reports to build a Markov simulation model to estimate the lifetime progression of disease, costs, and quality of life for adults with impaired glucose tolerance. The model assumed a health-payer perspective and compared DPP lifestyle and placebo interventions. Primary outcomes included cumulative incidence of diabetes, direct medical costs, quality-adjusted life-years (QALYs), and cost per QALY gained.

RESULTS — Compared with placebo, providing the lifestyle intervention at age 50 years could prevent 37% of new cases of diabetes before age 65, at a cost of $1,288 per QALY gained. A private payer could reimburse $655 (24%) of the $2,715 in total discounted intervention costs during the first 3 intervention years and still recover all of these costs in the form of medical costs avoided. If Medicare paid up to $2,136 in intervention costs over the 15-year period before participants reached age 65, it could recover those costs in the form of future medical costs avoided beginning at age 65.

CONCLUSIONS — Cost-sharing strategies to offer the DPP lifestyle intervention for eligible people between ages 50 and 64 could provide financial return on investment for private payers and long-term benefits for Medicare.

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The Diabetes Prevention Program (DPP) demonstrated that weight loss and moderate physical activity can delay or prevent the development of diabetes by 58% in high-risk people (1). We recently reported that, from a societal perspective and over the lifetime of eligible participants, the DPP lifestyle intervention cost $8,790 per quality-adjusted life-year (QALY) gained compared with placebo (2). From a single-payer perspective, the intervention cost $1,124 per QALY gained. These estimates were developed using methods recommended by the U.S. Public Health Service Panel on Cost-Effectiveness in Health and Medicine and should offer the best guidance for policy decisions about setting funding priorities for the allocation of resources for health services (3). Although these estimates suggest that the DPP lifestyle intervention can provide considerable benefits at reasonable costs, it is still unclear how the intervention could be financed.

The financing of health care in the U.S. involves multiple payers. Before the age of 65 years, 73% of Americans have private, employment-based health insurance (4). Because the duration of enrollment in such plans may be short, private payers are often reluctant to cover preventive interventions that have substantial initial costs and delayed benefits (5). Coverage decisions in the private sector are often based on a strong business case, defined as the promise for financial return on investment (ROI) in the form of avoided costs within a reasonable time frame (5). After the age of 65, essentially all Americans receive health care coverage through Medicare (4). Although implementation of preventive interventions before age 65 might reduce costs and improve length and quality of life in later years, Medicare does not pay for such interventions.

An essential step in delivering the benefits of the DPP lifestyle intervention to high-risk, middle-aged Americans is to determine whether there are tangible benefits for health insurers that offer the intervention. To explore this issue, we analyzed the health and economic outcomes associated with the DPP lifestyle intervention from a health-payer perspective that distributed direct intervention costs across different payers. Our goal was to determine whether this intervention can be offered in a way that provides financial ROI for private health insurers, while remaining attractive for consumers, employers, and Medicare.

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Abbreviations: DPP, Diabetes Prevention Program; IGT, impaired glucose tolerance; QALY, quality-adjusted life-year; ROI, return on investment.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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See accompanying editorial, p. 1447.

RESEARCH DESIGN AND METHODS

The DPP enrolled 3,234 participants with impaired glucose tolerance (IGT) who were at least 25 years of age and had a BMI of ≥24 kg/m^2. At baseline, the mean participant age was 51 years; 68% were women, and 45% were nonwhite.

The DPP lifestyle intervention

Details of the DPP lifestyle intervention are described elsewhere (6). The primary intervention goal was to achieve and maintain at least a 7% weight reduction through a combination of diet and moderate-intensity physical activity, such as brisk walking. The program included a one-on-one, 16-lesson core curriculum, followed by monthly maintenance visits that included both group sessions and one-on-one visits with case managers. Placebo participants received standard lifestyle recommendations through an annual 30-min education session.

Simulation model

We assessed the lifetime progression from IGT to diabetes to complications and death with a simulation model (2,7). The model has a Markov structure that includes annual transition probabilities between disease states and tracks costs and QALYs (7).

