Annex 12C. Studies Reporting Cost-Effectiveness of Diabetes Screening, Prevention, and Treatment Interventions

Supplementary material for: Ali, M., K. Siegal, E. Chandrasekar, N. Tandon, P.A. Montoya, and others. 2017. "Diabetes: An Update on the Pandemic and Potential Solutions." In *Cardiovascular, Respiratory, and Related Disorders* edited by D Prabhakaran, S Anand, TA Gaziano, J-C Mbanya, Y Wu, and R Nugent. Volume 5 of *Disease Control Priorities, third edition.* Washington, DC: World Bank.

Table 12C.1. Studies Reporting Cost-Effectiveness of Universal and Targeted Screening for Prediabetes, Diabetes, and Gestational Diabetes

Author (year)	Country or economy	Population	Population and intervention description	Study approach	Perspective (discount rate)	Unit of measure	Cost-effectiveness or ICER estimate
Screening (and preventive intervention) for undiagnosed diabetes							
CDC (1998)	United States	Adults (≥25 years of age)	Opportunistic or universal screening for type 2 diabetes	Modeling study (Monte Carlo simulation)	Health system (3%)	Cost per QALY and per LYG (1995 U.S. dollars)	Cost per QALY: US$56,649 Cost per LYG: US$236,449
Hoerger and others (2004)	United States	Hypertensive or at risk for type 2 diabetes	Targeted and universal screening for type 2 diabetes	Modeling study (Markov)	Health system (3%)	Cost per QALY (1997 U.S. dollars)	Targeted vs. no screening (age 55): US$34,375 Universal vs. targeted screening (age 55): US$360,966
Kahn and others (2010)	United States	Hypothetical population of adults 30+ years without type 2 diabetes (n=325,000)	8 strategies for screening type 2 diabetes (including no screening)	Modeling study (Archimedes)	Health system (3%)	Cost per QALY (U.S. dollars)	Compared to no screening at 30 years, every 3 years: US$10,512 45 years, every year: US$15,509 45 years, every 3 years: US$9,731 45 years, every 5 years: US$9,786 60 years, every 3 years: US$25,738 Hypertension diagnosis, every year: US$6,287 Hypertension diagnosis, every 5 years: US$6,490 Maximum screening: US$40,778 ICER, maximum screening vs. screening starting at 30 years and every 3 years: US$301,285

Mortaz and others (2012)	Canada	Normoglycemic, prediabetic, or adults with at least one type 2 diabetes risk factor	Targeted screening (IFG and type 2 diabetes) vs. no screening	Modeling study (Markov)	Health system (3%)	Cost per QALY (2010 Canadian dollars)	No screening vs. every screening 5 years: Can$4,812
Hoerger and others (2007)	United States	Adults (45–74 years) with BMI ≥ 25 kg/m² and at risk for type 2 diabetes	Screening for prediabetes and subsequent DPP intensive lifestyle intervention	Modeling study (Markov)	Health system (3%)	Cost per QALY (2001 U.S. dollars)	Screening + DPP for IGT + IFG individuals vs. no screening: US$8,181 Screening + DPP for IGT, IFG, or both: US$9,511
Gillies and others (2008)	United Kingdom	Hypothetical population of adults (45+ years) at risk for type 2 diabetes	Targeted screening strategies for type 2 diabetes followed by DPP intensive lifestyle intervention or metformin	Modeling study (Markov, decision analysis)	Societal (3.5%)	Cost per QALY (2006 pounds)	Type 2 diabetes screening vs. no intervention: £14,150 Type 2 diabetes and IGT screening + lifestyle intervention: £6,242 Type 2 diabetes and IGT screening + pharmaceuticals: £7,023
Bertram and others (2010)	Australia	Adults not diagnosed with type 2 diabetes (n=8,000)	Home-based screening for type 2 diabetes followed by pharmaceuticals (acarbose, metformin, orlistat) or lifestyle intervention (diet, exercise, diet + exercise) vs. no intervention	Modeling study (microsimulation)	Health system (3%)	Cost per DALY (2003 Australian dollars)	Screening program +: Diet + exercise: $A23,000 Exercise: $A30,000 Diet: $A38,000 Acarbose: $A37,000 Metformin: $A22,000 Orlistat: $A100,000 Metformin + diet + exercise: $A81,000
Schaufler and Wolff (2010)	Germany	Adults at risk for type 2 diabetes	Screening for type 2 diabetes vs. diagnosis of type 2 diabetes in routine clinical care, both followed by DPP intensive lifestyle intervention or metformin	Modeling study (Markov Monte Carlo simulation)	Health system (5%)	Cost per QALY (2006 euros)	Lifestyle intervention: €562.54 Metformin: €325.44

Sagarra (2014)	Spain	Adults (45–75 years) at risk for type 2 diabetes with IGT, IFG, or both	Screening using Finnish Diabetes risk sore + (O)GTT followed by intensive lifestyle intervention vs. standard care	Within-trial	Health system	Cost per QALY (2013 U.S. dollars)	Cost per QALY: US$5,359
Castro-Ríos (2010)	Mexico	Adults at risk for type 2 diabetes	Secondary analysis of Mexico's screening program + modeling benefits of providing preventive care to patients with type 2 diabetes, hypertension, or both	Modeling study and post-trial evaluation	Societal	Cost saved per dollar spent (2010 U.S. dollars)	Cost saved per dollar spent: US$141.00
Toscano (2008)	Brazil	Adults 40+	Evaluation of Brazilian nationwide diabetes screening program	Within-trial	Health system	Cost per diagnosed case (2001 U.S. dollars)	Cost per diagnosed case: US$76.00
Zhang (2013)	China	Random sample of Chinese population	Screening using fasting capillary glucose test vs. Chinese diabetes risk score	Within-trial	Societal	Cost per case identified (2008 U.S. dollars)	Using fasting capillary glucose test: US$96 Using Chinese diabetes risk score: US$121 Cost of screening 1,000 persons for fasting capillary glucose: US$9,143
Screening for undiagnosed gestational diabetes (and preventive intervention) among pregnant women							
Nicholson and others (2005)	United States	Pregnant women (mean age = 30 years) at 24–28 weeks gestation	4 strategies for universal gestational diabetes screening (sequential; 75- and 100-gram glucose tolerance test; no screening)	Modeling study (decision analysis)	Societal (3%)	Cost per QALY (2003 U.S. dollars)	Compared to sequential: 100-gram: US$32,374 (maternal outcomes) and US$8,251 (fetal outcomes) 75-gram and no screening: dominated (more costly and less effective)
Werner and others (2012)	United States	Hypothetical population of pregnant women	Screening strategies (none; current 50- and 100-gram (O)GTT; screening proposed by IADPSG[a]	Modeling study (decision analysis)	Health system (3%)	Cost per QALY (2011 U.S. dollars)	Current vs. no screening: US$16,689 IADPSG vs. no screening: US$19,339 Current vs. IADPSG: US$20,336

