Future sight loss UK (2): An epidemiological and economic model for sight loss in the decade 2010-2020

Full report

Report prepared for RNIB

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RNIB supporting blind and partially sighted people

EpiVision

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Advisory Committee

Executive Summary

Future Sight Loss in the Decade 2010 to 2020

An Epidemiological and Economic Model

This work was commissioned by the Royal National Institute of Blind People.

Commissioned Brief

The brief was that epidemiologists experienced in the area of ophthalmic research should apply the best methods to derive estimates of the numbers of persons that were likely to have Age-related macular Disease, Cataract, Diabetic Retinopathy and Glaucoma at two points in time 2010 and 2020. The baseline and cumulative costs to society of the prevailing health and social care provision and support in that time frame were to be estimated by an economist with experience of Ophthalmic research using a cost of illness approach from the societal perspective. A committee composed of clinical and academic members would have an advisory role.

The epidemiological and economic findings would provide estimates available to inform the UK Vision strategy up to 2020.

Structure of this Report

As this is a working document to inform the strategy, it is structured to allow each eye disease to stand alone for the estimated numbers and the related costs of the resources. Apart from notes which explain some basic terms, methods are presented in Appendices, as are the additional epidemiological tables for the prevalence of disease by age and sex for the year.

The report has an Executive Summary, four main Parts 1-4, one for each disease, and Appendices 1-3 which hold prevalence tables by age group and gender, and sections on methods for epidemiology and costing.

Within the main Parts, the epidemiological estimates of numbers for each disease and for the categories of that disease are given as Section 1. This covers a Decade, for the year 2010 (the base year), 2015 and 2020, for the UK and the “devolved countries “.

Section 2 presents the estimated costs to society of the resources used in health and social service and in providing informal care. All are directly related to the provision of care for those with, or at serious risk of, sight loss from the relevant eye disease.

These estimates and projections are made within the requirements of the initial brief that the recognised / recommended treatment for those diseases, forms the clinical basis for disease progression. This requires assumptions to be made at times about the rate of coverage of treatment and if these are varied in the model they are found in Section 3 of the relevant part of the report.

In this report, Partial Sight is defined as corrected visual acuity </612-6/60 in the better seeing eye. Blindness is defined as corrected visual acuity < 6/60 in the better seeing eye. The term ‘Sight Loss’ is used to indicate partial sight or blindness. For glaucoma, the definitions also take into account severe restriction of visual fields.

Key Findings

Age-related Macular Degeneration (AMD)

	year 2010	year 2020
Population at risk, UK	**21,585,853**	**25,332,332**

Persons with this disease are grouped here into early AMD, Neovascular AMD (wet) and Geographic atrophy (dry), and analysed further by those partially sighted and those blind from the disease.

Numbers with the disease

- 1,493,963 persons are estimated to have early AMD in 2010. By the end of the decade this is projected to be 1,821,434.
- Additionally, 414,561 in 2010 are estimated to have Neovascular AMD (wet) in one or both eyes and this will increase to 515,509 in 2020
- Apart from Neovascular AMD, 193,652 are estimated to have Geographic Atrophy (dry AMD) only in one or both eyes in 2010, increasing to 240,358 in 2020.

Sight Loss from both types of AMD.

In 2010 caused by both types of AMD, 132,970 will be partially sighted and 90,254 will be blind. This is assuming that the new treatment for Neovascular AMD covers 75% of those eligible from year 2010.

In 2020 the numbers expected to be partially sighted are 171,530, and 120,452 are expected to be blind. This is under the same assumption of 75% of Neovascular AMD treated, but allows for the increase in overall numbers of older persons in the population.

Cost

More than **£1.6 billion** in 2010 is the estimated cost of detection, treatment and provision of state and family social care for all those with Age-related Macular Disease. This is under the assumed 75% levels of anti-VEGF treatment for NV AMD and assuming status quo for "low vision" service for AMD. More than **£16.4 billion** is the estimated cumulative cost over the decade 2010 to 2020, under the same conditions but allowing for demographic change (at 2008/9 prices used at the baseline year of 2010). For the decade, the health care treatment component amounts to **17.8%** of the total, i.e. more than **£2.9 billion**. The personal and social costs are **76%**, i.e. more than **£12.5 billion** pounds. These proportions vary little for the single countries within the UK.

Varying the Assumptions about Treatment Levels

In our model, varying the assumptions about the likely percentage receiving treatment among suitable cases of Neovascular AMD, would have the following results:

If only 50% of those with neovascular disease are treated the numbers with sight loss due to Neovascular AMD will be 149,326 in 2010. If 90% are treated this number will be less, at 143,519 with sight loss, a difference of 5,807**.**

Sight Restored by Treatment

The gain in visual acuity over the decade due to Ranibizumab treatment was considered in terms of numbers who convert from being partially sighted to having adequate vision (6/12 or better), under the 3 assumed levels of treatment coverage. The expected numbers (to nearest 1000) regaining sight in this way over the decade are: 67,000 at 50% treatment coverage, 96,000 persons at 75% coverage, and 112,000 at 90% treatment coverage. Over the decade, number of people expected to convert from blindness to partially sighted are: 6,000 at 50%

treatment coverage, 8,000 at 75% coverage, and 10,000 at 90% treatment coverage.

For the year 2010, the AMD overall health care costs will be **£256,630,028** at 50% treatment, and **£354,290,363** at 90% treatment, an increase of **£ 97.66 million**. The social and personal costs will be **£1,263,008,484** and **£1,237,632,225** at 50% and 90% respectively, showing a difference (decrease) of **£25.376 million**

Cataract

	year 2010	year 2020
Population at risk, UK	**30,784,728**	**33,462,473**

Sight Loss from Cataract

For 2010 our model estimates that prevalence of partial sight due to cataract will be 206,224 and blindness to be 27,907. In 2020, should this condition remain visually impairing at this level in the population, it is estimated that 248,504 will be partially sighted, and 32,750 will be blind.

Number of Cataract Operations

Based upon the surgical workload for 2007/8 the number of cataract operations in 2010 are likely to be more than 389 thousand and based upon the expected population structure this will have increased to a yearly surgical load of 473,944 in 2020.

Cost

£995,144,453 in 2010 is the estimated cost which includes referral, and surgical treatment for those with operable cataract, and for ongoing social and personal care for those who are partially sighted or blind from cataract.

£9,516,840,540 is estimated to be the cumulative cost for the whole decade 2010 to 2020, under the same conditions but allowing for demographic change (at 2008/9 prices used at the baseline year of 2010). Under these conditions, **47.64%** of the decade costs are accounted for through health care treatment. Over **36%** of the decade costs are incurred on social and personal care, the majority of this latter 36% is expected to be spent on those with sight loss due to cataract, either with aphakia or irremediable lens opacity.

Varying the Assumptions about Endophthalmitis Risk

Though severe surgical complications with cataract are rare one in particular, endophthalmitis considerably affects quality of life post surgically and may lead to serious loss of sight even if treated. Prophylactic intervention incurs additional costs at the point of surgery and is being implemented. Under the Base Case assumption, 199 cases of endophthalmitis would be expected in 2010, the total cost of illness for cataract being £995,144,453. Under the assumption-2, the higher incidence will result in 510 cases, at a total cost of illness of £996,323,311. The extra cost incurred by the 311 additional cases will be about **£1.2 million**.

Diabetic Retinopathy (DR)

Diabetic retinopathy is a complication of diabetes, occurring as a result of damage to the blood vessels of the retina, induced by diabetes

	year 2010	year 2020
Population at risk, UK	**51,469,409**	**54,876,508**
Diabetes (diagnosed)	**2,665,029**	**3,342,634**

Numbers with Diabetic Retinopathy

For the coming year of 2010 more than 748 thousand persons are expected to have background diabetic retinopathy (early signs of DR) and 85,484 will be classified as falling into non proliferative and proliferative retinopathy combined. (more advanced stages than background DR). By 2020 this is expected to rise to more than 938 thousand for background retinopathy and 107,218 for non proliferative and proliferative retinopathy (combined).

Diabetic Maculopathy, which can occur from the non-proliferative stage onwards and can lead to sight loss, is expected to be present in 187,842 diabetic persons in 2010, increasing to 235,602 by the year 2020.

Sight Loss from Diabetic Retinopathy

40,982 persons in 2010 will be partially sighted from diabetic retinopathy and 24,976 will be blind. In 2020, 46,473 persons are expected to be partially sighted and an additional 29, 957 to be blind.

Cost

For the year 2010, **£680,317,387** is the estimated cost of detection, treatment and provision of state and family social care for all diabetics at risk of diabetic eye disease.

£6,430,973,067 is estimated to be the cumulative cost over the ten years to 2020. Of this, **25.5%** (more than £1.6 billion) are considered as health care costs, and **53.1%** (more than £3.4 billion) as personal and social care costs.

Lost productivity due to unemployment or days lost from work related to diabetic eye disease is estimated to amount to **£1.03 billion** over the decade.

Glaucoma

In this report, the term 'glaucoma' is used to indicate Primary Open-angle Glaucoma (POAG). Ocular hypertension (OH) is defined as intraocular pressure of more than 21 mmHg, without any accompanying signs of POAG. The risk of developing glaucoma is increased in eyes that have ocular hypertension.

	year 2010	year 2020
Population at risk, UK	**30,782,718**	**33,460,453**
African-Caribbean sub-group	**700,020**	**904,835**

Numbers with the disease (diagnosed)

- 308,044 persons in 2010 and 361,183 in 2020 will have ocular hypertension.
- 265,973 persons are estimated to have glaucoma in 2010.
- By the end of the decade this is projected to be 327,440.

Sight Loss from Glaucoma

- 57,646 persons in 2010 will be partially sighted from glaucoma and 17,511 will be blind (assuming that the level of detection of this disease in the population is at 50%).

- 71,806 persons are expected to be partially sighted by 2020, and 22,261 to be blind under the same assumption about detection.

African- Caribbean Ethnic sub-Group

Numbers appear small for African-Caribbean persons with glaucoma, but the percentage expected to go into partial sight and blindness is higher than that for the total population, which includes them.

The proportional increase over the decade for this group is 57.37% for partial sight and 57.31% for blindness in comparison to 24.56% for partial sight and 27.12% for blindness for the population in general.

Cost

For the year 2010, **£542,038,234** is the estimated cost of detection, treatment and provision of state and family social care for all those with ocular hypertension and glaucoma under the assumed 50% detection level.

£4,889,652,026 is estimated to be the cumulative cost over the ten years to 2020 assuming the same conditions. Of this, 42.33% (more than £2 billion) are considered as health care costs, and 34.14% (more than £1.6 Billion) as personal and social care costs.

Varying Assumptions about Detection Levels

Base Case Assumption: Detection rate is **50%**. In this situation**,** the estimated numbers in the U.K. with sight loss due to glaucoma (nearest 1000) are: 75,000 persons in 2010 and 94,000 people in 2020 The total cumulative cost of illness for glaucoma (including OH) for the decade is **£4.9 billion**

Assumption-2: Detection rate is improved to **75%**. In this situation**,** there will be a modest decrease in prevalence of sight loss from glaucoma over the decade, the estimated numbers being 71,000 in 2010, and 89,000 people in 2020. The total cumulative cost of illness for the decade will increase from £4.9 billion at 50% detection), to **£5.3 billion** at 75% detection

Assumption-3: Detection rate is improved to **90%**. Under this assumption, the estimated numbers with sight loss are lower at: 69,000 people in 2010, rising to 86,000 people in 2020. The cumulative cost of illness for glaucoma and OH over the decade will increased from £4.9 billion (at 50% detection), to **£5.5 billion** (at 90% detection)

Observation of the Authors:

The authors observe that a more robust information base is required to feed into projects such as this one and more importantly to inform policy initiatives of the UK Vision strategy. The serious deficit in reliable information on levels of detection and treatment coverage for eye conditions limits the output of this Decade Model at present. It may also hinder the monitoring of efforts to ensure that existing and improved entitlements to eye services are fully implemented.

Demography

The population of UK is expected to increase from 61.4 million in 2008, to about 66.8 million by 2020, an increase of around 8.7%. The proportional increase is expected to be the highest in England at 9.5%, followed by Northern Ireland at 7.7%, Wales at 6.0% and Scotland at 3.1%.

