Effectiveness and cost-effectiveness of cardiovascular disease prevention in whole populations: modelling study

Barton et al

APPENDICES

APPENDIX A
CVD event types and additional mortality in first and subsequent years for a 65-year-old man

APPENDIX B
CVD event types – costs and quality of life effects for a 65-year-old man

APPENDIX C
CVD events – Discounted effects for a 65-year-old man

APPENDIX D
Discounted results for 65-year-old men, according to baseline 10 year CVD risk

APPENDIX E
Discounted estimates of effects for an intervention with relative risk reduction of 10%

APPENDIX F
Discounted estimates of total England and Wales population effects for an intervention with relative risk reduction of 10% sustained over 10 years

APPENDIX G
Maximum acceptable cost (£million per programme) for intervention with given relative risk

APPENDIX H
Maximum acceptable cost (£million per programme) for intervention with given percentage reduction in systolic blood pressure

APPENDIX I
Maximum acceptable cost (£million per programme) for intervention with given percentage reduction in cholesterol

APPENDIX J
Estimated outcomes following a first CVD event.

Appendix K
Estimated outcomes for women experiencing a primary CVD event

APPENDIX L
Population estimates for England and Wales: numbers eligible for primary prevention

APPENDIX M
Illustrative calculations for 65-year-old male with a 12.5% 10-year CVD risk

APPENDIX N
Undiscounted outcomes for 65-year-old male with a 12.5% 10-year CVD risk

APPENDIX O
Discounted outcomes for 65-year-old male with a 12.5% 10-year CVD risk

APPENDIX P.
LIFE EXPECTANCY CALCULATIONS

APPENDIX Q..
SENSITIVITY ANALYSIS: Discounted outcomes for an intervention achieving a given relative risk reduction sustained over 10 years (all background risks INCREASED by 5%)

APPENDIX R
SENSITIVITY ANALYSIS: Discounted outcomes for an intervention achieving a given relative risk reduction sustained over 10 years (all background risks multiplied by 1.5)

APPENDIX S
SENSITIVITY ANALYSIS: Discounted outcomes for an intervention achieving a given relative risk reduction sustained over 10 years (all background risks REDUCED by 5%)

APPENDIX T
SENSITIVITY ANALYSIS: Discounted outcomes for an intervention achieving a given relative risk reduction sustained over 10 years (all background risks multiplied by 0.5, ie halved)

APPENDIX U
Principles of the ScHARR model incorporated into this modelling.

Effectiveness and cost-effectiveness of cardiovascular disease prevention in whole populations: modelling study

Pelham Barton, Lazaros Andronis, Andrew Briggs, Klim McPherson, Simon Capewell

APPENDICES

Appendix A

CVD event types and additional mortality in first and subsequent years for a 65-year-old man

Event type	Proportion	Additional mortality	
		First year	Later years
Stable Angina	0.214	0.0070	0.0070
Unstable Angina	0.083	0.1077	0.0124
Myocardial Infarction	0.173	0.0626	0.0159
Fatal CHD	0.097	0	0
TIA	0.100	0.0348	0.0348
Stroke	0.270	0.0520	0.0208
Fatal CVD (ex CHD)	0.063	0	0

Sources: Ward et al (2005), pages 138, 142.

Appendix B

CVD event types – costs and quality of life effects for a 65-year-old man

Event type	Proportion	Costs following event		QoL following event
		First year	Later yrs	
Stable Angina	0.214	£232	£232	0.808
Unstable Angina	0.083	£541	£232	0.770
Myocardial Infarction	0.173	£5,244	£232	0.760
Fatal CHD	0.097	£1,341	0	0
TIA	0.100	£1,224	£304	1.000
Stroke	0.270	£9,259	£2,489	0.629
Fatal CVD (ex CHD)	0.063	£8,102	0	0

Sources: Ward et al (2005), pages 146, 153. Costs following event have been inflated to 2008, except where GP contact costs have been identified, in which case the updated PSSRU cost has been used.

