Appendix 2 for

Simulating and Evaluating Local Interventions
to Improve Cardiovascular Health
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Cost Calculation in the Cardiovascular Health System Dynamics Simulation Model

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Cardiovascular Disease (CVD) Costs

We conducted a review of the literature to find the direct medical costs and indirect costs (i.e., lost productivity) in the first year after a first-time CVD event.

We used a human capital approach to value the non-medical morbidity costs associated with CVD events and risk factors. The human capital approach looks at the time lost to primary activities due to the risk factors and values that time using market values for such activities.

Direct medical costs were inflated to 2005 dollars using the Medical Care Consumer Price Index (CPI) provided by the Bureau of Labor Statistics. Indirect costs were inflated to 2005 dollars using the overall CPI.

Direct medical

- AMI non-fatal: $22,778
- AMI fatal: $25,698
- CHD sudden death: $ 1,045
- CVD non-fatal: $11,321

Captured:
- Emergency medical care (transportation + ER)
- Hospitalization costs

Not captured:
- Outpatient and office-based follow-up
- Long-term care costs

Sources:

Russell MW, Huse DM, Drowns S, et al. “Direct medical costs of coronary artery disease in the United States.” Am J Cardiol. 1998 May 1;81(9):1110-5.
Sasser AC, Rousculp MD, Birnbaum HG, et al. “Economic burden of osteoporosis, breast cancer, and cardiovascular disease among postmenopausal women in an employed population.” WOMENS HEALTH ISSUES 15 (3): 97-108 MAY-JUN 2005 (Table 4, incremental CVD vs. control group)

Indirect—Morbidity

The average productivity costs from morbidity for non-fatal events in the first year per CVD event was $6,205.

Based on days lost, valuing lost days as per Haddix et al (sex, age group):

Male 135, 273, 81; Female 115, 162, 59

Days lost for CVD sudden death: 365 (=full year)
Days lost for CVD non-sudden fatal: 270 (=9 months; assume survive 3 months)
Days lost for CVD non-fatal: 17.3 (Sasser 2005, Table 5, incremental CVD vs. control group)

(Let us take Male 30-64 as an example: $273 per day lost gives
CVD sudden death: 99,645
CVD non-sudden fatal: 73,710
CVD non-fatal: 4,723.)

Captured:
- Absenteeism (days missed from work)
- Disability payments

Not captured:
- Lost productivity at work (i.e., presenteeism)
- Lost productivity from premature mortality
- Value of lost home production
- Non-monetary value of poor health

Sources:
Haddix, Teutsch, Corso. 2003. "Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation" 2nd edition, p. 248-249. Tables 1.1b and 1.1c
Sasser AC, Rousculp MD, Birnbaum HG, et al. “Economic burden of osteoporosis, breast cancer, and cardiovascular disease among postmenopausal women in an employed population.” WOMENS HEALTH ISSUES 15 (3): 97-108 MAY-JUN 2005

Indirect—Mortality

Productivity costs from mortality for fatal CV events were calculated using expected years of life lost (YLL) by age and sex based on the Social Security actuarial life table. Midpoints of the age groups were used: age 25 as midpoint for 18-29 group; age 50 for 30-64 group; and age 75 for 65+ group. The value of lost time was derived as above from Haddix et al. (2003).

Average YLL per CV death, by sex and age:

Male			Female		
18-29	30-64	65+	18-29	30-64	65+
51	28	10	56	32	12

Captured:

- Lost productivity from premature mortality

Not captured:

- Non-monetary value of lost years

Sources:

Haddix, Teutsch, Corso. 2003. "Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation" 2nd edition, p. 248-249. Tables 1.1b and 1.1c

Risk factor costs

We estimated non-CVD direct and indirect morbidity costs for the risk factors using data from the Medical Expenditure Panel Survey (MEPS) 2000-2003 linked with the National Health Interview Survey (NHIS; N=38,202). The regression models controlled for demographics, CVD (heart disease, stroke and congestive heart failure (CHF)), and other diseases not linked to the risk factors (e.g., HIV).

The models provided estimates of annual costs attributable to the risk factor for those with the risk factor. These costs were net of any CVD-related costs.

All costs have been inflated to 2005 dollars as above.

Direct medical

We wanted to track medical costs associated with treatment and control of the risk factors separately. Therefore, we focused on non-CVD *inpatient hospitalization* costs associated with the presence of risk factors. Due to sample size limitations, we estimated one model for the adult population rather than separately by age and sex. There were no significant incremental costs for obesity and cholesterol once we controlled for the other risk factors and CVD.

- Smoking $187

- Obesity $ 0
- Hypertension $389
- High Cholesterol $ 0
- Diabetes $859

Captured:
- Inpatient hospitalization costs

Not captured:
- Other costs associated with treatment of non-CVD complications from risk factors

Indirect—Morbidity

We estimated the effect of the risk factors on *annual days of work missed due to illness*. In order to capture the impact on lost productivity at home, we calculated two estimates of total indirect cost (work + non-market):

1. The first assumed that annual days of household production lost due to the risk factors is the same as the annual days of work lost among the employed.
2. The second used the assumption used by Corso, Finkelstein, Miller, et al. (2006) that household work is lost on 90% of days that market work is lost. This applies for injuries and here we assumed it applies for our risk factors as well.

Because market time is valued more highly than non-market, the non-market component was a relatively small part of the overall indirect estimate. The difference in estimates between the two assumptions about non-market time was very small. The first calculation was used.

