Projecting the Future Diabetes Population Size and Related Costs for the U.S. *

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Funding

• National Changing Diabetes Program
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Outline

• Why do we need forecasts of chronic diseases?
• New natural history and treatment effect data relevant to type 2 diabetes
• A brief history of diabetes modeling
• Prior attempts to forecast of diabetes population
Outline

• New type 2 diabetes population cost model
• Baseline population and cost estimates for diabetes in U.S. for 25 years
• Sample policy simulation that examines impact of a 10-year and 25-year budget scoring window
• Other implications
Why do we need forecasts of chronic diseases?
Why do we need forecasts of chronic diseases?

• Broad U.S. Healthcare Challenges
• Incomplete access to care
  – Uninsured – 45.7 million (2008, Kaiser Family)
  – Passage of Health Care and Education Affordability Reconciliation Act of 2010
• Rising health care costs
Percentage of the U.S. Population With Chronic Diseases, 1995-2030

Percentage of Medicare $ Spent on Chronic Illness, 1987, 1997 and 2002

The Crucial Role of the Estimators in the Legislative Budget Process

• The U.S. federal budget process depends heavily on objective assessments of both federal spending and tax receipts under alternative scenarios.

• Typically, policymakers want to know two things: what will happen under current law or baseline, and what will happen if there were a change in the law.

• Cost estimating can be a straightforward exercise, or an extremely complex one.
Developing Federal Cost Estimates

• Two primary agencies project future spending
  – Office of the Actuary (OACT) at the Centers for Medicare and Medicaid Services
    • OACT responsible for projecting future spending for Medicare
  – Congressional Budget Office (CBO)
    • Nonpartisan body that “scores” new legislation

• CBO only includes data that meets their professional standards for scientific rigor.
  – By their nature short-term costs are almost always more predictable than long-term saving.
Developing Federal Cost Estimates

• CBO also works in a required “scoring” window
  – Currently 10 years
  – Used to be 5 years

• Modeling to Predict Effects of Legislation.
  – Traditionally provider and payer focused modeling, not disease-based.
  – Clinical information is typically not included

• CBO played crucial role in Health Care Reform providing estimates showing deficit reduction
Why do we need forecasts of chronic diseases?

• Beyond health care spending
• Patient treatment planning
• Workforce planning
• Design of public health interventions
Diabetes as a Model Chronic Condition
Diabetes as a Model Chronic Condition

• Diabetes is an excellent chronic condition for demonstrating potential contribution clinical information can make to forecasting

• Natural history of diabetes has been assessed and modeled extensively over a decade.
  – The baseline progression of major complications are well documented.
  – The effect of treatment interventions are generally well understood (but evolving).
  – Multiple scientific organizations have created diabetes models (NIH, CDC, UK, and European).
Diabetes Trials and Models

• Publication of groundbreaking trials has been followed by model building
  – Diabetes Control and Complication Trial (Type 1 Diabetes) 1993
  – DCCT first trial demonstrating microvascular benefits of intensive glucose control in diabetes
  – United Kingdom Prospective Diabetes Study (Type 2 Diabetes) 1998
  – UKPDS demonstrated benefits of intensive glucose and blood pressure control in type 2 diabetes
Diabetes Trials and Models

• Trials also provide us with information regarding
  – Natural history of disease
  – When treatments will have effects
  – How large treatment effects are
  – What complications are prevented

• UKPDS example
  – Microvascular benefits observed after 9 years of intensive glucose control
  – Mortality and cardiovascular benefits during 10 years of post-trial follow-up (metabolic memory)
Recent trials

• ACCORD (NEJM 2008; 358: 2545)
  – HbA1C 7.5 vs. 6.5
  – North America

• ADVANCE (NEJM 2008; 358: 2560)
  – HbA1C 7.5 vs. 6.5
  – Europe, Australasia, China

• VADT (NEJM 2008; 10.1056/NEJMoa0808431)
  – HbA1C 8.5 vs. 6.5
  – North America
Recent Trial Findings