Table D-1. Projected populations (in 1000s) at mid-years. 2006-based Principal projections. Source: Government Actuary's Department.

	Year: 2008	2010	2015	2020
England	**51,488**	**52,297**	**54,319**	**56,354**
Wales	**2,993**	**3,023**	**3,098**	**3,172**
Scotland	**5,157**	**5,190**	**5,258**	**5,316**
N. Ireland	**1,774**	**1,799**	**1,857**	**1,911**
UK	**61,412**	**62,309**	**64,532**	**66,754**

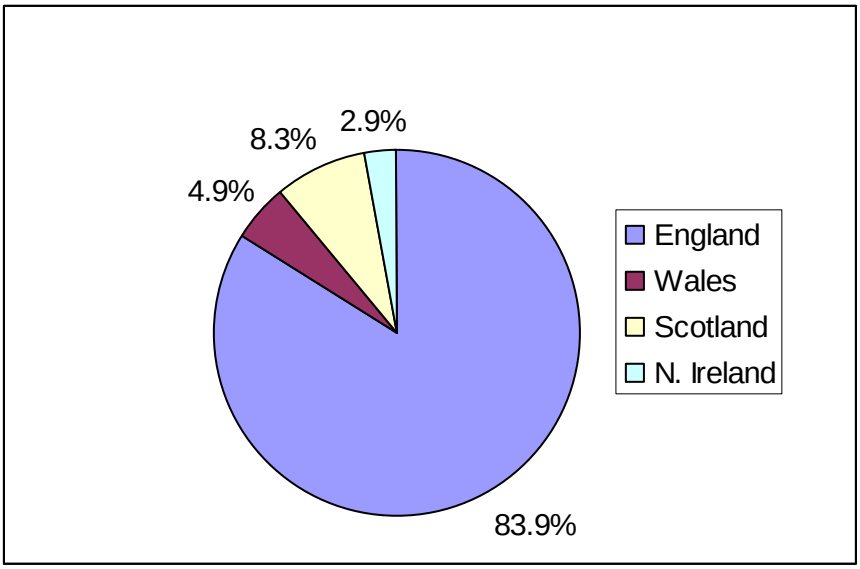
This pattern of growth and distribution, however, changes for the more pertinent older age groups, who carry the main burden of sight loss. Number of persons 60 or older in the UK is expected to increase by about 21% during the same period, rising from 13.6 million in 2008 to 16.4 million by 2020. Highest proportional increase in the 60+ age group is expected to occur in Northern Ireland (28.5%), followed by Scotland (22.7%), Wales (20.8%), and the lowest in England (20.6%). The details are shown in **Table D2**.

Table D-2. Projected increase in number of persons (1000s) aged 60 or older, in the period 2008 to 2020.

Country	Persons (1000s), age 60 or older Mid-Year 2008	Persons (1000s), age 60 or older Mid-Year 2020	% Increase
England	**11,317**	**13,654**	**20.6%**
Wales	**737**	**891**	**20.8%**
Scotland	**1,170**	**1,436**	**22.7%**
N. Ireland	**341**	**438**	**28.5%**
UK	**13,566**	**16,419**	**21.0%**

The geographic distribution of the UK population helps to view the devolved countries in perspective. About 84% of the UK population live in England. Proportions living in Wales, Scotland, and N. Ireland are approximately 5%, 8%, and 3% respectively (**Fig. D-1**)

Figure D-1. Geographic distribution of the UK population, year 2010.



Part 1: Age–related Macular Degeneration

Terminology and Definitions

Age–related Macular Degeneration (AMD)

Age-related macular degeneration. A chronic degenerative disease of the macula resulting in progressive damage to the light-sensitive cells in the macula. This leads to loss of central vision, which may be profound, obscuring all details, but peripheral vision (side vision) is unaffected. The disease affects mainly those 50 years or older.

Early ARM

Early age-related Maculopathy, also referred to as 'Early AMD'. Defined as presence of indistinct soft drusen (yellowish deposits under the retina) or soft drusen with pigmentary abnormalities present, but no signs of Neovascular AMD or of the later-stages of 'dry' AMD (Geographic atrophy), in line with the definition used by the Rotterdam Eye Study.

Neovascular AMD (NV-AMD)

Neovascular AMD. This is the 'wet' or exudative form of advanced AMD, and occurs when new abnormal blood vessels grow under the macula. These new vessels are fragile, and prone to leakage which may displace and damage the macula, causing rapid loss of central vision. Left untreated, the damage may lead to scarring of the macula and irreversible loss of central vision. NV-AMD can now be treated with intraocular injections of a new drug - Ranibizumab (Lucentis) - which may stop the progression of visual loss (at least in the short term) and even restore some of the lost sight. The drug blocks the effects of a protein called 'Vascular Endothelial Growth Factor' (VEGF), found in abnormally high levels in NV-AMD and thought to promote the growth of new vessels.

Geographic Atrophy (GA-AMD)

Geographic Atrophy. This is the 'dry' form of late-stage AMD, with part or all of the macular undergoing scarring. The resulting loss of vision is at present irreversible.

Sight Loss

Partial Sight: visual acuity <612 – 6/60**. Blind:** < 6/60**. Sight Loss:** < 6/12**.** These are the levels of vision loss in the better seeing eye, AMD being the primary cause.

Section 1: Epidemiology

Table P1 indicates the numbers at risk of AMD, in the population of the UK.

Table P-1. U.K. Population at Risk – AMD

Age	2010	2015	2020
50-54	3,978,875	4,485,009	4,531,218
55-59	3,571,598	3,882,157	4,382,168
60-64	3,743,048	3,430,499	3,737,819
65-69	2,926,015	3,543,212	3,261,471
70-74	2,474,738	2,707,771	3,301,487
75-79	2,001,596	2,187,302	2,425,401
80-84	1,492,415	1,606,402	1,819,154
85-89	939,994	1,008,200	1,151,503
90+	457,574	591,330	722,111
Total	**21,585,853**	**23,441,882**	**25,332,332**

Prevalence

From the RNIB epidemiology model we estimate that **1,493,963 persons** will have early stage of the disease in 2010 in the United Kingdom, and by the end of the decade this number is projected to rise to **1,821,434** (Table AMD-1). Additionally for the UK, **414,561** persons in 2010 are estimated to have NV-AMD

(wet) and this will increase to **515,509** in 2020. GA-AMD, which at present is irremediable, will be present in **193,652** persons in 2010 and will increase to **240,358** in 2020.

Sight Loss

For 2010 considering those numbers in the UK going into sight loss from both types of AMD, **132,970** are likely to be partially sighted and **90,254** will be blind. This assumes that the anti-VEGF treatment for Neovascular AMD covers 75% of those eligible. By 2020, the expected numbers will be **171,530** partially sighted persons, and **120,452** blind, under the same assumption about treatment (Table AMD-1).

As well as those affected by irremediable GA-AMD, these numbers with sight loss also include persons with Neovascular AMD who were blind before the availability of the new treatment.

Table AMD-1. Age-related macular degeneration (AMD) and sight loss attributed to AMD. Estimated number of affected persons. (Treatment coverage for Neovascular AMD is **75 %.)**

AMD	year: 2010	2015	2020
England			
Early ARM	1,246,983	1,386,497	1,519,059
NV-AMD	347,729	381,400	430,965
GA-AMD	162,437	177,961	200,926
Partially sighted	111,869	128,966	143,874
Blind	76,195	88,465	101,161
Wales			
Early ARM	80,622	89,546	98,100
NV-AMD	22,372	24,416	27,652
GA-AMD	10,452	11,395	12,900
Partially sighted	7,338	8,295	9,190
Blind	4,861	5,623	6,416
Scotland			
Early ARM	128,378	142,648	156,310
NV-AMD	34,359	38,400	43,645
GA-AMD	16,046	17,922	20,351
Partially sighted	10,660	12,474	14,155
Blind	7,124	8,445	9,879
N. Ireland			
Early ARM	37,979	42,808	47,965
NV-AMD	10,102	11,459	13,248
GA-AMD	4,717	5,349	6,182
Partially sighted	3,103	3,733	4,311
Blind	2,075	2,523	2,996
U.K.			
Early ARM	1,493,963	1,661,499	1,821,434
NV-AMD	414,561	455,675	515,509
GA-AMD	193,652	212,627	240,358
Partially sighted	132,970	153,468	171,530
Blind	90,254	105,056	120,452

AMD=Age-related Macular Degeneration, Early ARM=Early pre-AMD stage, NV-AMD=Neovascular 'wet' AMD in one or both eyes, GA-AMD=geographic atrophy ('dry' AMD) in either eye and **absence** of NV-AMD in both eyes.

Section 2: Costs to Society (Table AMD-2)

The cost of inputs into the detection treatment and ongoing support for those persons with Age-related Macular Degeneration is considered here as far as possible from the perspective of the resource use in the society of which they are a part, rather than just the implications for the National Health Service or the Local Authority Social services. Lost wage earning opportunity due to sight loss is calculated and costings are estimated for the "paid" and “informal care" given to those with compromised vision. For the UK, the total costs of the major itemised inputs for the decade model 2010-2020 are projected to be Sixteen billion, four hundred and thirty four million, five hundred and ten thousand pounds (to the nearest thousand) i.e. **£16,434,509,576 (**using 2008/9 prices).

The health care costs over the decade for AMD amount to Two billion, nine hundred and twenty seven million, eight hundred and seventy thousand pounds (to the nearest thousand i.e. **£2,927,699, 877,000**

The social and personal care costs for the decade may amount to Twelve billion, five hundred and five million, six hundred and forty four thousand pounds (to the nearest thousand) i.e. **£12,505,643,736.** Of this £12.5 billion, more than eight and a half billion pounds **(£8,694,855,367)** is costed for the provision of informal care for those partially sighted or blind over and above that which they might receive if they had no sight loss. This care is composed of inputs of labour which comes from within their family or near neighbourhood and is not reimbursed by the state, nor by the care recipients.

Cost of illness studies report the loss to society of the value of the productivity that would be produced if those with disease were functioning members of the labour force or not prone to time lost from work due to the eye condition. For the UK for those burdened by sight loss from AMD, this amounts to **£7,425,063** for the year 2010, and for the decade, the amount is **£50,629,800**.

Table AMD-2. Cumulative cost of illness for AMD over the decade and the cost at base year 2010 UK: (Treatment coverage for Neovascular AMD is **75 %.)**

AMD - U.K.	**Year 2010**	**Period 2010 - 2020**	**% of Total**
Direct Health Care Cost	**£319,452,167**	**£2,927,699,877**	**17.81%**
GP Consultations	£387,170	£3,772,559	**0.02%**
GOS	£17,335,679	£164,267,417	**1.00%**
Hospital Care	£279,318,765	£2,538,808,642	**15.45%**
Transport to Hospital	£529,645	£5,160,819	**0.03%**
LV Health Service Consultation	£9,871,483	£98,671,453	**0.60%**
Non-Ophthalmic related Medical	£12,009,426	£117,018,987	**0.71%**
Social and Personal Cost	**£1,247,141,650**	**£12,505,643,736**	**76.09%**
Low-Vision Devices & Rehabilitation	£67,910,441	£678,256,618	**4.13%**
Paid Care (excess)	£256,759,256	£2,581,817,315	**15.71%**
Informal Care (excess)	£867,277,857	£8,694,855,367	**52.91%**
Residential Care (excess)	£54,927,586	£548,590,144	**3.34%**
TV Licence allowance	£266,510	£2,124,291	**0.01%**
Other Costs	**£14,274,059**	**£142,791,787**	**0.87%**
Capital	£10,626,332	£105,070,286	**0.64%**
Tax Exemption (Blind persons)	£3,647,727	£37,721,500	**0.23%**
Indirect Costs: lost productivity	**£7,425,063**	**£50,629,800**	**0.31%**
Underemployment (excess)	£7,030,917	£47,931,707	**0.29%**
Absence from work (excess)	£394,146	£2,698,094	**0.02%**
Deadweight Loss	**£83,822,377**	**£807,744,376**	**4.91%**
Total Cost of Illness	**£1,672,115,316**	**£16,434,509,576**	

AMD - Costs Breakdown by Country.