Appendix C

CVD events – Discounted effects for a 65-year-old man

Event type	Proportion	Life Years lost	QALY lost	Lifetime costs
Stable Angina	0.214	0.76	2.12	£2,338
Unstable Angina	0.083	1.91	3.11	£2,380
Myocardial Infarction	0.173	1.89	3.17	£7,088
Fatal CHD	0.097	10.84	8.50	£1,341
TIA	0.100	2.97	2.33	£3,313
Stroke	0.270	2.19	4.16	£28,307
Fatal CVD (ex CHD)	0.063	10.84	8.50	£8,102
Overall	1.00	3.27	4.00	£10,539

Appendix D

Discounted results for 65-year-old men, according to baseline 10 year CVD risk

10-year risk	proportion	Cases prevented	Deaths prevented	Life Years gained	QALY gain	Cost saved
0.075	0.010	0.00551	0.00083	0.0164	0.0193	£56
0.125	0.088	0.00906	0.00138	0.0271	0.0319	£92
0.175	0.197	0.01251	0.00191	0.0376	0.0444	£127
0.225	0.223	0.01579	0.00242	0.0477	0.0564	£160
0.275	0.153	0.01892	0.00291	0.0573	0.0681	£192
0.325	0.329	0.02189	0.00339	0.0666	0.0793	£223
Overall		**0.0169**	**0.0026**	**0.051**	**0.061**	**£172**

Appendix E

Discounted estimates of effects for an intervention with relative risk reduction of 10%

for age groups between 40 and 79 years, both men and women

Per 1000	Cases prevented	Deaths prevented	LY gain	QALY gain	Savings
Males 40-49	**7.67**	**0.90**	**21.5**	**36.0**	**£82,000**
Males 50-59	**12.30**	**1.79**	**39.5**	**53.4**	**£133,000**
Males 60-69	**16.94**	**2.61**	**51.3**	**60.8**	**£172,000**
Males 70-79	**18.24**	**2.58**	**40.5**	**44.6**	**£158,000**
Females 40-49	**6.40**	**0.63**	**17.3**	**30.3**	**£77,000**
Females 50-59	**7.82**	**1.08**	**27.1**	**37.4**	**£95,000**
Females 60-69	**10.81**	**1.76**	**39.1**	**45.5**	**£124,000**
Females 70-79	**13.40**	**2.01**	**37.7**	**39.5**	**£130,000**

Appendix F

Discounted estimates of total England and Wales population effects for an intervention with relative risk reduction of 10% sustained over 10 years

	000s of cases prevented	000s of deaths prevented	000s of Life Years gained	000s of QALYs gained	Total savings £millions	Annual equivalent savings (£millions)
Males 40-49	30	3.5	84	140	319	**37**
Males 50-59	39	5.7	126	170	423	**49**
Males 60-69	43	6.7	131	156	441	**51**
Males 70-79	30	4.3	68	75	264	**31**
Females 40-49	26	2.5	69	121	307	**36**
Females 50-59	26	3.6	90	124	314	**36**
Females 60-69	30	4.8	108	125	343	**40**
Females 70-79	27	4.1	76	80	262	**30**
Totals	**251**	**35.2**	**751**	**990**	**2671**	**310**

Apparent anomalies with the addition are due to rounding effects

Appendix G Maximum acceptable cost (£million per programme) for intervention with given relative risk

Relative risk	For cost saving		For £20,000/QALY		For £30,000/QALY	
	one-off	*annual*	*one-off*	*annual*	*one-off*	*annual*
0.999	26	3	223	26	321	37
0.995	132	15	1115	130	1607	187
0.99	265	31	2231	259	3214	373
0.98	530	62	4466	519	6434	747
0.97	796	93	6705	779	9659	1122
0.96	1063	123	8947	1039	12890	1497
0.95	1330	154	11193	1300	16125	1873
0.94	1597	186	13443	1562	19366	2250
0.93	1865	217	15697	1824	22613	2627
0.92	2133	248	17954	2086	25865	3005
0.91	2402	279	20215	2349	29122	3383
0.9	2671	310	22480	2612	32385	3762
0.85	4024	467	33862	3934	48780	5667
0.8	5389	626	45338	5267	65313	7588
0.75	6766	786	56911	6612	81984	9524
0.7	8155	947	68582	7967	98795	11477
0.65	9557	1110	80350	9335	115747	13447
0.6	10971	1275	92218	10713	132842	15433
0.55	12397	1440	104187	12104	150081	17436
0.5	13836	1607	116256	13506	167466	19455