• 2/6/08, NIH announces discontinuation of ACCORD trial glucose control arm
• Excessive mortality in very, intensive glucose control arm
  – 3 deaths/1000 treated
  – 257 deaths vs. 203 deaths
• Unclear etiology
• In order to achieve lower target used multi-dose insulin, TZDs, exanatide in combination
• Dramatic result for diabetes world
Other Trial Findings

• ADVANCE
  – No cardiovascular benefit
  – Reduces nephropathy progression
  – No excess deaths

• VADT
  – No cardiovascular benefit
  – Non-significant increase in sudden cardiac death
Diabetes Trials and Models

• Diabetes Models
  – DCCT Research Group Type 1 diabetes model 1996
  – NIDDK type 2 diabetes model 1997
  – CDC/RTI model of diabetes complications 2002
  – UKPDS type 2 diabetes model 2004
  – Sheffield model
  – CORE diabetes model 2004
  – Eagle model
  – Archimedes model 2003

• Models designed to simulate the natural history of major diabetes complications

• Models regularly compared during the Mount Hood Challenge
The Budget Window, Disease Progression, and Effect of Treatment

Type 2 Diabetes and Glucose Control Efforts: Average Annual Complications Costs Averted - 2007$

The 10-Year “Budget Window”

Intensive Protocol

Conventional Protocol

Prior Attempts to Forecast the Diabetes Population
A Humbling History of Diabetes Forecasting

• 1992 (Helms, Diabetes Care)  
  – 6.5 million in 1987 to 11.6 million in 2030
• 1998 (King, Diabetes Care)  
  – 21.7 million by 2025
• 2001 (Boyle, Diabetes Care)  
  – 29 million by 2050
• 23.7 million with diabetes today
Prior Model Characteristics

- General population growth underestimated
- Used fixed age-specific and sex-specific prevalence rates for diabetes
- No formal accounting for obesity
- No formal accounting for costs
New type 2 diabetes population cost model
Figure 1:
Conceptual Model Of Costs Of Diabetes With Prevalent And Future Cohorts Over Time

2008 Prevalence
Costs of 2008 Prevalent Cohort
Age = a

2009 Prevalence
Costs of 2009 Incident Cohort
Age = b

2010 Prevalence
Costs of 2010 Incident Cohort
Age = c

Net Costs of 2008 Prevalent Cohort
Age = a + 1

Net Costs of 2008 Prevalent Cohort
Age = a + 2

Net Costs of 2009 Incident Cohort
Age = b + 1
Prevalence and Incidence Modeling

US Population Over Age 24

BMI (along with age) influences probability of having diabetes

Health care service use

Diagnostic Categories
- Non-Diabetic
- Undiagnosed Diabetic
- Diagnosed Diabetic
- Deceased

Probability of progressing to disease and screening rates determine populations in these categories

Body Mass Index (BMI):
- Normal (< 25)
- Overweight (25-30)
- Obese (> 30)

Probability estimates are used to sort the population into BMI categories
Screening Rate Assumptions for Men

Males’ Screening Rates by Age and Race/Ethnicity

http://www.cdc.gov/nchs/nhanes.htm
Modeling Diabetes Complications

Assign Initial Patient Characteristics

Simulate natural history of diabetes progression according to patient characteristics

- Retinopathy Module (Clarke, 2004)
- Nephropathy Module (UKPDS 33, 1998)
- Neuropathy Module (Clarke, 2004)
- Coronary Heart Disease Module (Stevens, 2001)
- Stroke Module (Kothari, 2002)

Advance in disease progression one year

Mortality Module (Vital Statistics)

Select next patient

Alive

Dead
Baseline Diabetes Population and Cost Projections
Figure 2: Projected Distribution of Newly Diagnosed, Undiagnosed and Established Cases of Diabetes, 2009-2034

Source: Diabetes Population Cost Model
Figure 3: Projected Direct Spending on Diabetes and Its Complications for Different Cohorts, 2008-2033

