Appendix 2. Methodologic Details Regarding Cost Analysis of Maternal Disease Associated With Suboptimal Breastfeeding

Methods to calculate disease related cost differences:
Percentage of infants breastfeeding was taken from monthly final data from the National Immunization Survey for 2008 up to 12 months, with additional data point at 18 months. This information was obtained by personal email communication from R. Li at the Centers for Disease Control and Prevention on October 5, 2012 and is found in Appendix 1 available at http://links.lww.com/xxx.

In our simulation model, we interpolated the monthly rates between 12 and 18 months in a linear fashion. Because there is no US recommendation for breastfeeding at 18 months, we assumed the optimal group would also have a breastfeeding rate of 35.6% at 18 months. We arrived this figure by dividing the (current) probability of breastfeeding at 18 months, 8.4%, by the current rate at 12 months, 23.4%, to estimate that 35.6% of women who breastfed through 12 months would continue breastfeeding through 18 months.

Fertility data came from National Vital Statistics Reports from 2010.[1]

Breast and ovarian cancer costs
Breast and ovarian cancer cost data were taken from Mariotto et. al.,[2] Table 4, and converted from 2010 dollars to 2011 dollars using a medical inflation rate of 1.03. See Appendix 3 available at http://links.lww.com/xxx.

Indirect costs of cancers were computed using the American Cancer Society's 2007 estimates[3] (page 3) which separate out the costs of morbidity as distinct from lost wages from premature death. Their ratio of indirect morbidity costs to direct costs is 0.229, so we applied this ratio to the above direct costs to calculate indirect costs. Note in its 2012 report, the American Cancer Society stopped reporting indirect morbidity costs.[4]
Cancer mortality data came from Surveillance Epidemiology and End Results.[5]

Hypertension cost calculations:
Heidenreich et al provide two separate, overlapping costs for hypertension: the cost of hypertension alone and the cost of hypertension plus cardiovascular complications associated with hypertension.[6] They supply both direct and indirect costs of both.

To calculate direct cost of hypertension, we used Heidenreich's direct cost including risk factors, $130.7 billion in 2008 dollars. (Table 2) We removed the portion of direct costs of hypertensive complications that was attributable to coronary heart disease, to avoid double counting this cost. To do this, we subtracted the direct costs of coronary heart disease from Heidenreich, $35.7 billion, from the $130.7 billion, leaving $95 billion of direct costs of hypertension along with complications other than coronary heart disease. (This reduction conservatively includes cases of coronary heart disease not attributable to hypertension.) We then divided this cost among all hypertensives (104,664,737, per Heidenreich et al, obtained from data from the National Health and Nutrition Examination Survey) to get a per person cost of $907.66. Adjusting to 2011 dollars gives a direct hypertension cost per person o $998.42. Of note, the American Heart Association lists a prevalence of diagnosed hypertension as 74.5 million persons; we used the higher prevalence data in the denominator of our per-person costs to be more consistent and more conservative.

We used Heidenreich's hypertension indirect cost without risk factors, $23.6 billion (Table 3), and divided it among all hypertensives, giving an indirect cost per person of $225.48. This indirect cost includes both morbidity costs and costs of lost wages due to premature death. We had to exclude these mortality costs, since we are using the value of a statistical life to cost mortality. Per the American Heart Association,[7] 58.5% of hypertension indirect costs are due to mortality, leaving an indirect cost of $93.52 per person in 2008 dollars for hypertension morbidity, or $98.19 in 2011 dollars.

Coronary Heart Disease cost estimates:
We used the U.S. direct coronary heart disease costs from Heidenreich et al,[6] of $35.7 billion (Table 2). We used the indirect costs of $73.2 billion, (Table 3), which includes the costs of lost wages due to premature death as well as lost wages from morbidity, as they do not distinguish the two. To subtract out the proportion of these costs due to lost wages due to death, we used the ratio of morbidity to total indirect costs (morbidity plus mortality), 0.139, for coronary heart disease found in the costs estimates from the American Heart Association,[7] which provides values for both types of indirect costs. We are left with an indirect coronary heart diease morbidity cost of $10,709,223,181. We calculated a 2010 coronary heart disease prevalence of 24,699,643 using the 8.0% coronary heart disease prevalence given in Heidenreich et al Table 1.