Appendix H

Maximum acceptable cost (£million per programme) for intervention with given percentage reduction in systolic blood pressure

Percentage reduction in SBP	Equivalent salt reduction (g/day)	For cost saving		For £20,000/QALY		For £30,000/QALY	
		one-off	annual	one-off	annual	one-off	annual
0.5	0.75	86	10	737	86	1062	**123**
1	1.5	173	20	1476	172	2128	**247**
1.5	2.25	260	30	2218	258	3197	**371**
2	3	347	40	2962	344	4269	**496**
2.5	3.75	435	50	3708	431	5344	**621**
3	4.5	522	61	4456	518	6423	**746**
3.5	5.25	610	71	5207	605	7505	**872**
4	6	699	81	5960	692	8590	**998**
4.5	6.75	787	91	6715	780	9679	**1124**
5	7.5	876	102	7473	868	10771	**1251**

Appendix I

Maximum acceptable cost (£million per programme) for intervention with given percentage reduction in cholesterol

Percentage reduction in cholesterol	For cost saving		For £20,000/QALY		For £30,000/QALY	
	one-off	annual	one-off	one-off	annual	one-off
0.5	68	8	581	67	837	97
1	136	16	1163	135	1676	195
1.5	205	24	1748	203	2519	293
2	274	32	2334	271	3365	391
2.5	343	40	2923	340	4213	489
3	412	48	3514	408	5065	588
3.5	481	56	4106	477	5919	688
4	551	64	4701	546	6776	787
4.5	621	72	5298	616	7637	887
5	691	80	5897	685	8501	988

APPENDIX J

Estimated outcomes following a first CVD event

Estimated results for men for the outcomes expected from a primary CVD event at any given age. (A brief explanation is provided in the Methods section).

Estimated outcomes for men experiencing a primary CVD event

		Undiscounted			Discounted		
Age	Deaths	Cost	LY lost	QALY lost	Cost	LY lost	QALY lost
40	0.101	19706	8.6372	13.7326	10629	2.6403	9.6878
41	0.101	19351	8.3430	13.2795	10552	2.6048	9.5464
42	0.101	18994	8.0523	12.8326	10473	2.5685	9.4031
43	0.101	18639	7.7683	12.3958	10392	2.5317	9.2589
44	0.101	18281	7.4879	11.9651	10309	2.4940	9.1127
45	0.101	17921	7.2112	11.5404	10223	2.4554	8.9644
46	0.101	17563	6.9410	11.1255	10135	2.4163	8.8150
47	0.101	17202	6.6744	10.7166	10045	2.3763	8.6635
48	0.101	16844	6.4144	10.3174	9953	2.3357	8.5108
49	0.101	16487	6.1608	9.9277	9859	2.2945	8.3570
50	0.134	18404	9.0444	11.6798	11512	3.3684	7.4314
51	0.134	18037	8.6665	11.2039	11398	3.3018	7.2940
52	0.134	17668	8.2980	10.7402	11280	3.2344	7.1554
53	0.134	17295	7.9347	10.2840	11159	3.1653	7.0144
54	0.134	16922	7.5809	9.8398	11034	3.0954	6.8720
55	0.134	16544	7.2325	9.4031	10905	3.0238	6.7270
56	0.134	16170	6.8973	8.9825	10775	2.9522	6.5818
57	0.134	15791	6.5674	8.5691	10640	2.8788	6.4339
58	0.134	15412	6.2467	8.1671	10501	2.8045	6.2845
59	0.134	15029	5.9314	7.7723	10358	2.7284	6.1321
60	0.160	15226	8.3164	9.1996	11297	3.8560	5.1415
61	0.160	14900	7.8775	8.7258	11151	3.7397	5.0158
62	0.160	14579	7.4611	8.2759	11005	3.6250	4.8909
63	0.160	14250	7.0515	7.8344	10853	3.5076	4.7632
64	0.160	13923	6.6588	7.4111	10698	3.3907	4.6352
65	0.160	13593	6.2778	7.0007	10539	3.2727	4.5055
66	0.160	13265	5.9134	6.6079	10377	3.1554	4.3755
67	0.160	12930	5.5556	6.2228	10209	3.0356	4.2425
68	0.160	12596	5.2140	5.8548	10038	2.9166	4.1093
69	0.160	12260	4.8837	5.4988	9862	2.7969	3.9743
70	0.143	12152	5.5870	5.8086	10310	3.2301	3.4617
71	0.143	11873	5.2089	5.4314	10142	3.0812	3.3425
72	0.143	11596	4.8540	5.0767	9973	2.9361	3.2246
73	0.143	11315	4.5114	4.7344	9798	2.7907	3.1050
74	0.143	11034	4.1861	4.4089	9620	2.6474	2.9853
75	0.143	10757	3.8828	4.1045	9442	2.5089	2.8675
76	0.143	10477	3.5909	3.8113	9258	2.3708	2.7482
77	0.143	10197	3.3153	3.5338	9072	2.2356	2.6294
78	0.143	9924	3.0601	3.2758	8888	2.1061	2.5131
79	0.143	9653	2.8200	3.0323	8702	1.9801	2.3978
80	0.137	8372	3.2050	3.1524	7808	2.3017	2.0231