For use within RNIB in England, Wales, Scotland, and Northern Ireland: the costs are broken down by countries within the UK assuming that treatment coverage for those with Neovascular AMD who are eligible will be **75%.**

Tables AMD-3 (a) - (d). Cumulative cost of illness for AMD over the decade and the cost at base year 2010 by UK country. (Treatment coverage for Neovascular AMD: **75 %.)**

Table AMD-3 (a)

AMD - England	**Year 2010**	**Period 2010 - 2020**	**% of Total**
Direct Health Care Cost	**£266,989,271**	**£2,445,126,433**	**17.72%**
GP Consultations	£324,756	£3,159,345	**0.02%**
GOS	£13,484,641	£127,556,629	**0.92%**
Hospital Care	£234,344,214	£2,129,109,552	**15.43%**
Transport to Hospital	£444,262	£4,321,949	**0.03%**
LV Health Service Consultation	£8,317,973	£82,980,926	**0.60%**
Non-Ophthalmic related Medical	£10,073,424	£97,998,032	**0.71%**
Social and Personal Cost	**£1,051,576,013**	**£10,521,812,023**	**76.24%**
Low-Vision Devices & Rehabilitation	£57,213,516	£570,336,017	**4.13%**
Paid Care (excess)	£216,620,908	£2,173,096,842	**15.75%**
Informal Care (excess)	£731,244,450	£7,315,311,299	**53.01%**
Residential Care (excess)	£46,275,658	£461,301,386	**3.34%**
TV Licence allowance	£221,480	£1,766,479	**0.01%**
Other Costs	**£11,333,511**	**£113,937,714**	**0.83%**
Capital	£8,248,787	£82,117,502	**0.60%**
Tax Exemption (Blind persons)	£3,084,724	£31,820,212	**0.23%**
Indirect Costs: lost productivity	**£6,228,925**	**£42,373,291**	**0.31%**
Underemployment (excess)	£5,899,651	£40,121,073	**0.29%**
Absence from work (excess)	£329,274	£2,252,218	**0.02%**
Deadweight Loss	**£70,398,611**	**£677,464,648**	**4.91%**
Total Cost of Illness	**£1,406,526,330**	**£13,800,714,109**	

Table AMD-3 (b)

AMD - Wales	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£17,249,837**	**£157,742,472**	**17.71%**
GP Consultations	£20,895	£203,022	**0.02%**
GOS	£881,527	£8,332,775	**0.94%**
Hospital Care	£15,131,865	£137,301,103	**15.41%**
Transport to Hospital	£28,584	£277,732	**0.03%**
LV Health Service Consultation	£538,851	£5,330,399	**0.60%**
Non-Ophthalmic related Medical	£648,116	£6,297,440	**0.71%**
Social and Personal Cost	**£67,757,319**	**£673,554,139**	**75.62%**
Low-Vision Devices & Rehabilitation	£3,711,366	£36,668,187	**4.12%**
Paid Care (excess)	£13,893,600	£138,702,485	**15.57%**
Informal Care (excess)	£47,136,009	£468,409,685	**52.59%**
Residential Care (excess)	£3,001,841	£29,658,105	**3.33%**
TV Licence allowance	£14,503	£115,677	**0.01%**
Other Costs	**£1,424,893**	**£13,443,069**	**1.51%**
Capital	£1,228,523	£11,420,921	**1.28%**
Tax Exemption (Blind persons)	£196,369	£2,022,148	**0.23%**
Indirect Costs: lost productivity	**£360,162**	**£2,483,375**	**0.28%**
Underemployment (excess)	£339,286	£2,342,227	**0.26%**
Absence from work (excess)	£20,875	£141,148	**0.02%**
Deadweight Loss	**£4,539,367**	**£43,499,222**	**4.88%**
Total Cost of Illness	**£91,331,578**	**£890,722,277**	

Table AMD-3 (c)

AMD - Scotland	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£27,479,551**	**£253,214,330**	**18.81%**
GP Consultations	£32,086	£315,865	**0.02%**
GOS	£2,560,766	£24,408,533	**1.81%**
Hospital Care	£23,061,692	£210,275,694	**15.62%**
Transport to Hospital	£43,894	£432,100	**0.03%**
LV Health Service Consultation	£785,842	£7,984,482	**0.59%**
Non-Ophthalmic related Medical	£995,271	£9,797,656	**0.73%**
Social and Personal Cost	**£98,984,341**	**£1,009,895,585**	**75.01%**
Low-Vision Devices & Rehabilitation	£5,410,254	£54,912,765	**4.08%**
Paid Care (excess)	£20,325,618	£208,128,919	**15.46%**
Informal Care (excess)	£68,848,918	£702,252,173	**52.16%**
Residential Care (excess)	£4,375,943	£44,414,755	**3.30%**
TV Licence allowance	£23,609	£186,974	**0.01%**
Other Costs	**£1,135,316**	**£11,546,641**	**0.86%**
Capital	£851,707	£8,560,161	**0.64%**
Tax Exemption (Blind persons)	£283,610	£2,986,480	**0.22%**
Indirect Costs: lost productivity	**£645,826**	**£4,442,621**	**0.33%**
Underemployment (excess)	£611,851	£4,208,339	**0.31%**
Absence from work (excess)	£33,975	£234,282	**0.02%**
Deadweight Loss	**£6,905,697**	**£67,228,640**	**4.99%**
Total Cost of Illness	**£135,150,731**	**£1,346,327,818**	

Table AMD-3 (d)

AMD - N. Ireland	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£7,733,509**	**£71,616,642**	**18.05%**
GP Consultations	£9,434	£94,326	**0.02%**
GOS	£408,746	£3,969,481	**1.00%**
Hospital Care	£6,780,993	£62,122,293	**15.66%**
Transport to Hospital	£12,905	£129,037	**0.03%**
LV Health Service Consultation	£228,818	£2,375,646	**0.60%**
Non-Ophthalmic related Medical	£292,614	£2,925,859	**0.74%**
Social and Personal Cost	**£28,823,977**	**£300,381,988**	**75.71%**
Low-Vision Devices & Rehabilitation	£1,575,304	£16,339,648	**4.12%**
Paid Care (excess)	£5,919,130	£61,889,070	**15.60%**
Informal Care (excess)	£20,048,480	£208,882,211	**52.65%**
Residential Care (excess)	£1,274,144	£13,215,898	**3.33%**
TV Licence allowance	£6,919	£55,161	**0.01%**
Other Costs	**£380,339**	**£3,864,362**	**0.97%**
Capital	£297,316	£2,971,702	**0.75%**
Tax Exemption (Blind persons)	£83,024	£892,660	**0.22%**
Indirect Costs: lost productivity	**£190,151**	**£1,330,513**	**0.34%**
Underemployment (excess)	£180,128	£1,260,067	**0.32%**
Absence from work (excess)	£10,023	£70,446	**0.02%**
Deadweight Loss	**£1,978,702**	**£19,551,866**	**4.93%**
Total Cost of Illness	**£39,106,677**	**£396,745,372**	

Section 3: Varying the Assumptions

Assumption-1: Treatment coverage is 75%

The model output of AMD 1-3d is based upon assumptions that entitlements within the NICE guidance will lead to 75% of all suitable cases of neovascular AMD receiving the new drug treatment, over the decade 2010 to 2020. Taking the calculations further than those in AMD table 1, and estimating the numbers in the U.K. with sight loss due specifically to NV-AMD (nearest 1000), these will amount to **146,000** persons in 2010, rising to **170,000** persons in 2015, and **190,000** people in 2020 (Table AMD-4). The rise in numbers with sight loss can be explained by the demographic effect (mainly ageing population) overwhelming the treatment effect (numbers treated and treatment efficacy).

Assumption-1: Treatment coverage is 90%.

Varying the assumptions and anticipating in the model that treatment coverage is improved from 75% to **90%,** there will be a modest decrease in prevalence of sight loss from NV-AMD over the decade, the estimated numbers being **144,000** in 2010, **168,000** in 2015 and **188,000** people in 2020 (Table AMD-4).

A treatment coverage at the lower **50%,** for 2010 and onwards might reflect possible limitations of access to treatment or level of patient presentation at clinics. Under this assumption, the estimated numbers with sight loss are higher at: **149,000** in 2010, **174,000** in 2015, and **194,000** people in 2020 (Table AMD-4). At the reduced coverage of 50%, there will be about 6,000 additional cases of sight loss from NV-AMD in each year of the decade in the U.K., compared to 90% coverage, and between 3,600-3,900 additional cases in each year of the decade compared to the base-case 75% coverage.

Table AMD-4 Cumulative Cost of illness and number of persons with sight loss due to Neovascular AMD, by levels of treatment coverage. Estimates for the U.K.

Assumed treatment coverage	Cumulative cost of illness over the decade	Sight Loss from NV-AMD in 2010	Sight Loss from NV-AMD in 2015	Sight Loss from NV-AMD in 2020
50%	**£15,990,508,406**	**149,326**	**173,994**	**193,804**
75%	**£16,434,509,576**	**145,697**	**170,272**	**189,890**
90%	**£16,672,596,715**	**143,519**	**167,992**	**187,523**

NV-AMD = Neovascular (wet) AMD, Sight Loss = VA < 6/12 (Partial Sight+Blind)

Sight Gained from Treatment

The gain in visual acuity over the decade due to Ranibizumab treatment is shown in table AMD-5**.** This is in terms of numbers who convert from partial sight to adequate vision and from blindness to partially sighted, under the 3 assumed levels of treatment coverage.

Table AMD-5. Gain in visual acuity over the decade with Ranibizumab treatment. Estimates for the U.K.

Assumed treatment coverage	Conversion from partial sight to adequate vision. Persons	Conversion from blindness to partial sight. Persons	Total
50%	**66,954**	**5,927**	**72,881**
75%	**95,814**	**8,467**	**104,281**
90%	**111,597**	**9,855**	**121,453**

Costs

Change from treatment coverage of 75% to 90%.

The total cumulative cost of illness for AMD for the decade is more than £16.4 billion as shown in Table AMD-2, and this includes costs for those with sight loss from the irremediable Geographic Atrophy form of AMD as well as those who have the Neovascular form. This sum for AMD for the decade will increase from £16,434,509,576 at 75% coverage, to £16,672,596,715 at 90% treatment coverage (Table AMD-4).

Change from treatment coverage of 90% to 50%

The costs over the decade under the changed assumptions for AMD is reduced from £16,672,596,715 (at 90% treated), to £15,990,508,406 (at 50% treated).

Part 2: Cataract

Terminology and Definitions

Cataract

Opacity of the normally clear lens of the eye, leading to visual impairment. In the vast majority of affected persons, it is 'caused' by cumulative biochemical insults to the lens proteins throughout the aging process, eventually overwhelming the protective mechanisms of the lens, leading to 'age-related cataract'. In rare cases, the cataract may be congenital or may have a distinct aetiology, such as trauma, other eye disorders or treatments, and exposure to toxic chemicals. Sight can be restored by surgical removal of the damaged lens (usually leaving the capsular bag of the lens in situ) and implantation of a synthetic intraocular lens, usually in the capsular bag.

Cataract Operations

Finished Consultant Episodes for cataract extraction by all surgical methods. An 'Episode' is a continuous period of care administered within a particular consultant specialty at a hospital provider, as defined in the Hospital Episode Statistics (HES), a data warehouse managed by The NHS Information Centre for Health and Social care (The NHS Information Centre).

Capsulotomies

Procedures to clear the posterior capsule of opacities which have developed following the cataract operation (mainly within 12 months).

Endophthalmitis

Intraocular inflammation (proven or presumed infection) following cataract surgery. This is a very rare event (5 - 13 cases per 10,000 operated eyes), but is of concern because in a substantial proportion of cases it lead to serious loss of

sight or loss of the eye, in spite of improved modern management strategies. The condition is often difficult to treat and can be very costly to manage.