Disease progression, complications, and comorbidities

The model used DPP data to determine the annual hazard of diabetes onset. For placebo recipients, this rate was 10.8 per 100 person-years, and the risk reduction for the lifestyle intervention was 55.8% (1). In the base case, we assumed that this risk reduction remained constant and that the lifestyle intervention was applied continuously until participants developed diabetes or died. A table summarizing model parameters for the development of diabetes, complications, and death for adults with IGT or undiagnosed (preclinical) diabetes is available in an online appendix (available at http://care.diabetesjournals.org). After a clinical diagnosis of diabetes, the model assumed that all people received intensive glycemic management as described in the U.K. Prospective Diabetes Study (8). Changes in HbA_{1c} and diabetes treatments were modeled to reflect those observed in the UK Prospective Diabetes Study intensive therapy group.

Direct medical costs

To estimate direct costs for the lifestyle intervention, we included costs of identifying each participant, implementing and maintaining the interventions, and monitoring and treating side effects (9). To estimate intervention costs beyond the DPP trial, we assumed that year 3 costs would be incurred each year until individuals developed diabetes or died.

The model used DPP data to estimate annual nonintervention direct medical costs for people with IGT who do not develop diabetes within 3 years (9). These costs included hospital, emergency room, urgent care, and outpatient services, as well as costs of prescription medications and telephone calls to health care providers. For people who developed diabetes, we applied an empirically derived, multiplicative prediction model that estimates annual direct medical costs according to demographic characteristics, diabetes and hypertension treatments, and the acute and ongoing costs of microvascular and macrovascular complications (10). The model applied multipliers for each of these states to the baseline cost for a nonobese white man with type 2 diabetes treated with diet and exercise and with no cardiovascular risk factors or microvascular, neuropathic, or cardiovascular complications ($1,684) (10). For people who developed nondiabetes complications before developing diabetes, the model estimated direct medical costs by applying the same multipliers to the average baseline cost of a male DPP participant ($1,296) (10). We discounted all future costs and QALYs at 3% per year, and all costs were expressed in year 2000 U.S. dollars.

Health state utilities

Health utility scores are measures of health-related quality of life and range from a value of 1.0 (optimal health) to 0.0 (equivalent to death). The utility score for each health state is multiplied by the time spent in that state and then summed to calculate the number of QALYs associated with a particular therapy (3). During the DPP, health utility scores were collected annually from study participants using the self-administered quality of well-being index (11).

For people with IGT who developed diabetes, we used an empirically derived, additive prediction model that estimated quality of well-being index scores by applying penalty scores for demographic, treatment, and disease state variables to a baseline health utility score of 0.69 (12). For those developing hypertension, coronary heart disease, or cardiovascular disease before developing diabetes, we used the mean year 3 health utility score for a male DPP participant as a baseline (0.73) and applied the same penalty scores for different demographic, treatment, and disease-state variables.

Analyses of single-payer financing of the lifestyle intervention

We adopted a single-payer perspective to estimate the lifetime costs, QALYs, and incremental cost-effectiveness for the DPP lifestyle intervention compared with placebo. Our first simulation applied the lifestyle intervention to participants with IGT at age 50 years. To estimate differences in health and economic outcomes resulting from a 15-year delay in offering the intervention, we conducted a second simulation that applied the placebo intervention until participants reached age 65 and then applied the lifestyle intervention for those who still had IGT.

Analyses of cost-sharing strategies to finance the lifestyle intervention

To explore the effects of distributing intervention costs across different health payers, we divided the remaining years of life for people beginning the intervention at age 50 years into two periods: an initial period between ages 50 and 64, when individuals received health care coverage from a private insurer, and a later period beyond age 64, when recipients were Medicare eligible. We first calculated the costs, QALYs, and incremental cost-effectiveness ratios for each time frame separately. This provided estimates of cost-effectiveness for both the private payer (before age 65) and Medicare (age 65 and older).

Next, we explored cost-sharing strategies. We calculated the maximum discounted, direct intervention costs that a private insurer could pay and still achieve complete ROI in 3 years' time. We used the present value of this maximal, 3-year contribution to calculate a fixed, monthly payment that the private insurer could pay. We then calculated the remaining average monthly intervention costs for participants 50–64 years of age (i.e., the amount the private payer would have to receive from other payers to provide the intervention), and we explored several scenarios that distributed remaining costs to Medicare and other payers.