		Undiscounted			Discounted		
Age	Deaths	Cost	LY lost	QALY lost	Cost	LY lost	QALY lost
81	0.137	8193	2.9583	2.9175	7673	2.1622	1.9269
82	0.137	8015	2.7267	2.6966	7537	2.0274	1.8320
83	0.137	7843	2.5149	2.4937	7404	1.9005	1.7408
84	0.137	7673	2.3172	2.3040	7271	1.7789	1.6517
85	0.137	7510	2.1380	2.1311	7142	1.6657	1.5668
86	0.137	7346	1.9672	1.9662	7012	1.5551	1.4824
87	0.137	7176	1.8001	1.8050	6875	1.4442	1.3965
88	0.137	7006	1.6412	1.6514	6736	1.3360	1.3110
89	0.137	6830	1.4862	1.5014	6590	1.2278	1.2239
90	0.137	6700	1.3778	1.3939	6482	1.1504	1.1586

Appendix K

Estimated outcomes for women experiencing a primary CVD event

Estimated results for women for the outcomes expected from a primary CVD event at any given age.

		Undiscounted			Discounted		
Age	Deaths	Cost	LY lost	QALY lost	Cost	LY lost	QALY lost
40	0.091	24973	8.9440	14.2751	12359	2.5067	5.0150
41	0.091	24534	8.6544	13.8265	12271	2.4764	4.9400
42	0.091	24092	8.3682	13.3838	12181	2.4454	4.8641
43	0.091	23652	8.0885	12.9510	12090	2.4140	4.7880
44	0.091	23209	7.8121	12.5241	11995	2.3818	4.7110
45	0.091	22763	7.5392	12.1031	11898	2.3489	4.6332
46	0.091	22320	7.2726	11.6917	11799	2.3156	4.5550
47	0.091	21868	7.0067	11.2824	11696	2.2811	4.4752
48	0.091	21423	6.7498	10.8862	11592	2.2466	4.3957
49	0.091	20976	6.4964	10.4958	11485	2.2112	4.3153
50	0.106	21101	9.7704	12.9985	12581	3.2153	5.2003
51	0.106	20708	9.3773	12.4964	12467	3.1570	5.0959
52	0.106	20315	8.9937	12.0069	12350	3.0980	4.9911
53	0.106	19917	8.6157	11.5252	12230	3.0376	4.8849
54	0.106	19514	8.2431	11.0512	12105	2.9757	4.7773
55	0.106	19110	7.8802	10.5895	11977	2.9131	4.6692
56	0.106	18700	7.5229	10.1354	11845	2.8490	4.5597
57	0.106	18295	7.1791	9.6978	11712	2.7848	4.4506
58	0.106	17879	6.8370	9.2633	11572	2.7184	4.3390
59	0.106	17463	6.5045	8.8407	11428	2.6511	4.2268
60	0.171	17915	10.2543	11.2387	12853	4.4055	5.4347
61	0.171	17564	9.7532	10.7006	12705	4.2890	5.2815
62	0.171	17212	9.2705	10.1825	12554	4.1722	5.1291
63	0.171	16853	8.7946	9.6733	12397	4.0527	4.9744
64	0.171	16493	8.3369	9.1836	12237	3.9330	4.8205
65	0.171	16125	7.8862	8.7026	12070	3.8105	4.6643
66	0.171	15754	7.4481	8.2355	11898	3.6866	4.5075
67	0.171	15377	7.0226	7.7821	11721	3.5612	4.3500
68	0.171	14997	6.6095	7.3423	11538	3.4345	4.1919
69	0.171	14613	6.2089	6.9159	11349	3.3065	4.0331
70	0.152	13882	7.4244	7.4120	11536	4.0009	4.3511
71	0.152	13586	6.9456	6.9501	11364	3.8320	4.1671