Cystoid Macular Oedema (CMO)

Leakage and accumulation of fluid in the macula, and macular thickening (as evidenced by angiography and optical coherence tomography) are observed in a large proportion of eyes that have had cataract surgery, but most of these are not associated with any loss of visual acuity (though they may result in some loss of contrast sensitivity). When the macular oedema is associated with clinically significant loss of visual acuity, the condition is termed **clinical CMO** (first reported by Irvine in 1953). The disorder may occur typically 3-12 weeks after cataract surgery. This is of concern because it may seriously delay the expected gain in visual function or negate the earlier gains, causing substantial anxiety and inconvenience to the patient, and places additional demand on eye services. The condition is largely self-limiting and may resolve in up to 90% of patients by 3-12 months. Some of the few persistent chronic cases may suffer permanent sight loss due to irreversible damage to the macula.

Sight Loss Attributable to Cataract

Partial Sight: visual acuity <612 – 6/60**. Blind:** < 6/60**. Sight Loss:** < 6/12

These are the levels of vision loss in the better seeing eye, and apply only to the following 3 categories of affected person.

- Persons with ‘irreversible’ sight loss **due to** complications following cataract surgery (e.g. endophthalmitis, secondary end-stage glaucoma, retinal detachment, etc.).
- Those with ‘irreversible’ sight loss having had uneventful cataract surgery, with **no apparent cause** for the poor vision.
- Cataract cases with sight loss **due to** the cataract, deemed to be unsuitable for surgery or unwilling to have surgery.

Section 1: Epidemiology

Table P-2. Population at Risk - Cataract

Age	2010	2015	2020
40-44	4,642,997	4,222,487	3,945,682
45-49	4,553,868	4,598,468	4,182,439
50-54	3,978,875	4,485,009	4,531,218
55-59	3,571,598	3,882,157	4,382,168
60-64	3,743,048	3,430,499	3,737,819
65-69	2,926,015	3,543,212	3,261,471
70-74	2,474,738	2,707,771	3,301,487
75-79	2,001,596	2,187,302	2,425,401
80-84	1,492,415	1,606,402	1,819,154
85-89	939,994	1,008,200	1,151,503
90+	457,574	591,330	722,111
Total	**30,784,728**	**32,264,852**	**33,462,473**

Sight Loss

For the UK, the number of people with partial sight due to cataract in the year 2010 is estimated to be **206,224**, and numbers with blindness to be **27,907**. In 2020, should this condition remain visually impairing at this level in the population, it is estimated that **248,504** will be partially sighted and **32,750** will be blind (Table CAT-1).

Number of Cataract Operations

Table CAT-1 shows the number of cataract operations in 2010 is likely to be more than **389 thousand**. In view of the expected changes in the population age structure, this will have increased to a surgical load of **473,944** in 2020. These estimates assume the same threshold levels for cataract surgery which prevailed in 2007/08.

Table CAT-1. Cataract Operations, main complications, and sight loss due to cataract. Estimated numbers projected to year 2020.

Cataract	year: 2010	2015	2020
England			
Cataract Operations	327,197	357,602	397,892
Capsulotomies	13,278	14,362	15,850
Endophthalmitis	167	182	203
Retinal detachment	539	589	655
Cystoid Macular Oedema	9,816	10,728	11,937
Partially sighted	172,334	187,352	207,286
Blind	23,233	25,230	27,302
Wales			
Cataract Operations	20,272	22,187	24,759
Capsulotomies	818	885	982
Endophthalmitis	10	11	13
Retinal detachment	33	37	41
Cystoid Macular Oedema	608	666	743
Partially sighted	11,114	12,037	13,278
Blind	1,484	1,600	1,709
Scotland			
Cataract Operations	32,250	35,354	39,263
Capsulotomies	1,295	1,411	1,555
Endophthalmitis	16	18	20
Retinal detachment	53	58	65
Cystoid Macular Oedema	968	1,061	1,178
Partially sighted	17,607	19,303	21,413
Blind	2,459	2,666	2,852
N. Ireland			
Cataract Operations	9,506	10,636	12,030
Capsulotomies	384	426	484
Endophthalmitis	5	5	6
Retinal detachment	16	18	20
Cystoid Macular Oedema	285	319	361
Partially sighted	5,169	5,792	6,528
Blind	732	811	888
U.K.			
Cataract Operations	**389,225**	**425,779**	**473,944**
Capsulotomies	**15,776**	**17,085**	**18,871**
Endophthalmitis	**199**	**217**	**242**
Retinal detachment	**641**	**701**	**781**
Cystoid Macular Oedema	**11,677**	**12,773**	**14,218**
Partially sighted	**206,224**	**224,483**	**248,504**
Blind	**27,907**	**30,306**	**32,750**

Section 2: Costs to Society (Table CAT-2)

For the UK, Nine hundred and ninety five million, one hundred and forty four thousand pounds (to the nearest 1000), i.e. **£995,144,453** in 2010 is the estimated cost, which includes referral, and surgical treatment for those with operable cataract , and for ongoing social and personal care for those who are partially sighted or blind from cataract.

Nine billion five hundred and sixteen million, eight hundred and forty one thousand pounds (nearest 1000), i.e. **£9,516,840,540** is estimated to be the cumulative cost under the same conditions, but allowing for demographic change, over the whole decade 2010 to 2020 (at 2008/9 prices used at the baseline year of 2010).

Under these conditions 47.64% of the decade costs are accounted for through health care treatment. Over 36% of the decade costs are incurred on social and personal care. The majority of this latter 36% is expected to be spent on those with sight loss due to cataract. This group will be visually impaired from cataract either with aphakia or irremediable lens opacity.

Cost of illness studies report the loss to society of the value of the productivity that would be produced if those with disease were functioning members of the labour force or not prone to time lost from work due to the eye condition. For the UK, for those burdened by sight loss from cataract, this amounts to **£65,805,080** for the year 2010, and for the decade, the amount is **£610,974,152**.

Table CAT-2. Cumulative cost of illness for cataract over the decade and the cost at base year 2010, for the UK.

Cataract - U.K.	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£470,996,110**	**£4,534,096,995**	**47.64%**
GP Consultations	£5,368,366	£51,805,861	**0.54%**
GOS	£29,659,694	£277,252,456	**2.91%**
Hospital Care	£405,364,335	£3,911,129,663	**41.10%**
Transport to Hospital	£7,343,866	£70,869,851	**0.74%**
LV Health Service Consultation	£18,636,830	£178,708,938	**1.88%**
Non-Ophthalmic related Medical	£4,623,019	£44,330,225	**0.47%**
Social and Personal Cost	**£364,330,134**	**£3,469,110,889**	**36.45%**
Low-Vision Devices & Rehabilitation	£71,228,452	£683,011,065	**7.18%**
Paid Care (excess)	£64,471,955	£611,554,560	**6.43%**
Informal Care (excess)	£169,536,016	£1,608,149,207	**16.90%**
Residential Care (excess)	£57,611,269	£552,435,625	**5.80%**
TV Licence allowance	£1,482,441	£13,960,432	**0.15%**
Other Costs	**£14,999,566**	**£143,755,845**	**1.51%**
Capital	£13,139,278	£126,204,568	**1.33%**
Tax Exemption (Blind persons)	£1,860,287	£17,551,277	**0.18%**
Indirect Costs: lost productivity	**£65,805,080**	**£610,974,152**	**6.42%**
Underemployment (excess)	£60,388,625	£560,683,264	**5.89%**
Absence from work (excess)	£5,416,455	£50,290,888	**0.53%**
Deadweight Loss	**£79,013,563**	**£758,902,659**	**7.97%**
Total Cost of Illness	**£995,144,453**	**£9,516,840,540**	

Cataract - Costs Breakdown by Country.

Tables CAT-3 (a) - (d). Cumulative cost of illness for cataract over the decade and the cost at base year 2010 by UK country.

Table CAT-3 (a)

Cataract – England	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£393,958,069**	**£3,790,737,466**	**47.71%**
GP Consultations	£4,512,845	£43,523,003	**0.55%**
GOS	£23,069,537	£215,628,302	**2.71%**
Hospital Care	£340,773,555	£3,285,871,685	**41.35%**
Transport to Hospital	£6,173,522	£59,538,992	**0.75%**
LV Health Service Consultation	£15,567,070	£149,172,112	**1.88%**
Non-Ophthalmic related Medical	£3,861,540	£37,003,372	**0.47%**
Social and Personal Cost	**£303,664,722**	**£2,891,964,674**	**36.40%**
Low-Vision Devices & Rehabilitation	£59,496,080	£570,123,712	**7.18%**
Paid Care (excess)	£53,673,379	£509,444,468	**6.41%**
Informal Care (excess)	£141,139,985	£1,339,639,617	**16.86%**
Residential Care (excess)	£48,121,847	£461,129,644	**5.80%**
TV Licence allowance	£1,233,430	£11,627,233	**0.15%**
Other Costs	**£12,530,492**	**£120,071,376**	**1.51%**
Capital	£10,981,517	£105,437,926	**1.33%**
Tax Exemption (Blind persons)	£1,548,975	£14,633,450	**0.18%**
Indirect Costs: lost productivity	**£54,703,637**	**£508,908,631**	**6.40%**
Underemployment (excess)	£50,201,077	£467,021,464	**5.88%**
Absence from work (excess)	£4,502,560	£41,887,167	**0.53%**
Deadweight Loss	**£66,037,114**	**£634,022,824**	**7.98%**
Total Cost of Illness	**£830,894,034**	**£7,945,704,971**	

Table CAT-3 (b)

Cataract – Wales	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£24,494,860**	**£236,014,469**	**47.37%**
GP Consultations	£279,604	£2,702,082	**0.54%**
GOS	£1,470,479	£13,691,737	**2.75%**
Hospital Care	£21,110,746	£203,977,757	**40.94%**
Transport to Hospital	£382,495	£3,696,419	**0.74%**
LV Health Service Consultation	£1,002,787	£9,572,048	**1.92%**
Non-Ophthalmic related Medical	£248,750	£2,374,425	**0.48%**
Social and Personal Cost	**£19,453,303**	**£183,901,926**	**36.91%**
Low-Vision Devices & Rehabilitation	£3,832,572	£36,583,592	**7.34%**
Paid Care (excess)	£3,428,103	£32,235,430	**6.47%**
Informal Care (excess)	£9,014,569	£84,766,567	**17.01%**
Residential Care (excess)	£3,099,875	£29,589,681	**5.94%**
TV Licence allowance	£78,184	£726,657	**0.15%**
Other Costs	**£787,574**	**£7,527,351**	**1.51%**
Capital	£689,458	£6,614,535	**1.33%**
Tax Exemption (Blind persons)	£98,116	£912,816	**0.18%**
Indirect Costs: lost productivity	**£3,413,988**	**£30,970,812**	**6.22%**
Underemployment (excess)	£3,132,957	£28,421,068	**5.70%**
Absence from work (excess)	£281,030	£2,549,745	**0.51%**
Deadweight Loss	**£4,146,132**	**£39,774,409**	**7.98%**
Total Cost of Illness	**£52,295,857**	**£498,188,968**	

Table CAT-3 (c)

Cataract - Scotland	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£41,032,036**	**£394,441,018**	**47.57%**
GP Consultations	£444,807	£4,292,128	**0.52%**
GOS	£4,404,661	£41,116,013	**4.96%**
Hospital Care	£33,580,611	£323,986,741	**39.07%**
Transport to Hospital	£608,491	£5,871,584	**0.71%**
LV Health Service Consultation	£1,597,255	£15,363,508	**1.85%**
Non-Ophthalmic related Medical	£396,212	£3,811,045	**0.46%**
Social and Personal Cost	**£31,790,074**	**£301,944,743**	**36.42%**
Low-Vision Devices & Rehabilitation	£6,104,580	£58,718,080	**7.08%**
Paid Care (excess)	£5,680,049	£53,587,938	**6.46%**
Informal Care (excess)	£14,936,306	£140,915,309	**16.99%**
Residential Care (excess)	£4,937,530	£47,492,583	**5.73%**
TV Licence allowance	£131,609	£1,230,833	**0.15%**
Other Costs	**£1,306,998**	**£12,501,514**	**1.51%**
Capital	£1,142,914	£10,967,361	**1.32%**
Tax Exemption (Blind persons)	£164,084	£1,534,153	**0.19%**
Indirect Costs: lost productivity	**£5,917,012**	**£54,334,921**	**6.55%**
Underemployment (excess)	£5,429,874	£49,860,668	**6.01%**
Absence from work (excess)	£487,138	£4,474,253	**0.54%**
Deadweight Loss	**£6,873,278**	**£65,951,864**	**7.95%**
Total Cost of Illness	**£86,919,398**	**£829,174,061**	