The value of the time applied different values to market and non-market work (Haddix et al. 2003). The value of the non-market time was found by looking at how much time people spent doing household work (by sex and age) and valuing the replacement cost of that time using market wages by occupation (e.g., cooks, maids). For market work, we used average earnings in each age/sex group including those employed and not employed; this should account for differential employment across the demographic groups. The different values for market and non-market captured some of the variation between market and non-market productivity.

We also only reported estimates of annual days of worked missed for the overall (adult, employed) population. This is mainly because after we restricted the sample to the working population there were too few people with some risk factors in some age/sex groupings. We performed statistical tests to see if there were significant differences in estimates for the risk factors in the different subgroups and there were none, except for cholesterol for ages 18-29. This group had only about 30 people of each sex with cholesterol. The value of time was calculated separately by age and sex, which will capture some of the variation between demographic groups.

Based on days lost, valuing lost days as per Haddix:

- Smoking 0.5 days
- Obesity 0.5 days
- Hyptn 0.8 days
- Diabetes 1.8 days

Lost Productivity (household days = work days)

Risk Factor	M 18-29	M 30-64	M 65+	F 18-29	F 30-64	F 65+
Smoking	$ 72	$ 145	$ 43	$ 61	$ 86	$ 31
Obesity	$ 71	$ 144	$ 43	$ 61	$ 85	$ 31
Hypertension	$ 112	$ 226	$ 67	$ 95	$ 134	$ 49
High Cholesterol	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
Diabetes	$ 247	$ 499	$ 147	$ 210	$ 295	$ 108

There were no significant incremental costs for high cholesterol once we controlled for the other risk factors and CVD.

Captured:
- Lost productivity from morbidity

Not captured:
- Lost productivity at work (i.e., presenteeism)
- Lost productivity from premature mortality
- Disability payments
- Non-monetary value of poor health

Sources:

Haddix, Teutsch, Corso. 2003. "Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation" 2nd edition, p. 248-249. Tables 1.1b and 1.1c

Corso P, Finkelstein E, Miller T, Fiebelkorn I, Zaloshnja E. Incidence and lifetime costs of injuries in the United States. Injury Prevention 2006;12(4):212-8.

Indirect—Mortality

Productivity costs from mortality for fatal non-CV events were based on death rates and YLL from published literature. Death rates were converted to rates per thousand with the risk factor. Because not all sources provided estimates broken down by sex and age, we created a ratio of the average YLL for each risk factor relative to the YLL for CV events. The value of lost time was derived as above from Haddix et al. (2003).

Captured:
- Lost productivity from premature mortality

Not captured:
- Non-monetary value of lost years

Sources:

Diabetes—American Diabetes Association, “Economic Costs of Diabetes in the U.S. in 2002,” Diabetes Care, 2003, 26:917–932.

Hypertension—World Health Organization. http://www.nationmaster.com/graph/mor_hyp_ren_dis-mortality-hypertensive-renal-disease#source. Last visited Feb. 8, 2008.

Clausen J, Jensen G. Blood pressure and mortality: an epidemiological survey with 10 years follow-up. J Hum Hypertens 1992;6:53–59.

Obesity—Flegal KM, Graubard BI, Williamson DF, Gail MH. “Cause-Specific Excess Deaths Associated With Underweight, Overweight, and Obesity,” JAMA, November 7, 2007—Vol 298, No. 17, 2028-2037.

Smoking—SAMMEC. http://apps.nccd.cdc.gov/sammec/. Last visited Feb. 8, 2008.

Haddix, Teutsch, Corso. 2003. "Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation" 2nd edition, p. 248-249. Tables 1.1b and 1.1c

Risk factor management costs

We estimated average expenditures for provider visits and medications for smokers and for people with diagnosed high BP, high cholesterol, and diabetes using data from the Medical Expenditure Panel Survey (MEPS) 2000-2003 linked with the National Health Interview Survey (NHIS; N=38,202). The estimates from MEPS measure the difference in spending for prescriptions and physician visits for those with the risk factor and those without, controlling for the presence of other risk factors and CVD. The numbers are the difference in spending given that the person has positive prescription or physician visit expenditures (i.e., given that they are accessing the medical care system).

Diabetes drug cost estimates also informed by ADA (2003). BP and cholesterol drug cost estimates also informed by proprietary industry data.

Relative costs for intensive management (corresponding to high-quality primary care) versus basic management (corresponding to mediocre primary care) of high BP, high cholesterol, and diabetes informed by Herman et al. (2005). This source also provides estimates for costs of smoking quit services and products.

Estimate for weight loss services based on information for costs of WeightWatchers and gym memberships.

Estimate for costs of mental health services based on typical session fees for psychologists and social workers.

All costs have been inflated to 2005 dollars as above.

Annual cost for basic diabetes mgmt	650	$/year
Annual cost for intensive diabetes mgmt	1550	$/year

Annual cost for basic high BP mgmt	350	$/year
Annual cost for intensive high BP mgmt	700	$/year
Annual cost for basic high chol mgmt	250	$/year
Annual cost for intensive high chol mgmt	550	$/year
Annual cost per user of smoking quit services and products	550	$/year
Annual cost per user of weight loss services	600	$/year
Annual cost per user of mental health services	2080	$/year

Sources:

American Diabetes Association, “Economic Costs of Diabetes in the U.S. in 2002,” Diabetes Care, 2003, 26:917–932.

Herman et al. “The Cost-Effectiveness of Lifestyle Modification or Metformin in Preventing Type 2 Diabetes in Adults with Impaired Glucose Tolerance.” Annals of Internal Medicine 2005;142:323-332 (Technical Appendix)