Table 1—*Lifetime impact of the DPP lifestyle intervention in overweight or obese 50-year-old adults with IGT

Outcomes	Placebo intervention	DPP lifestyle intervention begun at age 50	DPP lifestyle intervention delayed until age 65†
Progression to diabetes	86.7%	65.4%	83.2%
Lifetime direct medical costs	$52,321	$53,079	$52,552
Lifetime QALYs	10.68	11.27	10.83
Incremental cost versus placebo	—	$758	$231
Incremental QALY versus placebo	—	0.59	0.27
Incremental cost per QALY gained	—	$1,288	$1,575

*Single-payer perspective excluding direct nonmedical costs and indirect costs. All costs and QALYs are expressed per each participant with IGT and are discounted at 3% per year; all costs expressed as year 2000 U.S. dollars. †Standard diet and physical activity advice (placebo) between ages 50 and 64 years.

Sensitivity analyses

We recently reported the results of extensive sensitivity analyses showing that the lifetime incremental cost-effectiveness ratio for the DPP lifestyle intervention remained attractive across wide ranges of intervention adherence and effectiveness, the duration of preclinical diabetes, and the discount rate (2). We did not repeat all of these analyses. We did explore the effect of modeling the lifestyle intervention as a group-delivery model. Group lifestyle interventions foster enhanced social support and may improve weight loss and maintenance, while reducing the high personnel costs associated with a one-on-one approach (13–16). We calculated the costs for a group model by adjusting intervention costs assuming that the core curriculum and supervised activity sessions were all offered to a group of 10 participants (9). We also explored a scenario in which the intervention was only 50% as effective as in the DPP but cost the same. Finally, we modeled a scenario in which 10% of eligible participants dropped out of the program each year. In this scenario, we assumed that 50% of people who remained eligible would participate at age 65 if Medicare offered the program free of charge.

RESULTS

Analyses of financing by a single payer

Table 1 summarizes lifetime health and economic benefits of the lifestyle intervention compared with placebo. For people initiating the intervention at age 50 years, the lifetime risk for developing diabetes was reduced from 87 to 65% and the incremental cost-effectiveness ratio was $1,288 per QALY gained. A 15-year delay in the intervention increased the lifetime risk for developing diabetes from 65 to 83%, and the risk reduction attributable to the intervention decreased from 22 to only 4%.

Analyses of financing by two sequential payers

Table 2 summarizes health and economic outcomes when a private insurer paid all direct intervention costs before age 65 years, and Medicare paid all costs beginning at age 65. For every 100 people beginning the intervention at age 50, ~28 fewer people were living with diabetes at age 65. In addition, Medicare experienced lifetime cost savings. After age 65, direct medical costs were $2,136 lower for participants who began the intervention at age 50, compared with placebo recipients. For the private payer, these benefits were associated with a 15-year incremental cost of $2,894 and an incremental cost-effectiveness of $9,647 per QALY gained.

Analyses of cost-sharing strategies

We modeled a financing strategy in which costs of the one-on-one intervention for people <65 years of age were shared by different payers. Under this scenario, Medicare achieved complete recovery of invested costs over a lifetime if it contributed $2,136 (30%) of intervention costs for each participant from 50 to 64 years of age and all intervention costs from age 65 and beyond (Table 3). If we assumed that Medicare paid this amount to a private payer in the form of a fixed, monthly payment over 15 years, the cost to Medicare for each participant was ~$15 per month. A private payer could contribute 24% of total discounted intervention costs and achieve complete ROI after 3 years. Each year of coverage beyond this (i.e., years 4–15) resulted in cost savings. This translated to a fixed payment by the private payer of ~$19 per month. Under this

Table 2—*Health and economic consequences of placebo and DPP lifestyle interventions when offered by a private payer before 65 and by Medicare after 65 years of age*