Table CAT-3 (d)

Cataract - N. Ireland	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£11,511,144**	**£112,904,043**	**46.32%**
GP Consultations	£131,111	£1,288,648	**0.53%**
GOS	£715,017	£6,816,405	**2.80%**
Hospital Care	£9,899,423	£97,293,480	**39.91%**
Transport to Hospital	£179,358	£1,762,856	**0.72%**
LV Health Service Consultation	£469,717	£4,601,270	**1.89%**
Non-Ophthalmic related Medical	£116,517	£1,141,383	**0.47%**
Social and Personal Cost	**£9,422,035**	**£91,299,545**	**37.45%**
Low-Vision Devices & Rehabilitation	£1,795,221	£17,585,682	**7.21%**
Paid Care (excess)	£1,690,425	£16,286,725	**6.68%**
Informal Care (excess)	£4,445,155	£42,827,713	**17.57%**
Residential Care (excess)	£1,452,017	£14,223,718	**5.83%**
TV Licence allowance	£39,217	£375,707	**0.15%**
Other Costs	**£374,502**	**£3,655,603**	**1.50%**
Capital	£325,389	£3,184,746	**1.31%**
Tax Exemption (Blind persons)	£49,113	£470,857	**0.19%**
Indirect Costs: lost productivity	**£1,770,443**	**£16,759,787**	**6.88%**
Underemployment (excess)	£1,624,717	£15,380,064	**6.31%**
Absence from work (excess)	£145,726	£1,379,723	**0.57%**
Deadweight Loss	**£1,957,040**	**£19,153,562**	**7.86%**
Total Cost of Illness	**£25,035,164**	**£243,772,540**	

Section 3: Varying the Assumptions

Though severe surgical complications with cataract are rare one in particular, endophthalmitis considerably affects quality of life post surgically and may lead severe sight light loss even if treated. Prophylactic intervention incurs additional costs at the point of surgery and is being implemented.

The assumption which was varied, concerned incidence of endophthalmitis following cataract surgery.

- **The Base Case Assumption**: Endophthalmitis incidence in the U.K. is 0.51 per 1000 operated eyes.

- **Assumption**-2: Endophthalmitis incidence remains at 1.31 per 1000 operated eyes, for the year 2010.

The 1-year cumulative incidence of endophthalmitis following cataract surgery was taken from our earlier work – meta-analysis of 13 European studies, including 6 studies in the UK. Two rates were computed according to the prophylaxis strategy in widespread use: a) 1.31 per 1000 under conditions of routine prophylaxis, and b) 0.51 per 1000 with additional intracameral antibiotics at the time of surgery.

The results given in the tables above were calculated under the Base Case assumption (incidence rate = 0.51 per 1000 operated eyes). For the year 2010, however, the model also calculated the results under **Assumption-2** (incidence remains at around 1.3 per 1000 operated eyes).

Under the Base Case assumption, **199** cases of endophthalmitis would be expected in 2010, the total cost of illness for cataract being **£995,144,453.** Under the assumption-2, the higher incidence will result in **510** cases, at a total cost of

illness of **£996,323,311**. The extra cost incurred by the **311** additional cases will be about **£1.2 million** (Table CAT-4).

Table Cat-4. Number of endophthalmitis cases in the year 2010 in the UK, and the cost of illness, according to two assumptions regarding incidence rates.

Incidence of endophthalmitis per 1000 operated eyes	Endophthalmitis cases expected in year 2010	Total cost of illness for cataract, year 2010
0.51 (base case)	**199**	**£995,144,453**
1.31	**510**	**£996,323,311**
Difference	**311**	**£1,178,859**

Effect on Sight Loss

The effect of the higher incidence of endophthalmitis on numbers with **binocular** sight loss will be small. The higher incidence is expected to result in around 5 additional people with **binocular** sight loss (and 160 with sight loss in one eye) in 2010.

The scope is very limited therefore for decreasing sight loss through improved surgical procedures. The problem of high rates of sight impairing cataract at serious costs continues into the decade, with 248,504 partially sighted and 32,750 blind attributed to cataract by the year 2020. Cumulative costs of social and personal care incurred in the years over the decade are **£3,469,110,889** by the year 2020.

Part 3: Diabetic Retinopathy

Terminology and Definitions

DR

Diabetic retinopathy. A complication of diabetes, occurring as a result of damage to the blood vessels of the retina, induced by diabetes.

Background DR

Early signs of DR, include tiny balloon-like swellings (microaneurysms) in the small vessels of the retina. At this stage, the visual acuity is not affected.

Non-Proliferative DR

More advanced stage than background DR. Includes several levels of severity. As the disease progresses through this stage, increasing number of the small retinal blood vessels are blocked, cutting off nutrition to larger areas of the retina. Signals to grow new vessels are generated from the deprived (ischaemic) areas of the retina. There may be some leakage of fluid or small areas of bleeding from damaged retinal vessels.

Proliferative DR

This next stage of DR is heralded by the response to the signals to grow new retinal vessels. These grow along the retina and on the surface of the normally clear ‘jelly’ (vitreous) that fills the inside of the eye. The new blood vessels have thin fragile walls, and may bleed causing severe loss of vision. Later in this stage, the areas of haemorrhage may become scarred and contract, causing detachment of the retina. Treatment by laser surgery (scatter laser treatment), to shrink the abnormal blood vessels, is more effective before the vessels start to bleed. Surgical removal of the opaque vitreous (vitrectomy) may be a ‘last resort’ treatment late in this stage.

Diabetic Maculopathy

Swelling of the macula (macular oedema) induced by DR. This can occur from the non-proliferative stage onwards, causing sight loss. Treatment by placing hundreds of small laser burns in the areas of leakage surrounding the macula (focal laser treatment) reduces the leakage and the macular swelling. This stabalises the vision, and in a few cases, sight already lost may be regained.

Sight Loss Attributable to DR

Partial Sight: <612 – 6/60**. Blind:** < 6/60**. Sight Loss:** < 6/12

These are the levels of vision loss in the better seeing eye, Diabetic Retinopathy being the primary cause.

Section 1. Epidemiology

Table P-3. Population at Risk – Diabetic Retinopathy

Age	2010	2015	2020
15-19	3,897,303	3,631,863	3,522,291
20-24	4,326,076	4,238,617	3,969,895
25-29	4,336,718	4,690,744	4,595,270
30-34	3,904,901	4,473,388	4,820,725
35-39	4,221,693	3,944,384	4,507,874
40-44	4,642,997	4,222,487	3,945,682
45-49	4,553,868	4,598,468	4,182,439
50-54	3,978,875	4,485,009	4,531,218
55-59	3,571,598	3,882,157	4,382,168
60-64	3,743,048	3,430,499	3,737,819
65-69	2,926,015	3,543,212	3,261,471
70-74	2,474,738	2,707,771	3,301,487
75-79	2,001,596	2,187,302	2,425,401
80-84	1,492,415	1,606,402	1,819,154
85-89	939,994	1,008,200	1,151,503
90+	457,574	591,330	722,111
Total	**51,469,409**	**53,241,833**	**54,876,508**

Prevalence

For the United Kingdom, Table DR-1 shows that for 2010, of the **2,665,029 persons** diagnosed with diabetes in 2010, **748,209** will have background retinopathy. By the end of the decade this number of diabetics is projected to rise to **3,342,634,** and to **938,448** with background retinopathy. Moving to the next stages of diabetic retinopathy, for the UK 85,484 persons in 2010 and 107,218 in 2020 will fall into non proliferative and proliferative retinopathy stages combined. Diabetic Maculopathy which can occur from the non-proliferative stage onwards, causing sight loss, is expected to be present in **187,842** diabetic persons in 2010, increasing to **235,602** by 2020.

Sight Loss

For the year 2010, **40,982** persons are likely to be partially sighted and **24,976** to be blind from diabetic retinopathy. By 2020, these numbers will be **46,473** persons expected to be partially sighted and **29,957** to be blind (Table DR-1).

Table DR-1. Diabetes, diabetic retinopathy (DR), and sight loss due to DR. Estimated numbers projected to year 2020.

Diabetic Retinopathy	year: 2010	2015	2020
England			
Diabetes (diagnosed)	2,225,729	2,512,203	2,796,195
Background DR	624,876	705,303	785,034
Non-proliferative DR	55,151	62,250	69,287
Proliferative DR	16,241	18,332	20,404
Diabetic Maculopathy	156,878	177,070	197,087
Partially sighted	34,196	36,805	38,847
Blind	20,917	22,760	25,070
Wales			
Diabetes (diagnosed)	138,733	155,826	172,310
Background DR	38,949	43,748	48,376
Non-proliferative DR	3,438	3,861	4,270
Proliferative DR	1,012	1,137	1,257
Diabetic Maculopathy	9,778	10,983	12,145
Partially sighted	2,141	2,294	2,409
Blind	1,313	1,426	1,584
Scotland			
Diabetes (diagnosed)	229,903	257,179	283,467
Background DR	64,545	72,203	79,584
Non-proliferative DR	5,697	6,373	7,024
Proliferative DR	1,678	1,877	2,068
Diabetic Maculopathy	16,204	18,127	19,980
Partially sighted	3,565	3,787	3,962
Blind	2,107	2,296	2,508
N. Ireland			
Diabetes (diagnosed)	70,664	80,474	90,663
Background DR	19,839	22,593	25,454
Non-proliferative DR	1,751	1,994	2,247
Proliferative DR	516	587	662
Diabetic Maculopathy	4,981	5,672	6,390
Partially sighted	1,079	1,171	1,255
Blind	638	707	796
U.K.			
Diabetes (diagnosed)	**2,665,029**	**3,005,683**	**3,342,634**
Background DR	**748,209**	**843,848**	**938,448**
Non-proliferative DR	**66,037**	**74,478**	**82,827**
Proliferative DR	**19,447**	**21,932**	**24,391**
Diabetic Maculopathy	**187,842**	**211,853**	**235,602**
Partially sighted	**40,982**	**44,058**	**46,473**
Blind	**24,976**	**27,189**	**29,957**

Section 2: Costs to Society

The cost of inputs into the detection, treatment, and ongoing support for those persons with diabetic retinopathy is considered here as far as possible from the perspective of the resource use in the society of which they are a part, rather than just the implications for the National Health Service or the Local Authority Social services. Lost wage earning opportunity due to visual impairment is calculated and costings are estimated for the "paid" and for the "informal care" given to those with compromised vision.

The costs of diabetic retinopathy for the year 2010 for the UK are estimated to be **£680,317,387** (Six hundred and eighty million, three hundred and seventeen thousand pounds, to the nearest 1000). The total cost for the decade 2010-2020 are projected to be Six billion, four hundred and thirty million, nine hundred and seventy three thousand (to the nearest thousand) i.e. **£6,430,973,067 (**using 2008/9 prices).

The health care costs for diabetic retinopathy in the decade 2010-2020 are projected to be One billion, six hundred and thirty eight million, and one hundred and ninety one thousand pounds, i.e. **£1,638,191,105** amounting to 25.47% of the total costs**.**

The social and personal care costs over the decade for diabetic retinopathy amount to Three billion, four hundred and eleven million, four hundred and seventy seven thousand pounds (to the nearest thousand), i.e. **£3,411,477,700.** Of this, **£2,371,892,361** is costed for the provision of informal care for those partially sighted and blind over and above that which they might have required if they had no sight loss. This care is composed of inputs of labour which come from within their family or near neighbourhood and is not reimbursed by the state, nor by those who receive the care.

The value of lost productivity in the UK for those burdened by sight loss from diabetic retinopathy is projected to be **£116,160,712** for the year 2010, and for the decade, the amount is **£1,033,238,872**

Table DR-2. Cumulative cost of illness for diabetic retinopathy (DR) over the decade and the cost at base year 2010, for the UK.