		Undiscounted			Discounted		
Age	Deaths	Cost	LY lost	QALY lost	Cost	LY lost	QALY lost
72	0.152	13288	6.4870	6.5080	11188	3.6638	3.9848
73	0.152	12982	6.0425	6.0800	11005	3.4943	3.8022
74	0.152	12674	5.6180	5.6713	10818	3.3261	3.6216
75	0.152	12363	5.2133	5.2815	10625	3.1593	3.4433
76	0.152	12050	4.8280	4.9100	10429	2.9944	3.2674
77	0.152	11735	4.4618	4.5566	10228	2.8316	3.0942
78	0.152	11419	4.1144	4.2208	10022	2.6712	2.9239
79	0.152	11102	3.7856	3.9022	9813	2.5135	2.7569
80	0.147	9675	4.4439	4.0962	8925	3.0384	2.9440
81	0.147	9466	4.0876	3.7784	8770	2.8511	2.7652
82	0.147	9254	3.7506	3.4777	8612	2.6679	2.5909
83	0.147	9040	3.4325	3.1938	8449	2.4893	2.4212
84	0.147	8833	3.1446	2.9359	8290	2.3224	2.2624
85	0.147	8621	2.8687	2.6887	8125	2.1576	2.1060
86	0.147	8413	2.6159	2.4615	7962	2.0020	1.9581
87	0.147	8201	2.3746	2.2444	7793	1.8491	1.8130
88	0.147	7990	2.1500	2.0417	7623	1.7026	1.6739
89	0.147	7780	1.9415	1.8529	7452	1.5628	1.5411
90	0.147	7595	1.7688	1.6946	7300	1.4440	1.4269

Appendix L

Population estimates for England and Wales: numbers eligible for primary prevention

	Population in 000s	CVD prevalence per 1000	CVD free population in 000s
Males 40-49	3927	7.2	3898
Males 50-59	3257	23.2	3181
Males 60-69	2659	36.1	2563
Males 70-79	1748	44.2	1671
Females 40-49	3996	3.04	3983
Females 50-59	3346	11.0	3309
Females 60-69	2815	21.4	2754
Females 70-79	2090	34.7	2018

APPENDIX M

Illustrative calculations for 65-year-old male with a 12.5% 10-year CVD risk

Table (i) shows the calculations for a 65-year-old man with a 10-year CVD risk of 12.5%. The intervention is assumed to have a relative risk of 0.9 for each of the 10 years modelled.

Table i CVD events over 10 years for 65-year-old male with 12.5% 10-year risk

		no intervention		intervention		undiscounted	discounted
Age	OC death	risk CVD	CVD free	risk CVD	CVD free	cas prev	cas prev
A	B	C	D	E	F	G	H
65	0.00791	0.00819	0.98396	0.00737	0.98477	0.00081	0.00081
66	0.00844	0.01074	0.96518	0.00967	0.96703	0.00103	0.00100
67	0.00911	0.01197	0.94493	0.01077	0.94789	0.00111	0.00103
68	0.00989	0.01285	0.92356	0.01156	0.92766	0.00114	0.00103
69	0.01052	0.01354	0.90147	0.01219	0.90671	0.00115	0.00100
70	0.01121	0.01412	0.87878	0.01271	0.88515	0.00113	0.00095
71	0.01242	0.01462	0.85518	0.01316	0.86266	0.00111	0.00090
72	0.01341	0.01506	0.83100	0.01356	0.83955	0.00107	0.00084
73	0.01428	0.01546	0.80647	0.01392	0.81605	0.00103	0.00078
74	0.01553	0.01582	0.78138	0.01424	0.79194	0.00097	0.00071
					totals	0.01055	0.00906