Lohse, Marseille, and Khan (2011) [1]	India, Israel	Pregnant women at risk for gestational diabetes	Universal gestational diabetes screening + postpartum lifestyle management	Modeling study (GDModel)	Health system (3%)	Cost per DALY, savings per woman, DALYs averted (2011 U.S. dollars)	Cost per DALY: US$11.32 (India), cost-saving (Israel) Savings per woman: US$78 (India), US$1,945 (Israel) DALYs averted: 2.33 (India), 3.10 (Israel)
Marseille and others (2013)	India, Israel	Pregnant women at risk for gestational diabetes	Universal gestational diabetes screening + postpartum lifestyle management	Modeling study (GeDiForCE)	Societal (3%)	Cost per DALY (2011 euros)	India: €1,626 Israel: €1,830

Note: All studies were conducted in clinical settings unless otherwise stated. If no currency year, it is not reported in the study. ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year; LYG = life-year gained; BMI = body mass index; kg/m^2 = kilograms per square meter; DPP = Diabetes Prevention Program; IGT = impaired glucose tolerance; IFG = impaired fasting glucose; DALY = disability-adjusted life year; (O)GTT = (oral) glucose tolerance test; IADPSG = International Association of Diabetes Pregnancy Screening Guidelines.

a. Screening proposed by IADPSG: fasting plasma glucose at first prenatal visit, followed by 75-gram 2-hour glucose tolerance test at 24-28 weeks for those found to be at risk.

Table 12C.2 Studies Reporting Cost-Effectiveness of Interventions to Prevent Diabetes among High-Risk Individuals

Author (year)	Country or economy	Population	Population and intervention description	Study approach	Perspective (discount rate)	Unit of measure	Cost-effectiveness or ICER estimate
Preventing type 2 diabetes among identified high-risk individuals							
DPP (2003)	United States	High risk for type 2 diabetes	Individual (translated to group), intensive lifestyle intervention + metformin vs. placebo	Within-trial evaluation (DPP participants)	Health system + societal (3%)	Cost per QALY (2000 U.S. dollars)	Health system: Intensive lifestyle intervention: US$32,029 (group: US$8,982); metformin: US$102,164 Societal: Intensive lifestyle intervention: US$52,250 (group, US$29,052); metformin: US$101,713
DPP (2012)	United States	High risk for type 2 diabetes	Individual (translated to group), intensive lifestyle intervention + metformin vs. placebo	Within-trial evaluation (DPP participants at 10-year follow-up)	Health system + societal (3%)	Cost per QALY (2010 U.S. dollars)	Health system: Intensive lifestyle intervention vs. placebo: US$12,878 (group: US$1,478) Metformin vs. placebo: cost-saving Intensive lifestyle intervention vs. metformin: US$14,885 Societal: Intensive lifestyle intervention vs. placebo: US$19,812 (group: US$8,412) Metformin vs. placebo: cost-saving Lifestyle intervention vs. metformin: US$45,867

van Wier and others (2013)	Netherlands	High risk for type 2 diabetes (n=622)	Screen-identified, individual-based intensive lifestyle intervention	Within-trial evaluation	Societal (4%)	Cost per QALY (2008 euros)	Lifestyle intervention vs. control: €50,273
Irvine and others (2011) [2]	United Kingdom	Newly diagnosed type 2 diabetes or IFG (45–70 years)	Group-based lifestyle intervention vs. control	Within-trial evaluation	Health system (not discounted)	Cost per QALY (2008/09 pounds)	Lifestyle intervention vs. control: £67,184
Palmer and others, "Intensive Lifestyle" (2004)	Australia, France, Germany, Switzerland, United Kingdom	High risk for type 2 diabetes (IGT)	Individual intensive lifestyle intervention = metformin vs. placebo	Modeling study (DPP in other settings, Markov)	Health system (5%)	Cost per LYG (2002 pounds)	Control, intensive lifestyle intervention, metformin. respectively: Australia: €27,171, €26,535, €27,127 France: €35,160, €34,705, €34,916 Germany: €33,547, €32,963, €33,282 Switzerland: €49,472, €48,436, €48,917 United Kingdom: €17,632, €18,653, €18,010
Caro and others (2004)	Canada	Adults with IGT (hypothetical cohort)	Individual-based, intensive lifestyle intervention vs. metformin = acarbose	Modeling study (DPP beyond trial, Markov)	Health system (5%)	Cost per LYG (2000 Canadian dollars)	Intensive lifestyle intervention vs. no treatment: Can$749 Intensive lifestyle intervention vs. acarbose: Can$10,000 Acarbose vs. metformin: Can$1,798
Eddy, Schlessinger, and Kahn (2005)	United States	High risk for type 2 diabetes	Individual-based, intensive lifestyle intervention vs. metformin	Modeling study (DPP in other setting, Archimedes)	Health system + societal (3%)	Cost per QALY (2000 U.S. dollars)	Intensive lifestyle intervention: Health system: US$143,000 Societal: US$62,600