DR - U.K.	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£168,470,230**	**£1,638,191,105**	**25.47%**
GP Consultations	£0	£0	**0.00%**
GOS	£1,717,067	£8,765,071	**0.14%**
Hospital Care	£132,226,456	£1,294,078,020	**20.12%**
Transport to Hospital	£26,650,285	£260,821,846	**4.06%**
LV Health Service Consultation	£6,574,068	£62,244,465	**0.97%**
Non-Ophthalmic related Medical	£1,302,354	£12,281,703	**0.19%**
Social and Personal Cost	**£359,506,894**	**£3,411,477,700**	**53.05%**
Low-Vision Devices & Rehabilitation	£20,065,848	£189,228,757	**2.94%**
Paid Care (excess)	£72,570,675	£691,750,791	**10.76%**
Informal Care (excess)	£250,038,321	£2,371,892,361	**36.88%**
Residential Care (excess)	£16,229,737	£153,052,736	**2.38%**
TV Licence allowance	£602,312	£5,553,055	**0.09%**
Other Costs	**£6,097,207**	**£58,697,205**	**0.91%**
Capital	£5,013,724	£48,228,031	**0.75%**
Tax Exemption (Blind persons)	£1,083,483	£10,469,174	**0.16%**
Indirect Costs: lost productivity	**£116,160,712**	**£1,033,238,872**	**16.07%**
Underemployment (excess)	£107,256,358	£953,789,233	**14.83%**
Absence from work (excess)	£8,904,354	£79,449,639	**1.24%**
Deadweight Loss	**£30,082,345**	**£289,368,185**	**4.50%**
Total Cost of Illness	**£680,317,387**	**£6,430,973,067**	

Diabetic Retinopathy - Costs Breakdown by Country.

Tables DR-3 (a) - (d). Cumulative cost of illness for diabetic retinopathy (DR) over the decade and the cost at base year 2010 by UK country.

Table DR-3 (a)

DR - England	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£140,607,994**	**£1,368,741,639**	**25.44%**
GP Consultations	£0	£0	**0.00%**
GOS	£1,335,629	£6,817,952	**0.13%**
Hospital Care	£110,430,440	£1,081,607,776	**20.11%**
Transport to Hospital	£22,257,291	£217,998,399	**4.05%**
LV Health Service Consultation	£5,496,392	£52,051,106	**0.97%**
Non-Ophthalmic related Medical	£1,088,242	£10,266,406	**0.19%**
Social and Personal Cost	**£300,670,849**	**£2,853,439,506**	**53.04%**
Low-Vision Devices & Rehabilitation	£16,766,947	£158,178,318	**2.94%**
Paid Care (excess)	£60,732,644	£578,844,885	**10.76%**
Informal Care (excess)	£209,106,379	£1,983,828,378	**36.88%**
Residential Care (excess)	£13,561,507	£127,938,400	**2.38%**
TV Licence allowance	£503,371	£4,649,525	**0.09%**
Other Costs	**£5,094,105**	**£49,061,340**	**0.91%**
Capital	£4,188,236	£40,314,097	**0.75%**
Tax Exemption (Blind persons)	£905,869	£8,747,243	**0.16%**
Indirect Costs: lost productivity	**£97,114,852**	**£866,246,723**	**16.10%**
Underemployment (excess)	£89,673,568	£799,671,753	**14.87%**
Absence from work (excess)	£7,441,284	£66,574,971	**1.24%**
Deadweight Loss	**£25,129,416**	**£241,884,581**	**4.50%**
Total Cost of Illness	**£568,617,216**	**£5,379,373,789**	

Table DR-3 (b)

DR - Wales	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£8,770,784**	**£84,916,138**	**25.60%**
GP Consultations	£0	£0	**0.00%**
GOS	£87,314	£445,708	**0.13%**
Hospital Care	£6,883,271	£67,051,218	**20.22%**
Transport to Hospital	£1,387,325	£13,514,195	**4.07%**
LV Health Service Consultation	£344,664	£3,262,533	**0.98%**
Non-Ophthalmic related Medical	£68,210	£642,485	**0.19%**
Social and Personal Cost	**£18,857,862**	**£178,996,306**	**53.97%**
Low-Vision Devices & Rehabilitation	£1,050,935	£9,899,011	**2.98%**
Paid Care (excess)	£3,811,293	£36,376,551	**10.97%**
Informal Care (excess)	£13,115,318	£124,436,937	**37.52%**
Residential Care (excess)	£850,021	£8,006,556	**2.41%**
TV Licence allowance	£30,296	£277,252	**0.08%**
Other Costs	**£319,969**	**£3,074,898**	**0.93%**
Capital	£261,914	£2,513,681	**0.76%**
Tax Exemption (Blind persons)	£58,055	£561,216	**0.17%**
Indirect Costs: lost productivity	**£5,677,849**	**£49,584,658**	**14.95%**
Underemployment (excess)	£5,240,702	£45,755,706	**13.80%**
Absence from work (excess)	£437,147	£3,828,953	**1.15%**
Deadweight Loss	**£1,571,485**	**£15,082,087**	**4.55%**
Total Cost of Illness	**£35,197,949**	**£331,654,088**	

Table DR-3 (c)

DR - Scotland	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£14,634,006**	**£140,684,288**	**25.65%**
GP Consultations	£0	£0	**0.00%**
GOS	£253,639	£1,294,745	**0.24%**
Hospital Care	£11,406,712	£110,729,823	**20.19%**
Transport to Hospital	£2,299,026	£22,317,632	**4.07%**
LV Health Service Consultation	£562,632	£5,293,484	**0.97%**
Non-Ophthalmic related Medical	£111,996	£1,048,604	**0.19%**
Social and Personal Cost	**£30,683,703**	**£289,472,869**	**52.78%**
Low-Vision Devices & Rehabilitation	£1,725,566	£16,156,230	**2.95%**
Paid Care (excess)	£6,160,344	£58,440,076	**10.66%**
Informal Care (excess)	£21,350,344	£201,338,044	**36.71%**
Residential Care (excess)	£1,395,679	£13,067,544	**2.38%**
TV Licence allowance	£51,770	£470,975	**0.09%**
Other Costs	**£524,760**	**£5,012,609**	**0.91%**
Capital	£432,331	£4,120,610	**0.75%**
Tax Exemption (Blind persons)	£92,429	£891,999	**0.16%**
Indirect Costs: lost productivity	**£10,164,550**	**£88,560,834**	**16.15%**
Underemployment (excess)	£9,383,766	£81,730,569	**14.90%**
Absence from work (excess)	£780,784	£6,830,265	**1.25%**
Deadweight Loss	**£2,593,988**	**£24,723,661**	**4.51%**
Total Cost of Illness	**£58,601,008**	**£548,454,262**	

Table DR-3 (d)

DR - N. Ireland	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£4,457,447**	**£43,849,040**	**25.57%**
GP Consultations	£0	£0	**0.00%**
GOS	£40,486	£206,665	**0.12%**
Hospital Care	£3,506,034	£34,689,204	**20.23%**
Transport to Hospital	£706,642	£6,991,620	**4.08%**
LV Health Service Consultation	£170,379	£1,637,342	**0.95%**
Non-Ophthalmic related Medical	£33,906	£324,208	**0.19%**
Social and Personal Cost	**£9,294,479**	**£89,569,019**	**52.23%**
Low-Vision Devices & Rehabilitation	£522,400	£4,995,198	**2.91%**
Paid Care (excess)	£1,866,394	£18,089,279	**10.55%**
Informal Care (excess)	£6,466,280	£62,289,003	**36.32%**
Residential Care (excess)	£422,530	£4,040,236	**2.36%**
TV Licence allowance	£16,876	£155,304	**0.09%**
Other Costs	**£158,372**	**£1,548,358**	**0.90%**
Capital	£131,243	£1,279,643	**0.75%**
Tax Exemption (Blind persons)	£27,130	£268,715	**0.16%**
Indirect Costs: lost productivity	**£3,203,460**	**£28,846,656**	**16.82%**
Underemployment (excess)	£2,958,321	£26,631,205	**15.53%**
Absence from work (excess)	£245,139	£2,215,451	**1.29%**
Deadweight Loss	**£787,455**	**£7,677,856**	**4.48%**
Total Cost of Illness	**£17,901,214**	**£171,490,929**	

Part 4: Glaucoma

Terminology and Definitions

Glaucoma (GL)

In this report, the term ‘glaucoma’ is used to indicate Primary Open-angle Glaucoma (POAG), characterised by slow death of ganglion cells in the retina and degeneration of their axons. The diagnostic features are loss of functional visual fields (particular patterns of loss), and degeneration of nerve fibres at the optic disc rim, causing diminution of the rim area relative to the deeper central area of the disc (‘cupping’ or enlarged cup/disc ratio). In late stages, the whole of the optic disc may appear atrophic, with less than 10 degrees of functional visual field remaining (tunnel vision). Raised intraocular pressure is not a necessary feature for diagnosis, but is a risk factor (is associated with increased risk of POAG). Secondary glaucoma due to damage from other conditions or surgical complications is not included in our estimates, nor is angle closure glaucoma which is very uncommon in European populations. Congenital glaucoma is also excluded from our estimates.

Ocular Hypertension (OH)

Ocular hypertension (OH) is defined as intraocular pressure of more than 21 mmHg, without any of the accompanying signs of POAG. The risk of developing glaucoma is increased in eyes that have ocular hypertension. There is some evidence that treatments to reduce the intraocular pressure may reduce the risk of POAG in patients with ocular hypertension. Generally, once detected, the OH cases are monitored (about annually), some being treated with hypotensive eye drops.

Section 1: Epidemiology

Table P-4. U.K. Population at Risk – Glaucoma & Ocular Hypertension

Age	2010	2015	2020
European 'white'			
40-44	4,464,147	4,081,745	3,805,818
45-49	4,383,876	4,421,333	4,043,032
50-54	3,867,147	4,317,588	4,356,673
55-59	3,509,051	3,773,145	4,218,586
60-64	3,702,226	3,370,423	3,632,860
65-69	2,885,282	3,504,569	3,204,355
70-74	2,431,852	2,670,076	3,265,480
75-79	1,972,587	2,149,397	2,391,637
80-84	1,477,165	1,583,121	1,787,629
85-89	934,085	997,898	1,134,815
90+	455,280	587,613	714,732
Sub-total	**30,082,698**	**31,456,908**	**32,555,618**
African-Caribbean			
40-44	178,850	140,742	139,864
45-49	169,992	177,135	139,407
50-54	111,728	167,421	174,545
55-59	62,547	109,012	163,582
60-64	40,822	60,076	104,959
65-69	40,733	38,643	57,116
70-74	42,886	37,695	36,007
75-79	29,009	37,905	33,764
80-84	15,250	23,281	31,525
85-89	5,909	10,302	16,688
90+	2,294	3,717	7,379
Sub-total	**700,020**	**805,929**	**904,835**
Total	**30,782,718**	**32,262,837**	**33,460,453**

Prevalence

For the United Kingdom Table GL-1(a) shows that **308,044** persons will have ocular hypertension (diagnosed) in 2010. and by the end of the decade this number is projected to rise to **361,183.** Additionally for the UK, **265,973** persons in 2010 are estimated to have glaucoma (diagnosed) and this will increase to **327,440** by the year 2020.

Sight Loss

Considering those numbers in the UK with glaucoma who go into sight loss from the disorder, **57,646** are likely to be partially sighted and an additional **17,511** will be blind in the year 2010. This assumes a detection rate of 50% for glaucoma. By 2020, the expected numbers will be **71,806** partially sighted persons and **22,261** blind, under the same assumption about rates of detection and treatment.