Column A simply shows the age at the start of each year. Column B gives the risk of other causes death in the year, defined as the probability of other causes death conditional on survival to the start of the year. Yearly all-cause death rates have been adjusted for the proportion of CVD deaths to obtain this estimate. Column C is the assumed risk profile in the absence of an intervention, so that (for example) someone who has survived to age 70 without a CVD event has a probability of 0.01412 of a first CVD event in the next year. This is obtained from applying the algorithm of Anderson et al (1991). Column D gives the probability of CVD-free survival to the end of each year. It is calculated by a formula such as $D_{67} = (1 - B_{67})(1 - C_{67})D_{66}$, where D_{67} represents the entry in column D on the row for age 67, and so on. In other words, the CVD-free survival is multiplied each year by two factors, one representing other cause death and a second representing first CVD event. The multiplicative formula allows appropriately for competing risks. Column E is simply calculated as $E_{65} = 0.9C_{65}$, and so on, showing the intervention effect. Then column F is calculated as $F_{67} = (1 - B_{67})(1 - E_{67})F_{66}$, by analogy with column D. Next, the estimated cases prevented each year are calculated by a formula such as $G_{67} = (D_{66} - D_{67}) - (F_{66} - F_{67})$.

Finally, column H gives the discounted figure from column G at a rate of 3.5% as required by NICE. For example, $H_{67} = G_{67} / (1.035^2)$.

For the alternative risk-factor modification version of the model, the annual risk of CVD in column E is calculated directly from the modified risk equation instead of working in terms of column C.

APPENDIX N

Undiscounted outcomes for 65-year-old male with a 12.5% 10-year CVD risk

Undiscounted outcomes for 65-year-old male with a 12.5% 10-year CVD risk

Age	Cases prevented	Deaths prevented	LY gain	QALY gain	Cost saved
65	0.00081	0.00013	0.0051	0.0057	11
66	0.00103	0.00017	0.0061	0.0068	14
67	0.00111	0.00018	0.0062	0.0069	14
68	0.00114	0.00018	0.0059	0.0067	14
69	0.00115	0.00018	0.0056	0.0063	14
70	0.00113	0.00016	0.0063	0.0066	14
71	0.00111	0.00016	0.0058	0.0060	13
72	0.00107	0.00015	0.0052	0.0054	12
73	0.00103	0.00015	0.0046	0.0049	12
74	0.00097	0.00014	0.0041	0.0043	11
Totals	0.01055	0.00160	0.0549	0.0596	129

APPENDIX O

Discounted outcomes for 65-year-old male with a 12.5% 10-year CVD risk

Discounted outcomes for 65-year-old male with a 12.5% 10-year CVD risk

Age	Cases prevented	Deaths prevented	LY gain	QALY gain	Cost saved
65	0.00081	0.00013	0.0027	0.0032	9
66	0.00100	0.00016	0.0031	0.0038	10
67	0.00103	0.00017	0.0031	0.0038	11
68	0.00103	0.00016	0.0030	0.0036	10
69	0.00100	0.00016	0.0028	0.0034	10
70	0.00095	0.00014	0.0031	0.0035	10
71	0.00090	0.00013	0.0028	0.0031	9
72	0.00084	0.00012	0.0025	0.0028	8
73	0.00078	0.00011	0.0022	0.0025	8
74	0.00071	0.00010	0.0019	0.0021	7
Totals	0.00906	0.00138	0.0271	0.0319	92

APPENDIX P.

LIFE EXPECTANCY CALCULATIONS

Suppose an individual has an annual risk of mortality λ. Then the probability of survival at time *t* is $e^{-\lambda t}$, so the life expectancy is $\int_0^\infty e^{-\lambda t}dt = \left[\frac{-1}{\lambda}e^{-\lambda t}\right]_0^\infty = \frac{1}{\lambda}$. Thus a known life expectancy can be approximated by an annual risk equal to the reciprocal of the life expectancy.