Palmer and Tucker (2012)	Australia	High risk for type 2 diabetes (high BMI + IGT, n=8,717)	Individual-based, metformin vs. placebo	Modeling study (DPP in Australian setting, Markov, Monte Carlo)	Health system (5%)	Cost per QALY (2009 Australian dollars)	Metformin vs. control: $A10,142 Generic metformin vs. control: $A8,908
Segal, Dalton, and Richardson (1998) [3]	Australia	High risk for type 2 diabetes	Individual- and group-based, surgical vs. behavioral strategies	Modeling study (Markov)	Health system (5%)	Cost per LYG (1997 U.S. dollars)	Behavioral (diet): US$720–US$1,900 Surgery: US$3,300
Herman and others (2005)	United States	High risk for type 2 diabetes (IGT)	Individual with group components, intensive lifestyle intervention + metformin vs. placebo	Modeling study (DPP participants with IGT, Markov simulation)	Societal (3%)	Cost per QALY (2000 U.S. dollars)	Health system: intensive lifestyle intervention: US$1,100; metformin: US$31,300 Societal: intensive lifestyle intervention: US$8,800; metformin: US$29,900
Lindgren and others (2007)	Sweden	IGT, BMI > 25 kg/m^2, FPG < 6.1mmol/l (60+ years)	Community-based intensive lifestyle intervention (DPS) vs. placebo	Modeling study (Diabetes Protection Study in Swedish setting, simulation)	Societal (3%)	Cost per QALY (2003 U.S. dollars)	3-year intensive lifestyle intervention vs. placebo: US$31,512
Feldman (2013)	Sweden	High-risk adults in Kalmer Metabolic Syndrome Program	Individual-based, intensive lifestyle intervention vs. placebo	Modeling study (Markov)	Health system + societal (3%)	Cost per QALY (2012 euros)	Health system: High-risk men: €3,305 High-risk women: €18,739 Societal: High-risk men: cost-saving High-risk women: €18,191
Ramachandran (2007)	India	High risk for type 2 diabetes (IGT)	DPP adaptation	Within-trial	Health system	Cost per case prevented (2006 U.S. dollars)	Lifestyle modification cost per case prevented vs. control: US$1,052 Metformin cost per case prevented vs. control: US$1,095

Notes: All studies were conducted in clinical settings unless otherwise stated. If no currency year, it was not reported in the study. ICER = incremental cost-effectiveness ratio; DPP = Diabetes Prevention Program; QALY = quality-adjusted life year; IFG = impaired fasting glucose; IGT = impaired glucose tolerance; LYG = life-years gained; BMI = body mass index; kg/m^2 = kilograms per square meter; FPG = fasting plasma glucose; mmol/l = millimoles per liter.

Table 12C.3 Studies Reporting Cost-Effectiveness of Interventions to Manage Diabetes

Author (year)	Country or economy	Population	Population and intervention description	Study approach	Perspective (discount rate)	Unit of measure	Cost-Effectiveness or ICER estimate
Lifestyle and drug intervention in individuals with diabetes							
Eddy, Schlessinger, and Kahn (2005)	United States	Type 2 diabetes, newly diagnosed	Intensive lifestyle intervention and metformin	Modeling study (Archimedes)	Health system (3%)	Cost per QALY (2000 U.S. dollars)	Metformin: US$35,400 Intensive lifestyle intervention: US$24,500
Coyle and others (2012)	Canada	Type 2 diabetes (n=3,642)	Community-based lifestyle intervention	Modeling study (UKPDS)	Health system (5%)	Cost per QALY (2008 Canadian dollars)	Aerobic vs. no: Can$116,793 Resistance vs. no Can$206,985 Combined vs. no: Can$37,782
Ohno and others (2011)	United States	Pregnant women with gestational diabetes mellitus	Diet or pharmaceutical treatment	Modeling study (decision analysis)	Societal (3%)	Cost per QALY (2009 U.S. dollars)	Treating gestational diabetes: US$20,412
Diabetes self-management and education in individuals with diabetes							
Gozzoli and others (2001)	Switzerland	Type 2 diabetes	Educational program vs. standard care alone (part of a multifactorial intervention and screening program)	Modeling study (Markov simulation based on Palmer and others 2000)	Health system (3%)	Cost per LYG (1996 Swiss francs)	Sw F 7,731
Shearer and others (2004)	United Kingdom	Type 1 diabetes	Structured community- and clinic-based STTP, diet + insulin adjustment vs. routine care	Modeling study (Markov)	Health system + societal (6%)	Cost per QALY (pounds)	STTP vs. current practice: -£2,237