Table GL-1(a). Glaucoma, ocular hypertension, and sight loss. Estimated number of affected persons by UK country : Detection Rate = **50%**

(a) All ethnic groups

Glaucoma	year 2010	2015	2020
England			
OH	512,952	555,148	601,737
OH Detected	256,476	277,574	300,869
GL	381,772	420,852	468,373
GL Detected	222,286	245,339	273,443
Partially sighted	48,169	53,424	59,931
Blind	14,630	16,401	18,581
Wales			
OH	32,962	35,547	38,112
OH Detected	16,481	17,773	19,056
GL	24,416	26,853	29,814
GL Detected	14,229	15,670	17,422
Partially sighted	3,102	3,435	3,843
Blind	940	1,052	1,188
Scotland			
OH	54,133	58,543	62,997
OH Detected	27,067	29,271	31,499
GL	39,044	43,075	47,842
GL Detected	22,733	25,120	27,947
Partially sighted	4,924	5,481	6,145
Blind	1,498	1,684	1,906
N. Ireland			
OH	16,041	17,750	19,520
OH Detected	8,020	8,875	9,760
GL	11,558	13,049	14,784
GL Detected	6,725	7,604	8,628
Partially sighted	1,450	1,651	1,887
Blind	442	508	586
U.K.			
OH	616,089	666,988	722,366
OH Detected	308,044	333,494	361,183
GL	456,789	503,828	560,813
GL Detected	265,973	293,733	327,440
Partially sighted	57,646	63,991	71,806
Blind	17,511	19,646	22,261

GL=glaucoma, OH=ocular hypertension

The epidemiology of glaucoma recognises that members of the African – Caribbean ethnic group are at higher risk of developing glaucoma. Table GL-1(b) for the UK shows that **4,792** persons of African-Caribbean ethnic group will have ocular hypertension (diagnosed) in 2010, and by the end of the decade this number is projected to rise to **8,256.** In 2010, some **19,431** persons are estimated to have glaucoma (diagnosed) and this will increase to **30,569** in 2020. Numbers likely to be partially sighted by 2010 are **4,260,** and an additional **2,563** will be blind. By 2020, these numbers will amount to **6,703** persons expected to be partially sighted and **4,032** are expected to be blind.

Though the numbers appear small for African-Caribbean persons with glaucoma, the percentage expected to go into partial sight and blindness is higher than that for the total population, which includes them. The proportional increase over the decade for this group is 57.37% for partial sight and 57.31% for blindness, in comparison to 24.56% for partial sight and 27.12% for blindness for the population in general.

Table GL-1(b). Glaucoma, ocular hypertension, and sight loss. Estimated number of affected persons by UK country: Detection Rate = **50%**

(b) African-Caribbean ethnic group

Glaucoma	year 2010	2015	2020
England			
OH	7,970	10,687	13,761
OH Detected	3,985	5,344	6,881
GL	26,726	33,728	42,096
GL Detected	16,209	20,456	25,531
Partially sighted	3,554	4,485	5,598
Blind	2,138	2,698	3,368
Wales			
OH	507	670	849
OH Detected	253	335	425
GL	1,679	2,107	2,617
GL Detected	1,019	1,278	1,587
Partially sighted	223	280	348
Blind	134	169	209
Scotland			
OH	853	1,138	1,447
OH Detected	426	569	724
GL	2,794	3,499	4,330
GL Detected	1,695	2,122	2,626
Partially sighted	372	465	576
Blind	224	280	346
N. Ireland			
OH	255	349	454
OH Detected	127	174	227
GL	839	1,075	1,359
GL Detected	509	652	824
Partially sighted	112	143	181
Blind	67	86	109
U.K.			
OH	9,584	12,844	16,511
OH Detected	4,792	6,422	8,256
GL	32,038	40,410	50,403
GL Detected	19,431	24,508	30,569
Partially sighted	4,260	5,374	6,703
Blind	2,563	3,233	4,032

GL=glaucoma, OH=ocular hypertension

Section 2: Costs to Society

The cost of inputs into the detection treatment and ongoing support for those persons with glaucoma is considered here as from the perspective of the resource use in the society, rather than just the implications for the National Health Service or the Local Authority Social services. Informal care given to those with compromised vision and days lost from work are included in the costing system.

The total costs for the year 2010 is projected to be Five hundred and forty two million, and thirty eight thousand pounds (to the nearest thousand) i.e. **£542,038,234** (using 2008/9 prices). For the decade, the costs amount to Four billion, eight hundred and eighty nine million, six hundred and fifty two thousand pounds, i.e. **£4,889,652,026** (using 2008/9 prices).

The health care costs over the decade for glaucoma amount to **£2,070,001,026** which is 42.33% of the total.

The social and personal care costs for the decade may amount to **£1,669,110,804.** Of this, more than £940 million is costed for the provision of informal care for those partially sighted and blind, over and above that which they might receive if they had no sight loss. This care is composed of inputs of labour which comes from within their family or near neighbourhood and is not reimbursed by the state, nor by those who receive the care.

For the UK, the cost of lost productivity for those burdened by glaucoma is **£79,594,870** for the year 2010, and for the decade, the amount is **£754,242,423**.

Details are shown in Table GL-2.

Table GL-2. Cumulative cost of illness for glaucoma (including Ocular hypertension) for the decade and for base year, 2010 UK. Detection Rate = **50%**

Glaucoma - U.K.	**Year 2010**	**Period 2010 - 2020**	**% of Total**
Direct Health Care Cost	**£229,559,536**	**£2,070,001,026**	**42.33%**
GP Consultations	£583,279	£5,154,833	**0.11%**
GOS	£76,906,415	£720,901,137	**14.74%**
Hospital Care	£136,787,979	£1,208,888,793	**24.72%**
Transport to Hospital	£3,245,870	£28,685,973	**0.59%**
LV Health Service Consultation	£10,551,995	£93,255,184	**1.91%**
Non-Ophthalmic related Medical	£1,483,998	£13,115,106	**0.27%**
Social and Personal Cost	**£188,805,885**	**£1,669,110,804**	**34.14%**
Low-Vision Devices & Rehabilitation	£22,864,511	£202,069,304	**4.13%**
Paid Care (excess)	£40,454,886	£357,527,460	**7.31%**
Informal Care (excess)	£106,380,522	£940,157,328	**19.23%**
Residential Care (excess)	£18,493,363	£163,438,477	**3.34%**
TV Licence allowance	£612,603	£5,918,234	**0.12%**
Other Costs	**£7,102,772**	**£64,575,737**	**1.32%**
Capital	£6,162,529	£55,287,006	**1.13%**
Tax Exemption (Blind persons)	£940,243	£9,288,732	**0.19%**
Indirect Costs: lost productivity	**£79,594,870**	**£754,242,423**	**15.43%**
Underemployment (excess)	£73,111,519	£692,711,561	**14.17%**
Absence from work (excess)	£6,483,352	£61,530,862	**1.26%**
Deadweight Loss	**£36,975,171**	**£331,722,035**	**6.78%**
Total Cost of Illness	**£542,038,234**	**£4,889,652,026**	

Glaucoma - Costs Breakdown by Country.

Tables GL-3 (a) - (d). Cumulative cost of illness for glaucoma over the decade and the cost at base year 2010 by UK country. Detection Rate = **50%.**

Table GL-3 (a)

Glaucoma - England	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£187,297,950**	**£1,687,106,095**	**41.81%**
GP Consultations	£487,472	£4,308,126	**0.11%**
GOS	£59,819,135	£560,488,739	**13.89%**
Hospital Care	£114,226,509	£1,009,497,677	**25.02%**
Transport to Hospital	£2,707,806	£23,930,729	**0.59%**
LV Health Service Consultation	£8,817,029	£77,922,111	**1.93%**
Non-Ophthalmic related Medical	£1,239,998	£10,958,713	**0.27%**
Social and Personal Cost	**£157,747,099**	**£1,394,541,164**	**34.56%**
Low-Vision Devices & Rehabilitation	£19,105,115	£168,844,949	**4.18%**
Paid Care (excess)	£33,799,828	£298,712,169	**7.40%**
Informal Care (excess)	£88,880,324	£785,496,126	**19.47%**
Residential Care (excess)	£15,452,673	£136,565,825	**3.38%**
TV Licence allowance	£509,159	£4,922,094	**0.12%**
Other Costs	**£5,844,715**	**£53,108,160**	**1.32%**
Capital	£5,058,955	£45,345,966	**1.12%**
Tax Exemption (Blind persons)	£785,760	£7,762,194	**0.19%**
Indirect Costs: lost productivity	**£66,244,019**	**£628,362,602**	**15.57%**
Underemployment (excess)	£60,848,871	£577,110,139	**14.30%**
Absence from work (excess)	£5,395,148	£51,252,463	**1.27%**
Deadweight Loss	**£30,353,731**	**£272,075,797**	**6.74%**
Total Cost of Illness	**£447,487,515**	**£4,035,193,818**	

Table GL-3 (b)

Glaucoma - Wales	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£12,006,373**	**£108,035,293**	**42.05%**
GP Consultations	£31,205	£275,781	**0.11%**
GOS	£3,832,750	£35,799,408	**13.93%**
Hospital Care	£7,321,198	£64,702,431	**25.18%**
Transport to Hospital	£173,768	£1,535,702	**0.60%**
LV Health Service Consultation	£567,623	£5,016,471	**1.95%**
Non-Ophthalmic related Medical	£79,829	£705,500	**0.27%**
Social and Personal Cost	**£10,143,966**	**£89,673,522**	**34.90%**
Low-Vision Devices & Rehabilitation	£1,229,949	£10,869,904	**4.23%**
Paid Care (excess)	£2,172,796	£19,202,483	**7.47%**
Informal Care (excess)	£5,713,604	£50,495,017	**19.65%**
Residential Care (excess)	£994,812	£8,791,837	**3.42%**
TV Licence allowance	£32,804	£314,281	**0.12%**
Other Costs	**£374,820**	**£3,400,149**	**1.32%**
Capital	£324,603	£2,907,276	**1.13%**
Tax Exemption (Blind persons)	£50,217	£492,872	**0.19%**
Indirect Costs: lost productivity	**£4,145,315**	**£38,398,591**	**14.94%**
Underemployment (excess)	£3,807,245	£35,262,441	**13.72%**
Absence from work (excess)	£338,071	£3,136,150	**1.22%**
Deadweight Loss	**£1,947,620**	**£17,443,658**	**6.79%**
Total Cost of Illness	**£28,618,093**	**£256,951,213**	

Table GL-3 (c)

Glaucoma - Scotland	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£24,529,075**	**£222,904,510**	**47.14%**
GP Consultations	£49,853	£440,589	**0.09%**
GOS	£11,408,778	£106,951,478	**22.62%**
Hospital Care	£11,760,872	£103,938,862	**21.98%**
Transport to Hospital	£281,109	£2,484,348	**0.53%**
LV Health Service Consultation	£901,657	£7,968,561	**1.69%**
Non-Ophthalmic related Medical	£126,806	£1,120,672	**0.24%**
Social and Personal Cost	**£16,151,184**	**£142,781,599**	**30.19%**
Low-Vision Devices & Rehabilitation	£1,953,749	£17,266,617	**3.65%**
Paid Care (excess)	£3,461,201	£30,589,001	**6.47%**
Informal Care (excess)	£9,101,606	£80,437,105	**17.01%**
Residential Care (excess)	£1,580,239	£13,965,652	**2.95%**
TV Licence allowance	£54,389	£523,224	**0.11%**
Other Costs	**£705,253**	**£6,437,369**	**1.36%**
Capital	£624,863	£5,644,829	**1.19%**
Tax Exemption (Blind persons)	£80,389	£792,541	**0.17%**
Indirect Costs: lost productivity	**£7,091,494**	**£66,878,257**	**14.14%**
Underemployment (excess)	£6,513,480	£61,416,654	**12.99%**
Absence from work (excess)	£578,014	£5,461,603	**1.15%**
Deadweight Loss	**£3,749,179**	**£33,868,972**	**7.16%**
Total Cost of Illness	**£52,226,185**	**£472,870,707**	

Table GL-3 (d)

Glaucoma - N. Ireland	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£5,726,137**	**£51,955,128**	**41.69%**
GP Consultations	£14,748	£130,337	**0.10%**
GOS	£1,845,752	£17,661,511	**14.17%**
Hospital Care	£3,479,399	£30,749,824	**24.67%**
Transport to Hospital	£83,189	£735,194	**0.59%**
LV Health Service Consultation	£265,685	£2,348,041	**1.88%**
Non-Ophthalmic related Medical	£37,365	£330,221	**0.26%**
Social and Personal Cost	**£4,763,636**	**£42,114,518**	**33.79%**
Low-Vision Devices & Rehabilitation	£575,698	£5,087,835	**4.08%**
Paid Care (excess)	£1,021,060	£9,023,806	**7.24%**
Informal Care (excess)	£2,684,989	£23,729,079	**19.04%**
Residential Care (excess)	£465,638	£4,115,163	**3.30%**
TV Licence allowance	£16,251	£158,635	**0.13%**
Other Costs	**£177,984**	**£1,630,060**	**1.31%**
Capital	£154,107	£1,388,935	**1.11%**
Tax Exemption (Blind persons)	£23,877	£241,125	**0.19%**
Indirect Costs: lost productivity	**£2,114,041**	**£20,602,973**	**16.53%**
Underemployment (excess)	£1,941,922	£18,922,327	**15.18%**
Absence from work (excess)	£172,119	£1,680,646	**1.35%**
Deadweight Loss	**£924,641**	**£8,333,609**	**6.69%**
Total Cost of Illness	**£13,706,441**	**£124,636,288**	

Section 3: Varying the Assumptions

Sight loss from this condition is insidious, so that many patients present only when the disease is advanced. According to a substantial section of the literature, at any one time about half of affected cases remain undetected. Initiatives to improve this rate are regularly considered and in the present model three possible levels of detection were assumed: **50%** (Base Case), **75%**, and **90%**.