	Placebo intervention		DPP lifestyle intervention	
Outcomes	Age 50–64	Age 65+	Age 50–64	Age 65+
Private payer				
Direct intervention costs	$377	—	$7,047	—
Other direct medical costs	$27,166	—	$23,390	—
Total direct medical costs*	$27,543	—	$30,437	—
Interval QALYs	7.42	—	7.72	—
Incremental Cost versus placebo	—	—	$2,894	—
Incremental QALY versus placebo	—	—	0.30	—
Incremental cost per QALY gained	—	—	$9,647	—
Medicare				
Direct intervention costs	—	$30	—	$1,474
Other direct medical costs	—	$24,748	—	$21,168
Total direct medical costs*	—	$24,778	—	$22,642
Interval QALYs	—	3.26	—	3.55
Incremental cost versus placebo	—	—	—	−$2,136
Incremental QALY versus. placebo	—	—	—	0.29
Incremental cost per QALY gained	—	—	—	Cost saving

*Health-payer perspective that excludes direct nonmedical costs and indirect costs. All costs and QALYs are expressed per each participant with impaired glucose tolerance and are discounted at 3% per year; all costs are expressed in year 2000 U.S. dollars.

Table 3—*Distribution of intervention costs that allow 3-year cost-recovery for a private payer and lifetime cost-recovery for Medicare for a participant beginning the intervention at age 50 years*

	Monthly direct intervention costs* by payer, for each participant, age 50–64		
Assumptions	Private payer†	Medicare‡	Other payers§
One on one	$19	$15	$44
One on one, 50% less effective	$15	$4	$57
One on one, 10% drop out per year	$17	$10	$39
Group based	$19	$13‖	$0
Group based, 50% less effective	$15	$9	$7
Group based, 10% drop out per year	$17	$12	$0

*Health-payer perspective; costs in year 2000 U.S. dollars, derived by discounting all future costs and effectiveness at 3% per year. Incremental lifestyle intervention costs and effectiveness cease when a participant drops out, develops diabetes, or dies. †Calculated using present value of total costs over 3 years that allow complete ROI, assuming 36 equal monthly payments; this payment level returns cost-savings for all future years of coverage (i.e. participants 53–64 years of age). ‡Calculated using present value of total costs over 15 years (i.e. participants 50–64 years of age) that allow the incremental lifetime cost-effectiveness ratio to equal zero, assuming 180 equal monthly payments. Private insurer pays other direct medical costs before age 65 and Medicare assumes all intervention and other direct medical costs beginning at age 65. §Average residual costs after payments by a private payer and Medicare; these are the direct program costs for which a purchaser (i.e. individual and/or employer) would be responsible. ‖Level of contribution allows 3-year cost recovery by private payer and lifetime cost savings for Medicare, with no co-pay by other purchasers.

scenario, the residual payment for an individual consumer and/or employer amounted to ~$44 per month.

Sensitivity analyses

If the intervention were offered in a group format that achieved similar effectiveness, the private-payer contribution allowing complete ROI after 3 years now comprised 58% of the intervention costs. In this scenario, Medicare could contribute all remaining intervention costs and would achieve lifetime cost savings, with no residual cost for other payers (Table 3). If the group format were only 50% as effective, the allowable monthly payment decreased to ~$9 for Medicare and $15 for the private payer. This resulted in a residual payment of ~$7 per month for other payers. If the intervention were offered in a one-on-one format that was only 50% as effective, Medicare could now only contribute $1,543 (10%) of intervention costs over 15 years, and the monthly cost for other payers would increase to ~$57. With a 10% annual drop-out rate by eligible participants, maximum allowable contributions decreased only modestly ($2-$5 per month) for all payers, compared with the one-on-one format with full participation (Table 3).

CONCLUSIONS — Compared with standard lifestyle advice, providing the DPP lifestyle intervention to eligible adults at age 50 years could prevent 37% of new cases of diabetes before age 65, at a cost of $1,288 per QALY gained. Although intervention costs are reduced by delaying the program until after age 65, the benefit of diabetes prevention is essentially lost. These estimates offer a compelling argument for policy makers to make this intervention available to eligible Americans before the age of 65. Because 73% of Americans between 50 and 64 are insured by private, employment-based health insurers (4), the private sector may need to champion efforts to make the DPP lifestyle intervention available to Americans before the age of Medicare eligibility.