Gillett and others (2010 [4]	United Kingdom	Type 2 diabetes, newly diagnosed in DESMOND trial	Diabetes education and self-management	Within-trial (DESMOND) and modeling analyses	Health system + purchasers (4%)	Cost per QALY (2008 pounds)	DESMOND: £5,387 "Real-world": £2,092
Brown III and others (2012) [5]	United States	Low-income Hispanic adults with type 2 diabetes (n=6,551)	Community-based diabetes education and self-management	Modeling study (Archimedes)	Health system (3%)	Cost per QALY (2010 U.S. dollars)	20-year period: US$33,319
Adibe, Aguwa, and Ukwe (2013)	Nigeria	Type 2 diabetes	Tailored pharmaceutical care plan	Randomized control trial	Health care purchaser	Cost per QALY (2011 naira)	Usual pharmaceutical care: 78,524.51 Pharmaceutical education: 80,098.36
Diaz de Leon-Castanada and others (2012)	Mexico	Type 2 diabetes	Cost-effectiveness of common oral hypoglycemic agents	Modeling (Markov)	Societal	Cost per QALY (2009 US$)	Metformin: US$296.48 Glibenclamide: US$272.63 Acarbose: US$409.86 Glibenclamide vs. metformin: US$114.83 Glibenclamide vs. acarbose: US$642.19 5 years' use of glibenclamide: US$146.85
Self-monitoring of blood glucose in individuals with diabetes							
Tunis and Minshall (2008)	United States	Type 2 diabetes without complications in a large health maintenance organization (n=8,242)	Home-based self-monitoring of blood glucose among non-insulin users	Modeling study (COMPUS using Markov Monte Carlo simulation)	Health system (3%)	Cost per QALY (2006 U.S. dollars)	No self-monitoring of blood glucose vs. self-monitoring 1 time a day: US$7,856 No self-monitoring of blood glucose vs. self-monitoring 3 times a day: US$6,601
Pollock and others (2010)	Switzerland	Type 2 diabetes, non-insulin dependent (n=1,000)	Home-based self-monitoring of blood glucose among non-insulin users	Modeling study (simulation)	Health system (3%)	Cost per QALY (2006 Swiss francs)	Self-monitoring of blood glucose: 1 time a day: Sw F 9,177 2 times a day: Sw F 12,928 3 times a day: Sw F 17,342

Cameron and others (2010)	Canada	Type 2 diabetes patients in UKPDS (n=3,642)	Home-based self-monitoring of blood glucose among non-insulin users	Modeling study (UKPDS)	Health system (5%)	Cost per QALY, per LYG (2008 Canadian dollars)	Self-monitoring of blood glucose with 9 tests per week vs. no self-monitoring: per QALY: Can$113,643 per LYG: Can$97,729
Intensive glycemic control in individuals with diabetes							
DCCT Research Group (1996)	United States	Type 1 diabetes	Intensive glycemic control vs. conventional therapy	Within-trial modeling study (Monte Carlo)	Health system (3%)	Cost per LYG (1994 U.S. dollars)	Intensive vs. conventional: US$28,661
Clarke and others (2001)	United Kingdom	Type 2 diabetes, newly diagnosed + overweight	Intensive glycemic control with metformin vs. conventional	Within-trial analysis (UKPDS)	Purchasers (6%)	Net saving per patient (1997 pounds)	Intensive vs. conventional: £258
Almbrand and others (2000)	Sweden	Type 2 diabetes with acute myocardial infarction in DIGAMI trial (n=620)	Intensive glycemic control with insulin vs. conventional therapy	Within-trial analysis (DIGAMI trial)	Societal (3%)	Cost per QALY, per LYG (1999 euros)	Intensive vs. conventional: per QALY: €24,100 per LYG: €16,900
Clarke and others (2005)	United Kingdom	Type 2 diabetes, newly diagnosed (insulin-dependent)	Intensive glycemic control with sulphonylurea or insulin	Within-trial analysis (and modeling, UKPDS)	Purchasers (3.5, 6%)	Cost per QALY (2004 pounds)	Intensive glycemic control: £6,028
Gray and others (2000)	United Kingdom	Type 2 diabetes	Intensive glycemic control with sulphonylurea or insulin vs. control	Within-trial analysis (UKPDS)	Purchasers (6%)	Cost per event-free year gained (1997 pounds)	Intensive vs. conventional: £1,166
Wake and others (2000)	Japan	Type 2 diabetes	Multiple insulin injection vs. conventional therapy	Within-trial analysis	Health system (3%)	Cost per patient (over 10 years) (1998 U.S. dollars)	Multiple insulin injection treatment: US$30,310 Conventional insulin treatment: US$31,525
Palmer and others (2000)	Switzerland	Type 1 diabetes, newly diagnosed	Intensive glycemic control with insulin vs. conventional therapy	Modeling study	Health system (not discounted)	Cost per LYG (1996 Swiss francs)	Intensive vs. conventional: Sw F 12,536

Eastman and others (1997)	United States	Type 2 diabetes, newly diagnosed	Treating type 2 diabetes with intensive glycemic control vs. none	Modeling study (Monte Carlo)	Health system (3%)	Cost per QALY (1994 U.S. dollars)	Intervention vs. none: US$16,000
CDC (2002) [6]	United States	Type 2 diabetes, newly diagnosed	Intensive glycemic control with sulphonylurea or insulin vs. control	Modeling study (Markov)	Health system (3%)	Cost per QALY (1997 U.S. dollars)	Intensive glycemic control: US$41,384
Xie and Vondeling (2008) [7]	China	Type 2 diabetes (25–65 years) + overweight	Intensive glycemic control with metformin vs. conventional	Modeling study (UKPDS decision analysis)	Health system (3%)	Cost per QALY (2008 U.S. dollars)	Intensive vs. conventional: US$16,400
Intensive hypertension control in individuals with diabetes							
UKPDS (1998) [8]	United Kingdom	Type 2 diabetes and hypertension	Intensive blood pressure control (pharmaceuticals) vs. less tight control	Within-trial analysis (UKPDS)	Purchasers (6%)	Incremental cost per LYG (1997 pounds)	Intensive vs. conventional: £720
Clarke and others (2005)	United Kingdom	Type 2 diabetes and hypertension	Intensive blood pressure control: target <150/85 mmHg	Within-trial analysis (UKPDS) + modeling	Purchasers (3.5%)	Cost per QALY (2004 pounds)	Intensive blood pressure control: £369
Elliott, Weir, and Black (2000)	United States	Type 2 diabetes and hypertension, free of CVD/ESRD	Intensive blood pressure control: target <130/85 vs. <140/90 mmHg	Modeling study (Markov)	Health system (3%)	Cost per LYG (1996 U.S. dollars)	For 50-year-olds: US$1,664 For 60- and 70-year-olds: cost-saving
CDC (2002)	United States	Type 2 diabetes and hypertension	Intensive blood pressure control: pharmaceuticals	Modeling study (Markov)	Health system (3%)	Cost per QALY (1997 U.S. dollars)	Intensified blood pressure control: US$1,959
Howard and others (2010)	Australia	Type 2 diabetes, hypertension, proteinuria (50–69 years)	Alternative strategies to prevent ESRD vs. usual care	Modeling study (Markov)	Health system (5%)	Cost per QALY (2008 Australian dollars)	Intensive control of previously inadequately controlled blood pressure: $A2,588