Now suppose the individual has additional mortality μ in the first year and *v* in subsequent years. Then the life expectancy can be approximated as

$$\int_0^1 e^{-(\lambda+\mu)t}dt + \int_1^\infty e^{-(\lambda+\mu)}e^{-(\lambda+\nu)(t-1)}dt = \frac{1-e^{-(\lambda+\mu)}}{\lambda+\mu} + \frac{e^{-(\lambda+\mu)}}{\lambda+\nu} = \frac{\lambda+\nu+e^{-(\lambda+\mu)}(\mu-\nu)}{(\lambda+\mu)(\lambda+\nu)}.$$

Now $e^{-(\lambda+\mu)} \approx 1-(\lambda+\mu)$, so the life expectancy can be approximated by

$$\frac{\lambda+\nu+(1-\lambda-\mu)(\mu-\nu)}{(\lambda+\mu)(\lambda+\nu)} = \frac{\lambda+\nu+\mu-\nu-\lambda\mu+\lambda\nu-\mu^2+\mu\nu}{(\lambda+\mu)(\lambda+\nu)}$$

$$= \frac{\lambda+\mu+\lambda\nu+\mu\nu-\lambda\mu-\mu^2}{(\lambda+\mu)(\lambda+\nu)} = \frac{(\lambda+\mu)(1+\nu-\mu)}{(\lambda+\mu)(\lambda+\nu)} = \frac{(1+\nu-\mu)}{(\lambda+\nu)}.$$

This is the formula used to estimate the life expectancy following a particular CVD event.

For discounted life expectancy, note that applying an annual discount rate of ρ effectively multiplies the value of survival at time *t* by $e^{-\rho t}$. Thus if the undiscounted life expectancy is $\frac{1}{\lambda}$, then the discounted life expectancy may be approximated by $\int_0^\infty e^{-\lambda t}e^{-\rho tt}dt = \frac{1}{\lambda+\rho}$.

The approximations used in developing these formulae are well within the range of reasonable modelling approximations given the assumptions made in other parts of the model.

SENSITIVITY ANALYSES

APPENDIX Q..

SENSITIVITY ANALYSIS: Discounted outcomes for an intervention achieving a given relative risk reduction sustained over 10 years (all background risks INCREASED by 5%)

Relative risk reduction	Cases prevented (000)	Deaths prevented (000)	Life years gained (000)	QALYs gained (000)	Total savings (£millions)	Annual equivalent savings (£millions)
0.001	3	0.5	10	13	35	4
0.005	16	2.3	49	66	177	15
0.01	33	4.5	98	133	354	41
0.02	66	9.1	197	266	708	82
0.03	99	14	296	399	1064	124
0.04	132	18	395	533	1420	165
0.05	165	23	494	666	1776	206
0.06	199	27	594	800	2134	248
0.07	232	32	694	935	2492	290
0.08	265	37	793	1069	2851	331
0.09	299	41	894	1204	3211	373
0.1	333	46	994	1340	3572	415
0.15	502	69	1500	2020	5387	626
0.2	673	93	2011	2707	7222	839
0.25	846	117	2528	3401	9076	1054
0.3	1021	141	3051	4103	10951	1272
0.35	1198	165	3579	4811	12846	1492
0.4	1377	190	4114	5527	14762	1715
0.45	1558	215	4655	6251	16698	1940
0.5	1741	241	5202	6982	18656	2167

APPENDIX R

SENSITIVITY ANALYSIS: Discounted outcomes for an intervention achieving a given relative risk reduction sustained over 10 years (all background risks multiplied by 1.5)

Relative risk reduction	Cases prevented (000)	Deaths prevented (000)	Life years gained (000)	QALYs gained (000)	Total savings (£millions)	Annual equivalent savings (£millions)
0.001	4	0.5	11	14	38	4
0.005	18	2.5	53	71	191	15
0.01	36	5.0	107	143	382	44
0.02	71	10.0	214	286	766	89
0.03	107	15	322	429	1150	134
0.04	143	20	429	573	1536	178
0.05	179	25	537	717	1923	223
0.06	216	30	646	862	2310	268
0.07	252	35	755	1007	2699	314
0.08	288	40	864	1152	3089	359
0.09	325	45	973	1298	3480	404
0.1	362	50	1083	1444	3872	450
0.15	547	76	1636	2181	5850	680
0.2	734	103	2198	2927	7855	913
0.25	925	129	2767	3684	9889	1149
0.3	1118	156	3346	4451	11953	1389
0.35	1315	184	3933	5228	14046	1632
0.4	1514	212	4528	6015	16169	1878
0.45	1717	240	5133	6814	18322	2129
0.5	1922	269	5747	7623	20507	2382