However, we assume that Heidenreich et al's costs for coronary heart disease include cost of incident MI, which we count separately as a one-time cost per event. We used data from Kauf et al[8] showing a direct MI cost per patient of $9,196 in 2002 dollars, or $13,426 in 2011 dollars. Using the American Heart Association ratio of indirect morbidity costs to total direct cost gives an indirect MI cost of $1,580. To separate out the costs of incident MI from annual coronary heart disease costs, we multiplied these two MI costs by the 935,000 people who have MI each year,[7,9] then subtracted the product from the total direct and indirect morbidity costs from Heidenreich et al. We then divided these figures ($26,716,540,400 and $9,301,276,695 respectively) by the population with coronary heart disease minus the 935,000 MIs per year. We are then left with annual direct costs of $1,124 and indirect costs of $388 for people with coronary heart disease, but no MI in the current year.

The estimates of coronary heart disease prevalence varies from 17.6 million (per the American Heart Association, Table 21-1),[7] and 24.7 million (per Heidenreich et al).[6] We used only prevalence numbers from Heidenreich et al to compute coronary heart disease costs, since these yielded the more conservative cost-per-person figures.

We used the 2010 American Heart Association report rather than their two more recent reports (2011 and 2012). After 2010, their methodology changed and they no longer reported out the kinds of specific cost data we required for our methods, both for hypertension and for coronary heart disease.

Diabetes cost calculations: The most recent cost estimates with the most robust methodology came from Dall et al for the total costs of diabetes.[10] They gave a type 2 diabetes cost per person in 2007 dollars of $9,677, which includes direct costs, indirect morbidity costs, and costs due to lost wages from premature death. Because they do not separate out these mortality costs, we used the ratios from the American Diabetes Association, which does separate out these costs.[11] Using their ratios, direct costs are 66.6% of the total. Adjusting direct and indirect costs separately for their differing rates of inflation gives a direct cost of $7,411 and $3,459 indirect, in 2011 dollars. Morbidity costs alone are 58% of indirect costs ($1,860). Because neither paper separates out microvascular costs from macrovasular costs, we used data from Caro et al[12], who reported that 48% of the total costs of diabetes are microvascular (neuropathy, nephropathy, and retinopathy). We used for our model the resulting annular microvascular type 2 diabetes costs per person of $3,557 direct, and $893 indirect.

Notes about the simulation tools:
Two open source packages were used in the construction of the Java™ simulation. Java™ Excel API was used to read Excel spreadsheets. JAMA, a linear algebra package for Java, ™ was used for various computations in the program. Information regarding these packages can be found at http://www.andykhan.com/jexcelapi/ and http://math.nist.gov/javanumerics/jama/#Package respectively.

For each simulation pair, we took one draw of the random parameters (i.e., the parameters that involved the effects of breastfeeding) and calculated the health outcomes for 100,000 women under optimal and current rates of breastfeeding and summarized the results. We repeated this process this 2000 times, and stored the 4,000 results.

References

1. Martin J.A., Hamilton B.E., Ventura S.J., Osterman M.J.K., Wilson E.C., Mathews T.J. Births: Final Data for 2010. Hyattsville, MD; 2012.
2. Mariotto A.B., Yabroff K.R., Shao Y., Feuer E.J., Brown M.L. Projections of the cost of cancer care in the United States: 2010-2020. J Natl Cancer Inst 2011;103:117-28.
3. American Cancer Society. Cancer Facts & Figures 2007. Atlanta, Georgia; 2007.
4. American Cancer Society. Cancer Facts and Figures 2012. Atlanta, GA: American Cancer Society; 2012.
5. Surveillance Epidemiology and End Results: Cancer Statistics, Fast Stats. National Institutes of Health, 2012. (Accessed October 2, 2012, at http://seer.cancer.gov/faststats/selections.php?#Output.)
6. Heidenreich P.A., Trogdon J.G., Khavjou O.A., et al. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. Circulation 2011;123:933-44.
7. Lloyd-Jones D., Adams R.J., Brown T.M., et al. Heart disease and stroke statistics--2010 update: a report from the American Heart Association. Circulation 2010;121:e46-e215.
8. Kauf T.L., Velazquez E.J., Crosslin D.R., et al. The cost of acute myocardial infarction in the new millennium: evidence from a multinational registry. Am Heart J 2006;151:206-12.
9. Roger V.L., Go A.S, Lloyd-Jones D.M., et al. Heart Disease and Stroke Statistics--2012 Update: A Report From the American Heart Association. Circulation 2012;125:e2-e220.
10. Dall T.M., Zhang Y., Chen Y.J., Quick W.W., Yang W.G., Fogli J. The economic burden of diabetes. Health Aff (Millwood) 2010;29:297-303.
11. American Diabetes Association. Direct and indirect costs of diabetes in the United States; 2008.
12. Caro J.J., Ward A.J., O'Brien J.A. Lifetime costs of complications resulting from type 2 diabetes in the U.S. Diabetes Care 2002;25:476-81.