Cholesterol control in individuals with diabetes							
Jönsson, Cook, and Pedersen (1999) [9]	European Union	Type 1 and type 2 diabetes, previous myocardial infarction, angina, dyslipidemia	Simvastatin therapy	Within-trial (4S) analysis	Health system (3%)	Cost per LYG (U.S. dollars)	Type 1 diabetes: US$28,661 Type 2 diabetes: US$16,000
Grover and others (2000)	Canada	Adults with dyslipidemia, with and without type 2 diabetes and CVD	Simvastatin therapy	Modeling study (Markov, compared with 4S)	Health system (5%)	Cost per YOLS (1996 U.S. dollars)	Men and women with type 2 diabetes + CVD: US$4,000–US$8,000 Men with type 2 diabetes and high LDL: US$4,000–US$10,000 Men with type 2 diabetes and no CVD: US$7,000–US$15,000 Women with type 2 diabetes and no CVD: US$24,000–US$40,000
CDC (2002)	United States	Type 2 diabetes, dyslipidemia, no CVD history	Pravastatin therapy	Modeling study (Markov)	Health system (3%)	Cost per QALY (1997 U.S. dollars)	Reduction in serum cholesterol level: US$51,889
Raikou and others (2007)	United Kingdom and Ireland	Type 2 diabetes, no CVD history, normal LDL and 1+ CVD risk factor	Atorvastatin therapy	Within-trial (CARDS) and modeling analyses	Purchasers (3.5%)	Cost per QALY and per LYG (2003/04 pounds)	Over lifetime, per QALY: £6,471 Over lifetime, per LYG: £5,107
Lafuma, Colin, and Solesse (2008)	France	Type 2 diabetes (40–75 years), no CVD + normal LDL in CARDS (n=2,838)	Intensive lipid control: statin	Within-trial (CARDS) and modeling analyses (Markov)	Health system (not discounted)	Cost per event or death and per LYG (2007 euros)	Over trial, per event avoided: €3,862 Over lifetime, CVD mortality per LYG: €2,506 Over lifetime, all-cause mortality: €1,418

Annemans and others (2010) [10]	Belgium	Type 2 diabetes patients in CARDS (2,938)	Intensive lipid control: statin	Within-trial (CARDS) and modeling analyses (Markov)	Health system (3% and 1.5%)	Cost per QALY, per DALY, per event, and per LYG (2009 euros)	Cost per QALY: €16,681 Cost per DALY: €3,833 Cost per event: €8,935 Cost per LYG: €16,981
Sorensen and others (2009) [11]	United States	Type 2 diabetes patients (n=20,838)	Intensive lipid control, comparing statin, fibrate, or both	Modeling study (simulation)	Health system (3%)	Cost per QALY (2007 U.S. dollars)	Cost per QALY: US$50,315 10-year follow-up: US$92,371 15-year follow-up: US$64,198
Case management and disease management in individuals with diabetes							
Mason and others (2005)	United Kingdom	Type 2 diabetes, with hypertension, dyslipidemia, or both	Specialist nurse-led clinics to improve lipid and blood pressure control in type 2 diabetes patients vs. usual hospital care	Within-trial (UKPDS) and modeling analyses (Markov)	Health system (5%)	Cost per QALY (2003 U.S. dollars)	Lower blood pressure: US$1,400 Lower lipids: US$8,230 Blood pressure clinics: US$4,020 Lipid clinics: US$19,950 Blood pressure + lipid clinics: US$9,070
Gilmer and others (2007)	United States	Latino adults with type 2 diabetes in Project Dulce (n=3,893)	Culturally specific diabetes case management and self-management training program vs. usual care (4 insurance cohorts)	Within-trial (Project Dulce) and modeling analyses (Markov, Monte Carlo simulation)	Health system (3%)	Cost per QALY (2003 U.S. dollars)	vs. uninsured: US$10,141 vs. county medical services: US$24,584 vs. MediCal: US$44,941 vs. commercial insurance: US$69,587
Gaede and others (2008)	Denmark	Type 2 diabetes and microalbuminuria	Intensive multifactorial treatment vs. conventional therapy	Modeling study (Markov using Steno-2 data)	Health system (3%)	Cost per QALY (2005 euros)	ICER: €2,538

Brownson and others (2009)	United States	Type 2 diabetes patients (n=1,273) from Robert Wood Johnson Foundation Diabetes Initiative	Diabetes management programs in real-world setting (long-term)	Modeling study (Markov)	Health system (3%)	Cost per QALY (2009 U.S. dollars)	US$39,563
Drabik (2012)	Germany	Type 2 diabetes patients with insurance (n=86,968)	Diabetes management program vs. routine care	Modeling study (linear regression)	Health system (3%)	Cost per LYG (2005–07 euros)	Diabetes management programs vs. routine care: €1,396

Note: All studies were conducted in clinical settings unless otherwise stated. If no currency year, it is not reported in the study. ICER = incremental cost-effectiveness ratio; n = number in the study; QALY = quality-adjusted life year; LYG = life-year gained; STTP = structured teaching and treatment program; UKPDS = United Kingdom Prevention of Diabetes Study; mmHg = millimeters of mercury; CVD = cardiovascular disease; YOLS = years of life saved; ESRD = end-stage renal disease; LDL = low-density lipoprotein; CARDS = Collaborative Atorvastatin Diabetes Study; DALY = disability-adjusted life year.