- Diagnosed 2029-2033
- Diagnosed 2019-2028
- Diagnosed 2009-2018
- Currently have Diabetes
- Total Spending

Billions of 2007 Dollars


Spending amounts for different years and cohorts, showing an increasing trend.
Baseline Population and Cost Projections

• U.S. adult population (24-85)
  – 2009- 23.7 million people with diabetes
  – 2034- 44.1 million people with diabetes

• Direct medical costs of population
  – 2034- 336 billion

• Trends reflect
  – Expected demographic shift that currently is occurring with the aging of the baby boom generation
  – Current high rates of obesity.
Figure 4: Projected Distribution of Newly Diagnosed, Undiagnosed and Established Medicare Cases of Diabetes, 2009-2034
Figure 6(a):
Projected Direct Medicare Spending on Diabetes and Its Complications for Different Cohorts, 2009-2034
Medicare Baseline Population and Cost Projections

• Medicare population
  – 2009- 23.7 million people with diabetes
  – 2034- 44.1 million people with diabetes

• Direct medical costs of population
  – 2034- 336 billion
Figure 6(b):
Projected Real Growth – Medicare Direct Spending on Diabetes and Its Complications, Medicare Overall and GDP, 2009-2034
Policy Projections
Policy Projections

• Modeled a prototypical diabetes treatment improvement intervention that is similar to current well-designed disease management programs.

• Intensify the treatment of individuals with prevalent and incident diabetes aiming to improve
  – Glucose control
  – Blood pressure control
  – Cholesterol control
  – Use of beneficial preventive therapies (aspirin, ACEI)
Policy Projections

• $20 billion gross program spending over 25 years
• Enroll 41-64 year olds with existing diabetes
• 60,000-100,000 per year
• Assume lifelong adherence
# Diabetes Quality Improvement Intervention

<table>
<thead>
<tr>
<th>Entry Age Cohort</th>
<th>Number of patients entering treatment program each year</th>
<th>Baseline spending (no improvement intervention)</th>
<th>Improvement intervention spending</th>
<th>New spending plus cost of intervention</th>
<th>Net new spending</th>
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<td>$36.5 billion</td>
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</tr>
</tbody>
</table>

Dollar amounts in 2007 $.  

Source: Derived from the authors' own analyses/computations.
Diabetes Quality Improvement Intervention (25-year spending)

Source: Derived from the authors’ own analyses/computations.
Policy Projections

- Younger subpopulations experience greater clinical benefits and larger cost offsets.
- For most age groups, the program does not reduce overall spending but does generate a cost offset.
- Savings from younger cohorts could partially subsidize costs of older cohorts.
- Size of the offset is correlated with the budgetary window (10 years vs. 25 years) most clearly for the youngest cohorts.
U.S. Budget Process Implications

- Paper highlights recent progress in the world of chronic disease modeling
- Work has been largely supported by public $:
  - Cancer (NCI-Cancer Intervention and Surveillance Modeling Network)
  - HIV (NIMH, NIAID, CDC-Cost-Effectiveness of Preventing AIDS Complications Team)
  - Obesity (CDC)
  - Neurological diseases (NINDS-Immediate Practice-Altering Clinical Trials)
- Discoveries regarding natural history of diseases and their treatments could be leveraged by cost estimators
Current congressional budget procedures are already moving toward a longer-term focus:

- CBO is issuing more long-term estimates for health care entitlements
- The Senate adopted a new rule which will require CBO to produce long-term cost estimates under certain circumstances
U.S. Budget Process Implications

• Our focus:
  – Introducing epidemiological modeling as a viable supplement to current cost estimating approaches
  – Extension of the budget window as appropriate, especially in the context of policymaking for chronic illnesses with long time horizons
  – Where there is clear and convincing data, allowing improved chronic illness cost estimating to influence budget enforcement within the current ten-year window
Other Implications

• The forecast is not set in stone
• Diabetes prevention has more trial data behind it than ever before
• Obesity rates are starting to level off – can this be reversed?
• Early intensive diabetes care may have long-lasting cost implications
Research Team

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