APPENDIX S

SENSITIVITY ANALYSIS: Discounted outcomes for an intervention achieving a given relative risk reduction sustained over 10 years (all background risks REDUCED by 5%)

Relative risk reduction	Cases prevented	Deaths prevented	Life years gained	QALYs gained	Total savings	Annual equivalent savings
	(000)	(000)	(000)	(000)	(£millions)	(£millions)
0.001	2	0.2	5	6	17	2
0.005	8	1.2	25	31	86	15
0.01	17	2.4	49	63	172	20
0.02	33	4.8	98	125	345	40
0.03	50	7	148	188	518	60
0.04	66	10	197	251	691	80
0.05	83	12	247	313	864	100
0.06	100	14	296	376	1038	121
0.07	116	17	346	439	1212	141
0.08	133	19	396	503	1386	161
0.09	150	22	446	566	1560	181
0.1	166	24	495	629	1735	202
0.15	251	36	746	947	2612	303
0.2	336	48	999	1267	3496	406
0.25	421	61	1253	1589	4387	510
0.3	507	73	1509	1914	5284	614
0.35	594	85	1768	2241	6188	719
0.4	682	98	2028	2570	7099	825
0.45	771	111	2291	2902	8017	931
0.5	860	124	2555	3236	8942	1039

APPENDIX T

SENSITIVITY ANALYSIS: Discounted outcomes for an intervention achieving a given relative risk reduction sustained over 10 years (all background risks multiplied by 0.5, ie halved)

Relative risk reduction	Cases prevented (000)	Deaths prevented (000)	Life years gained (000)	QALYs gained (000)	Total savings (£millions)	Annual equivalent savings (£millions)
0.001	1	0.2	4	5	14	2
0.005	7	0.9	19	25	69	15
0.01	13	1.8	39	51	138	16
0.02	26	3.7	78	102	275	32
0.03	39	5	117	153	413	48
0.04	52	7	156	204	551	64
0.05	65	9	195	255	689	80
0.06	78	11	234	306	827	96
0.07	91	13	273	357	966	112
0.08	104	15	312	408	1104	128
0.09	117	17	352	459	1243	144
0.1	131	18	391	510	1381	160
0.15	196	28	588	767	2076	241
0.2	262	37	785	1024	2774	322
0.25	329	46	983	1283	3475	404
0.3	395	56	1183	1542	4178	485
0.35	462	65	1383	1803	4885	567
0.4	529	74	1584	2064	5594	650
0.45	597	84	1785	2327	6306	733
0.5	664	93	1988	2590	7021	816

APPENDIX U

Principles of the ScHARR model incorporated into this modelling

Primary CVD events can be classified as:

- Stable angina
- Unstable angina
- Myocardial infarction (non fatal)
- Fatal Coronary Heart Disease
- Transient Ischaemic Attack
- Stroke (non fatal)
- Fatal CVD (excluding CHD)

The proportion of each type of event depends on age and sex.

For each type of non-fatal event, there is an additional annual mortality and an appropriate reduction in quality of life for survivors. There is also an immediate cost of treatment and an expected annual cost of maintenance therapy (including secondary prevention) for survivors.

Using data published in the ScHARR model report, we estimated the discounted quality adjusted life expectancy and lifetime costs following each type of non-fatal event, as a function of age and sex. Comparing these with the discounted quality adjusted life expectancy in the absence of a primary CVD event, we were able to estimate the cost saving and QALY gain for each event prevented, also as a function of age and sex.

The quality of life data used in the model for each type of non-fatal event were as follows:

Event type	QoL following event
Stable Angina	0.808
Unstable Angina	0.770
Myocardial Infarction	0.760
TIA	1.000
Stroke	0.629

Source: Ward *et al* [16], p. 153
http://www.nice.org.uk/nicemedia/live/11563/33142/33142.pdf

These were taken as multipliers for population quality of life data as follows:

Age	Population norm for quality of life
45	0.869
50	0.848
55	0.826
60	0.805
65	0.784
70	0.763
75	0.741
80	0.72
85	0.699
90	0.678

Source: Ward *et al* [16], p. 151
http://www.nice.org.uk/nicemedia/live/11563/33142/33142.pdf