Table 12C.4 Studies Reporting Cost-Effectiveness of Interventions to Detect, Prevent, and Detect Complications among People with Diabetes

Author (year)	Country or economy	Population	Population and intervention description	Study approach	Perspective (discount rate)	Unit of measure	Cost-effectiveness or ICER estimate
Diabetes complications, screening, and prevention (retinopathy)							
Javitt and others (1994)	United States	Type 2 diabetes, newly diagnosed	Screening and treatment of retinopathy vs. usual care	Modeling study (Monte Carlo simulation)	Health system (5%)	Average lifetime savings (1990 U.S. dollars)	Each additional type 2 diabetes patient enrolling in screening or treatment above current: US$973
Javitt and Aiello (1996)	United States	Type 1 or 2 diabetes	Screening and treatment for eye disease vs. other intervention	Modeling study (Monte Carlo simulation)	Health system (5%)	Cost per QALY (1990 U.S. dollars)	Screening and treatment of eye disease: US$3,190
Palmer and others (2000)	Switzerland	Type 1 diabetes, newly diagnosed	Retinopathy screening + treatment vs. conventional insulin therapy	Modeling study (Markov simulation)	Health system (not discounted)	Cost per LYG (1996 Swiss francs)	Sw F 6,838 (author's calculations)
Vijan, Hofer, and Hayward (2000)	United States	Type 2 diabetes (low-risk, population level)	Annual vs. less frequent retinal screening intervals	Modeling study (Markov Monte Carlo simulation)	Health system (3%)	Cost per QALY (U.S. dollars)	Annual vs. every 2 years for type 2 diabetes: US$107,510 Every other year vs. every 3 years: US$49,760
Maberley and others (2003)	Canada	Isolated First Nations cohort with type 1 or type 2 diabetes	Retinopathy screening by traveling retina specialists vs. retinal photography with portable digital camera	Modeling study (Monte Carlo simulation)	Health system (5%)	Cost per QALY (1998 Canadian dollars)	Camera: Can$15,000 Specialist: Can$37,000
Tung and others (2008)	Taiwan, China	Type 2 diabetes in China (n=971)	Community-based screening for diabetic retinopathy	Modeling study (Markov)	Health system (5%)	Cost per QALY (2008 new Taiwan dollars)	Annual: NT$21,924 Biennial: NT$25,319 3-year: NT$30,098 4-year: NT$35,106 5-year: NT$40,037 Control: NT$61,542

Rein and others (2011)	United States	Type 2 diabetes with no or minimal retinopathy	Biennial eye evaluation or telemedicine screening vs. self-referral	Modeling study (Monte Carlo simulation)	Health system + societal (3%)	Cost per QALY (2010 U.S. dollars)	Annual telemedicine: US$54,979 Biennial evaluation: US$37,531 Annual evaluation: US$45,586
Khan and others (2013)	South Africa	Type 2 diabetes	Opthalmologic screening using digital fundoscopy	Program evaluation and analysis	Health system (not discounted)	Cost per blindness case averted (2011 U.S. dollar	US$1,206
Rachapelle and others (2013)	India	Rural type 2 diabetes patients (hypothetical cohort 40+ years, n=1,000)	Telemedicine diabetic retinopathy screening (at different intervals) in rural Southern India	Modeling study (Markov)	Health system + societal (3%)	Cost per QALY (2009 U.S. dollars)	Health system and societal, respectively: 1 per lifetime: US$1,320, US$2,692 2 per lifetime: US $1,343, US$2,475 Every 5 years: US$2,017, US$3,134 Every 3 years: US$2,034, US$3,365 Every 2 years: US$2,435, US$3,669 Annual: US$4,029, US$5,677
Diabetes complications, screening, and prevention {neuropathy)							
Ortegon, Redekop, and Niessen (2004) [12]	Netherlands	Type 2 diabetes, newly diagnosed	International standards (intensive glycemic control and optimal foot care) for diabetic foot vs. current care	Modeling study (Markov)	Health system (3%)	Cost per QALY (1999 U.S. dollars)	Intensive glycemic control: US$32,057 Optimal foot care (10% lesion reduction): US $220,100 Intensive glycemic control + optimal foot care (10% lesion reduction): US$24,556 Optimal foot care (90% lesion reduction): US$12,163 Intensive glycemic control + optimal foot care (90% lesion reduction): US$7,860

Ragnarson Tennvall and Apelqvist (2011) [13]	Sweden	Type 1 and 2 diabetes	Intensified foot care in risk groups: 1 = low risk, no specific risk factors; 2 = only neuropathy; 3 = neuropathy + peripheral vascular disease and/or foot deformity; 4 = high risk, previous foot ulcer, or amputation	Modeling study (Markov)	Health system (5%)	Cost per QALY (1998 euros)	Age 24–69: risk group 1: not cost-effective (>€100,000 per QALY); groups 2 and 4: cost-saving; group 3: €5,087 Age 70–84: risk group 1: not cost-effective; groups 2 and 4: cost-saving; group 3: €4,045 Age > 85: risk group 1: not cost-effective; groups 2, 3, and 4: cost-saving
Nason and others (2013)	Ireland	Type 2 diabetes at risk for foot ulcers	Multidisciplinary foot clinic vs. standard care	Clinic-based trial evaluation	Purchasers (not discounted)	Cost savings per year (2006–10 euros)	€114,063
Diabetes complications, screening, and prevention (nephropathy screening)							
Borch-Johnsen and others (1993)	Germany	Simulated cohort of type 1 diabetes (n=8,000)	Microalbuminuria screening + antihypertensive treatment vs. natural disease progression	Modeling study (simulation using Markov-chain model)	Health system (2.5% and 6%)	Savings per patient per year (1991 U.S. dollars)	Savings per patient ranging from US$800 (real discount rate of 6%, effect of treatment: 33%) to US$7,700 (real discount rate of 2.5%, effect of treatment: 67%)
Kiberd and Jindal (1995)	Canada	Type 1 diabetes patients	Microalbuminuria vs. hypertension + macroproteinuria screening	Modeling study (Markov)	Health system + purchasers (5%)	Cost per QALY (1990 U.S. dollars)	Microalbuminuria vs. macro/hypertension screening: US$27,041.69
Palmer and others (2000)	Switzerland	Type 1 diabetes, newly diagnosed	Screening + treatment for microalbuminuria vs. conventional insulin therapy	Modeling study (Markov)	Health system (not discounted)	Cost per LYG (1996 Swiss francs)	Sw F 5,654 (author's calculations)