As a health care payer for 96% of Americans age 65 years and older (4), Medicare stands to benefit considerably if private payers offer the DPP lifestyle intervention at earlier ages. If eligible adults receive the intervention from ages 50 to 64, Medicare would experience cost savings. Because Medicare does not currently have authority to pay for services offered to non-Medicare beneficiaries, the viability of a strategy to offer this intervention at age 50 may rely on the presence of a strong business case for a private payer. Our model estimates that a private payer could reimburse up to $655 (24%) of the $2,715 in intervention costs during the first 3 years of the program and still achieve complete ROI.

Although strategies to reduce intervention costs for private insurers could create a business case for offering the DPP lifestyle intervention, it is unclear how this should be achieved. One approach is to offer the intervention in a lower-cost group-delivery format (2). Offering the intervention to a group of 10 could reduce year 1 costs by ~$870 (~62% reduction) and costs beyond year 1 by $380 per year (54–56% reduction) (9). With a group- delivery format, a contribution by the private payer that permitted ROI in 3 years left only ~$13 per month in residual intervention costs (Table 3). Our model estimated that Medicare could pay all residual costs (i.e., no remaining costs for individuals and/or employers) for participants before the age of 65 years and then all intervention costs beginning when participants reach age 65 and achieve lifetime cost savings.

Another strategy for reducing private payer costs is for other payers to share intervention costs. During the DPP, ~0.54 fewer days per year of work or school were lost to illness or death for lifestyle recipients compared with control subjects (9). Because missed work days and reductions in work performance impact employer costs (17), employers should strongly consider the value of contributing to the cost of a DPP lifestyle intervention benefit for employees at age 50 years.

Our study has some limitations. Our base-case analyses assumed that the intervention would be applied as it was during the DPP until a participant developed diabetes or died. In addition, intervention costs were the same as in the DPP, and the program's effectiveness remained constant over time. Because an intervention might be less effective in the real world, we explored a scenario in which the intervention achieved only 50% of the effectiveness observed in the DPP. In this scenario, a private payer could pay 20% and Medicare could pay 10% of intervention costs for participants 50–64 years of age, and this would allow the private payer to achieve complete ROI in 3 years and Medicare to recover all costs over a participant's lifetime. This left an average of $57 per month in residual costs for payment by individual participants and/or employers. However, if offered in a reduced-cost group format, a 50% less-effective intervention could allow the private payer to achieve complete ROI in 3 years and Medicare to recover all costs over a participant's lifetime with only $7 per month in residual costs for other payers.

Our estimates assumed that cost shar-

ing by Medicare, employers, and individual purchasers could allow the intervention to be widely adopted as a benefit across different private payers, so that changes in private health plan coverage for people 50–64 years of age would not lead to loss of intervention access. Thus, when we modeled the impact of a 10% annual intervention drop-out rate by eligible participants, we assumed that private payers would still experience a healthier future member population with lower overall health care costs because of intervention participation in earlier years. Because a payer also spends less on intervention costs as members stop participating, we found that a 10% annual drop-out rate had only a modest effect on overall cost recovery for any payer.

Recent health policy changes have directed Medicare to reimburse for screening tests that would identify DPP-eligible participants and will allow the DPP lifestyle intervention to be considered as a future Medicare benefit (18,19). In this context, our findings suggest that Medicare should also consider seeking authority to offer the DPP lifestyle intervention to eligible adults before age 65 years. Our findings also justify strong efforts to define real-world strategies for making the DPP lifestyle intervention accessible to a rapidly growing population of Americans who might benefit. Cost sharing of program expenses for people between ages 50 and 64 could provide both long-term benefits for Medicare and a strong business case for private payers. In addition, this could be achieved without prohibitively high residual costs for individual consumers or employers. The extent to which program costs should be divided among different payers to maximize long-term sustainability of strategies to offer this intervention remains unclear. Conversion to a group-delivery format could decrease intervention costs and reduce the need for significant out-of-pocket contributions by individuals or their employers. Future studies that demonstrate whether intervention effects are preserved after conversion to a group format and that describe patterns of program utilization in the setting of different cost-sharing models will help private and public health payers to make essential decisions regarding coverage for a lifestyle intervention to prevent diabetes.

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