Hoerger and others (2010)	United States	Type 2 diabetes	Microalbuminuria screening (universal and targeted) at 1-, 2-, 5-, or 10-year intervals followed by ACEi or ARB	Modeling study (microsimulation)	Health system (3%)	Cost per QALY (2006 U.S. dollars)	Universal, annual: Starting at 50 years (vs. none): US$73,000 Starting at 50 years (vs. usual care): US$145,000 Targeted, annual: Type 2 diabetes vs. no screening: US$21,000 Type 2 diabetes + hypertension vs. no screening: US$55,000 Without diabetes or hypertension vs. no screening: US$155,000
Diabetes complications, screening, and prevention (nephropathy treatment)							
Golan, Birkmeyer, and Welch (1999)	United States	Type 2 diabetes, newly diagnosed	Universal ACEi vs. if kidney damage	Modeling study (Markov)	Societal (3%)	Cost per QALY (1998 U.S. dollars)	Marginal cost-effectiveness ratio: US$7,500
Clark and others (2000)	Canada	Type 1 diabetes and nephropathy	Cost-effectiveness of government covering ACEi	Decision analysis tree	Health system (5%)	Cost per QALY (1996 Canadian dollars)	50% reduction in ACEi price: Can$299
Sakthong and others (2001)	United States	Type 2 diabetes with microalbuminuria and normal blood pressure	ACEi vs. no ACEi to delay nephropathy	Modeling study (Markov simulation)	Health system (8%)	Cost per LYG (1999 U.S. dollars)	ACEi therapy: US$788.37
Souchet and others (2003)	France	Type 2 diabetes and nephropathy	Losartan therapy vs. placebo to delay ESRD	Within-trial evaluation and modeling analysis	Societal (8.1%)	Decreased cost of ESRD per patient, 4 years (2002 euros)	€5,834
Palmer and others (2003)	Belgium, France	Type 2 diabetes, with macroalbuminuria and hypertension	Irbesartan therapy vs. amlodipine or placebo	Modeling study (Markov)	Health system (3%)	Cost saving per patient over 10 years (2002 euros)	Belgium: vs. amlodipine: €14,949 vs. control: €9,205 France: vs. amlodipine: €20,128 vs. control: €13,337

Dong and others (2004)	United States	Type 1 diabetes, newly diagnosed (20+ years)	ACEi (captopril) immediately following type 1 diabetes diagnosis vs. therapy post-microalbuminuria	Modeling study (semi-Markov)	Health system (5%)	Cost per QALY (1999 U.S. dollars)	Early use of captopril for average adult with type 1 diabetes: US$27,143
Szucs, Sandoz, and Keusch (2004) [14]	Switzerland	Type 2 diabetes and nephropathy	Losartan therapy vs. placebo to delay ESRD	Within-trial evaluation and modeling analysis	Health system (0%)	ESRD-associated costs saved, net savings per patient (Swiss francs)	Over 3.5 years: Sw F7,226 Net savings: Sw F4,084
Palmer and others, "Economic Evaluation" (2004) [15]	United Kingdom	Type 2 diabetes, with hypertension and nephropathy	Irbesartan therapy vs. amlodipine or control to delay ESRD	Modeling study (Markov)	Health system (6% and 1.5%)	Decreased cost per patient over 10 years (2000 pounds)	vs. amlodipine: £5,125 vs. control: £2,919
Palmer, "Cost-Effectiveness" (2004) [16]	United States	Type 2 diabetes, with hypertension and microalbuminuria	Irbesartan initiation times in delaying progression of microalbuminuria to nephropathy	Modeling study (Markov)	Health system (3%)	Decreased cost per 1,000 patients (2000 U.S. dollars)	Early: US$3,300,000 Late: US$2,700,000
Rosen and others (2005)	United States	Medicare beneficiaries with type 1 or type 2 diabetes	Medicare's first-dollar coverage (no cost sharing) of ACEi for beneficiaries with diabetes	Modeling study (Markov)	Health system + societal (3%)	Cost per QALY (2003 U.S. dollars)	ACEi savings per Medicare beneficiary: US$1,606
Palmer and others (2005) [17]	Spain	Type 2 diabetes, with microalbuminuria and hypertension	Irbesartan therapy + hypertension treatment vs. conventional hypertension treatment	Modeling study (Markov)	Health system (3%)	Decreased cost per patient (2000 euros)	Irbesartan: €11,082 Irbesartan (25 years): €14,038

Palmer and others (2007)	Hungary	Type 2 diabetes and microalbuminuria	Irbesartan therapy vs. placebo	Modeling study (Markov)	Health system (5%)	Savings per patient (2002 Hungarian forint)	Irbesartan: Ft 519,993 Irbesartan (25 years): Ft 1,250,204
Palmer, Valentine, and Ray (2007) [18]	United States	Type 2 diabetes and hypertension	Irbasartan (early and late initiation) vs. control	Modeling study (Markov)	Health system (3.5%)	Costs saved (2002 pounds)	Early vs. late: £2,310 Early vs. control: £3,801
Coyle and others (2007)	Canada	Type 2 diabetes and hypertension	Irbesartan (early and late initiation) vs. usual care	Modeling study (Markov)	Health system (5%)	Decreased treatment cost (2006 Canadian dollars)	Early vs. late Irbesartan: Can$54,100 Early vs. usual: Can$68,400
Adarkwah and others (2011)	Netherlands	Type 2 diabetes, newly diagnosed	ACEi: treating all type 2 diabetes patients at diagnosis vs. micro/macro-albuminuria screening	Modeling study (Markov decision model)	Health system (4%)	Cost of screening (2010 euros)	Macro: €110,777 Micro: €101,140 Treating all: €98,421
Kessler and others (2012)	Switzerland	Type 2 diabetes	Microalbuminuria screening intervals + hypertension treatment	Modeling study (microsimulation)	Health system (3.1%)	Cost per QALY (2010 Swiss francs)	2-year interval for type 2 diabetes: Sw F 54,000 5-year interval for hypertension (no type 2 diabetes): Sw F 33,000 Remaining population at 10-year interval: Sw F 34,000

Notes: All studies were conducted in clinical settings unless otherwise stated. If no currency year, it is not reported in the study. ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year; LYG = life-year gained; QALY = quality-adjusted life year; LYG = life-year gained; n = number in the study; ACEi = angiotensin converting enzyme inhibitor; ARB = angiotensin receptor blocker; ESRD = end-stage renal disease; DALY = disability-adjusted life year

References

1. Lohse, N., E. Marseille, and J.G. Kahn, *Development of a model to assess the cost-effectiveness of gestational diabetes mellitus screening and lifestyle change for the prevention of type 2 diabetes mellitus.* Int J Gynaecol Obstet, 2011. 115 Suppl 1: p. S20-5.
2. Irvine, L., et al., *Cost-effectiveness of a lifestyle intervention in preventing Type 2 diabetes.* Int J Technol Assess Health Care, 2011. 27(4): p. 275-82.
3. Segal, L., A.C. Dalton, and J. Richardson, *Cost-effectiveness of the primary prevention of non-insulin dependent diabetes mellitus.* Health Promotion International, 1998. 13(3): p. 197-210.
4. Gillett, M., et al., *Delivering the diabetes education and self management for ongoing and newly diagnosed (DESMOND) programme for people with newly diagnosed type 2 diabetes: cost effectiveness analysis.* BMJ, 2010. 341: p. c4093.
5. Brown, H.S., 3rd, et al., *Cost-effectiveness analysis of a community health worker intervention for low-income Hispanic adults with diabetes.* Prev Chronic Dis, 2012. 9: p. E140.
6. CDC, *Cost-effectiveness of intensive glycemic control, intensified hypertension control, and serum cholesterol level reduction for type 2 diabetes.* JAMA, 2002. 287(19): p. 2542-51.
7. Xie, X. and H. Vondeling, *Cost-utility analysis of intensive blood glucose control with metformin versus usual care in overweight type 2 diabetes mellitus patients in Beijing, P.R. China.* Value Health, 2008. 11 Suppl 1: p. S23-32.
8. UKPDS, *Cost effectiveness analysis of improved blood pressure control in hypertensive patients with type 2 diabetes: UKPDS 40. UK Prospective Diabetes Study Group.* BMJ, 1998. 317(7160): p. 720-6.
9. Jonsson, B., J.R. Cook, and T.R. Pedersen, *The cost-effectiveness of lipid lowering in patients with diabetes: results from the 4S trial.* Diabetologia, 1999. 42(11): p. 1293-301.
10. Annemans, L., et al., *Cost effectiveness of atorvastatin in patients with type 2 diabetes mellitus: a pharmacoeconomic analysis of the collaborative atorvastatin diabetes study in the belgian population.* Clin Drug Investig, 2010. 30(2): p. 133-42.
11. Sorensen, S.V., et al., *Model-based simulation to explore the cost-effectiveness of following practice guidelines for triglyceride and low-density lipoprotein cholesterol control among patients with diabetes mellitus and mixed dyslipidemia.* Clin Ther, 2009. 31(4): p. 862-79.
12. Ortegon, M.M., W.K. Redekop, and L.W. Niessen, *Cost-effectiveness of prevention and treatment of the diabetic foot: a Markov analysis.* Diabetes Care, 2004. 27(4): p. 901-7.
13. Ragnarson Tennvall, G. and J. Apelqvist, *Prevention of diabetes-related foot ulcers and amputations: a cost-utility analysis based on Markov model simulations.* Diabetologia, 2001. 44(11): p. 2077-87.
14. Szucs, T.D., M.S. Sandoz, and G.W. Keusch, *The cost-effectiveness of losartan in type 2 diabetics with nephropathy in Switzerland--an analysis of the RENAAL study.* Swiss Med Wkly, 2004. 134(31-32): p. 440-7.
15. Palmer, A.J., et al., *An economic evaluation of the Irbesartan in Diabetic Nephropathy Trial (IDNT) in a UK setting.* J Hum Hypertens, 2004. 18(10): p. 733-8.
16. Palmer, A.J., et al., *Cost-effectiveness of early irbesartan treatment versus control (standard antihypertensive medications excluding ACE inhibitors, other angiotensin-2 receptor antagonists, and dihydropyridine calcium channel blockers) or late irbesartan treatment in patients with type 2 diabetes, hypertension, and renal disease.* Diabetes Care, 2004. 27(8): p. 1897-903.

17. Palmer, A.J., et al., *Irbesartan is projected to be cost and life saving in a Spanish setting for treatment of patients with type 2 diabetes, hypertension, and microalbuminuria.* Kidney Int Suppl, 2005(93): p. S52-4.
18. Palmer, A.J., W.J. Valentine, and J.A. Ray, *Irbesartan treatment of patients with type 2 diabetes, hypertension and renal disease: a UK health economics analysis.* Int J Clin Pract, 2007. 61(10): p. 1626-33.