The number of people with ocular hypertension, glaucoma and sight loss due to glaucoma in the UK, in relation to the assumed detection rates is shown in Table GL-4.

Table GL-4. Glaucoma, ocular hypertension, and sight loss due to glaucoma. Estimated number of diagnosed cases for the U.K, in relation to the assumed **Detection Rate**.

Glaucoma: U.K.	year: 2010	2015	2020
Detected = 50%			
OH Detected	308,044	333,494	361,183
GL Detected	265,973	293,733	327,440
Partially sighted	57,646	63,991	71,806
Blind	17,511	19,646	22,261
Detection = 75%			
OH Detected	462,067	500,241	541,775
GL Detected	360,442	397,625	442,738
Partially sighted	54,763	60,774	68,182
Blind	16,635	18,658	21,138
Detection = 90%			
OH Detected	554,480	600,289	650,129
GL Detected	418,025	460,937	512,992
Partially sighted	53,034	58,845	66,009
Blind	16,110	18,066	20,464

GL=glaucoma, OH=ocular hypertension.

The detailed costs for glaucoma and ocular hypertension in the U.K., for each detection level, are shown in Tables GL-2 (above), and GL-5, and GL-6.

Table GL-5. Cumulative cost of illness for glaucoma and ocular hypertension over the decade, and the cost at base year 2010. Assumption-2**: Improved detection rate = 75%.**

Glaucoma - U.K.	**Year 2010**	**Period 2010 - 2020**	**% of Total**
Direct Health Care Cost	**£280,371,611**	**£2,520,092,700**	**47.78%**
GP Consultations	£790,449	£6,985,735	**0.13%**
GOS	£78,829,076	£738,923,665	**14.01%**
Hospital Care	£184,848,357	£1,633,631,185	**30.97%**
Transport to Hospital	£4,469,536	£39,500,340	**0.75%**
LV Health Service Consultation	£10,024,395	£88,592,425	**1.68%**
Non-Ophthalmic related Medical	£1,409,798	£12,459,351	**0.24%**
Social and Personal Cost	**£179,365,591**	**£1,585,654,118**	**30.06%**
Low-Vision Devices & Rehabilitation	£21,721,286	£191,965,839	**3.64%**
Paid Care (excess)	£38,432,142	£339,651,087	**6.44%**
Informal Care (excess)	£101,061,496	£893,149,462	**16.93%**
Residential Care (excess)	£17,568,695	£155,266,553	**2.94%**
TV Licence allowance	£581,973	£5,621,177	**0.11%**
Other Costs	**£7,965,715**	**£72,171,917**	**1.37%**
Capital	£7,072,484	£63,349,517	**1.20%**
Tax Exemption (Blind persons)	£893,231	£8,822,401	**0.17%**
Indirect Costs: lost productivity	**£75,615,127**	**£716,443,303**	**13.58%**
Underemployment (excess)	£69,455,943	£657,996,146	**12.48%**
Absence from work (excess)	£6,159,184	£58,447,157	**1.11%**
Deadweight Loss	**£42,434,904**	**£380,097,101**	**7.21%**
Total Cost of Illness	**£585,752,947**	**£5,274,459,139**	

Table GL-6. Cumulative cost of illness for glaucoma and ocular hypertension over the decade and the cost at base year 2010. Assumption-3: **Improved detection rate = 90%.**

Glaucoma - U.K.	Year 2010	Period 2010 - 2020	% of Total
Direct Health Care Cost	**£311,191,760**	**£2,793,089,814**	**50.70%**
GP Consultations	£916,728	£8,101,755	**0.15%**
GOS	£79,982,672	£749,737,182	**13.61%**
Hospital Care	£214,011,002	£1,891,361,397	**34.33%**
Transport to Hospital	£5,208,244	£46,028,813	**0.84%**
LV Health Service Consultation	£9,707,835	£85,794,769	**1.56%**
Non-Ophthalmic related Medical	£1,365,278	£12,065,898	**0.22%**
Social and Personal Cost	**£173,701,414**	**£1,535,580,164**	**27.88%**
Low-Vision Devices & Rehabilitation	£21,035,351	£185,903,760	**3.37%**
Paid Care (excess)	£37,218,495	£328,925,263	**5.97%**
Informal Care (excess)	£97,870,080	£864,944,742	**15.70%**
Residential Care (excess)	£17,013,894	£150,363,399	**2.73%**
TV Licence allowance	£563,595	£5,443,000	**0.10%**
Other Costs	**£8,490,049**	**£76,787,766**	**1.39%**
Capital	£7,625,025	£68,245,068	**1.24%**
Tax Exemption (Blind persons)	£865,024	£8,542,698	**0.16%**
Indirect Costs: lost productivity	**£73,227,281**	**£693,768,226**	**12.59%**
Underemployment (excess)	£67,262,597	£637,170,931	**11.57%**
Absence from work (excess)	£5,964,684	£56,597,295	**1.03%**
Deadweight Loss	**£45,750,151**	**£409,470,411**	**7.43%**
Total Cost of Illness	**£612,360,655**	**£5,508,696,381**	

Table GL-7. Cumulative Cost of illness and number of persons with sight loss due to glaucoma, at 3 levels of detection rate. Estimates for the U.K.

Assumed detection rate	Cumulative cost of illness over the decade	Sight Loss from glaucoma in 2010	Sight Loss from glaucoma in 2015	Sight Loss from glaucoma in 2020
50%	**£4,889,652,026**	**75,157**	**83,637**	**94,067**
75%	**£5,274,459,139**	**71,399**	**79,432**	**89,319**
90%	**£5,508,696,381**	**69,144**	**76,910**	**86,473**

Sight Loss = VA < 6/12 (VI+BLIND

Table GL-7 shows the total costs of illness over the decade for each assumed level of detection, in relation to number of people blind and partially sighted due to glaucoma, for the years 2010, 2015 and 2020.

Base Case Assumption: Detection rate is **50%**. In this situation**,** the estimated numbers in the U.K. with sight loss due to glaucoma (nearest 1000) are: 75,000 persons in 2010, rising to 84,000 persons in 2015, and 94,000 people in 2020 The total cumulative cost of illness for glaucoma (including OH) for the decade is £4.9 billion

Assumption-2: Detection rate is improved to **75%**. In this situation**,** there will be a modest decrease in prevalence of sight loss from glaucoma over the decade, the estimated numbers being 71,000 in 2010, rising to 79,000 in 2015 and 89,000 people in 2020. The total cumulative cost of illness for the decade will increase from £4.9 billion (at 50% detection), to £5.3 billion (at 75% detection) (Table GL-7).

Assumption-3: Detection rate is improved to **90%**. Under this assumption, the estimated numbers with sight loss are lower at: 69,000 people in 2010, rising to 77,000 in 2015, and 86,000 people in 2020 At this improved rate of detection, there will be between 6,000 & 7,600 fewer cases of sight loss from glaucoma in each year of the decade in the U.K., compared to 50% coverage. The cumulative cost of illness for glaucoma and OH over the decade will increased from £4.9 billion (at 50% detection), to £5.5 billion (at 90% detection)

Observation of the Authors:

We are honoured to have had the opportunity to do professionally what we like best to do, which is to work on these vision related models. Hopefully they will contribute to the information base within RNIB and beyond to all agencies delivering the UK Vision Strategy. As part of our brief we were asked for our thoughts on the ways forward for this work. We were also asked to identify the "gaps" in the information base which might be addressed to better inform the use of the model in the UK Vision Strategy and we happily comply.

Epidemiological models such as those that we have constructed for this report can estimate how many in the population are at risk of eye disease and how many have the disease and to some extent, they can tell us how many have related sight loss. We can also estimate the numbers of persons who (if they are receiving existing treatments considered to be effective), may have their vision regained or preserved or unfortunately go into irrevocable sight loss.

For existing treatment however, our models at present cannot estimate how many of those eligible for treatment present for, receive and take full advantage of their entitlements to these sight preserving treatments. Therefore our estimation of the likely pool of those going into sight loss could be at a more robust and detailed level than it is at present. A major cause of this limitation is the reliance on large scale but very limited data bases, and the paucity or lack of access to monitoring systems at the patient or disease level.

The UK recording systems in health and social services beyond the levels of audit to ensure professional competence, still have their basis in the aspiration of "money following patients" for the most cost effective returns on expenditures. Even if they were perfectly structured for their main objective, these recording systems will not suffice as ***effective*** systems to address the information we need on the match between services which are provided and those in need entitled to

be the recipients. Most certainly on their own or combined with demography or epidemiology, these databases have little facility to tell us the numbers of those in need of treatment or care who get left out from, or short changed by, the existing services.

As the costing aspects of our model, where “bottom up” methods are used, are applied to the numbers estimated by the epidemiology, they take the same limitations about knowledge of treatment levels. Use of “top down methods” (e.g. for cataract surgery) disaggregates expenditure to some level of budgetary category. This then can be related to a treatment code for intervention which cannot necessarily allow differentiation between patients receiving multiple or single treatment and has no information on those who are excluded. However we proceed, our work in the economic estimation of resource use reflects the poor information base on levels of accessibility, availability and outcome related to sight preservation or loss.

As a half way measure, in the models we make some implicit assumptions about levels of access, detection and coverage, and we explicitly vary some of the assumptions. This is more an indication of what knowing more would imply for estimations of sight loss, than it is about cost changes in expenditure.

Explicit assumptions are:

- The levels of coverage of the new treatment for Neovascular AMD could be at 50%, 75%, or 90%.

- The levels of detection for glaucoma could be 50%, 75%, or 90%, and the proportion treated among diagnosed ocular hypertension cases could be 30%.

Some implicit assumptions are:

- Whilst showing that persons from the African - Caribbean ethnic group are at higher risk of glaucoma than the general population, we assume that they are receiving and require the same level of treatment and of social care as the rest of the population.

- That members of this group also have the same benefit from treatment at different levels of disease as the wider patient group.

- That the lower level of employment opportunity for blind persons is not subject to a labour market racial discrimination effect which might make this even lower.

- That the old beyond the age of 85 years, have the same level of access to cataract operations as those in the younger groups of elderly.

- That persons on low income will purchase spectacles to maximise the functional outcome of cataract surgery.

- That the ratio of new to old used in the model and set as a government target for provider treatment, is “value free” without the effect of deferring patients who should be recalled for low vision or routine follow up appointments.

We offer the following thoughts for the future:

1. A concerted questioning of the “fit for purpose” of the routine health and social care recording systems if used as an information base for the Vision strategy or indeed for monitoring policy initiatives.

2. A strong impression that the assumptions about detection of disease and levels of treatment which we have had to make in the models suggest the need for an information base far more robust than we have at present.

3. A view that the necessary information base can be accrued at many levels of project size and expenditure, but should have criteria for collection which emphasise objectivity.

4. A conviction that removing this reliance on “not fit for purpose” systems and requiring collaborative systems of investigation and monitoring, will see positive returns for the UK Vision strategy. One such return would be that ongoing efforts in policy and strategy aimed at bettering access to new or improved treatments, will not fall short of ensuring the entitlements in eye care which the RNIB seeks to fulfil.

Angela Reidy and Darwin Minassian

Appendix 1

Methods – Epidemiology and Modelling

METHODS – Epidemiology & Modelling

The Decade Model - Overview

The Decade Model comprises a main controlling ECONOMIC Section, which carries out the following tasks:

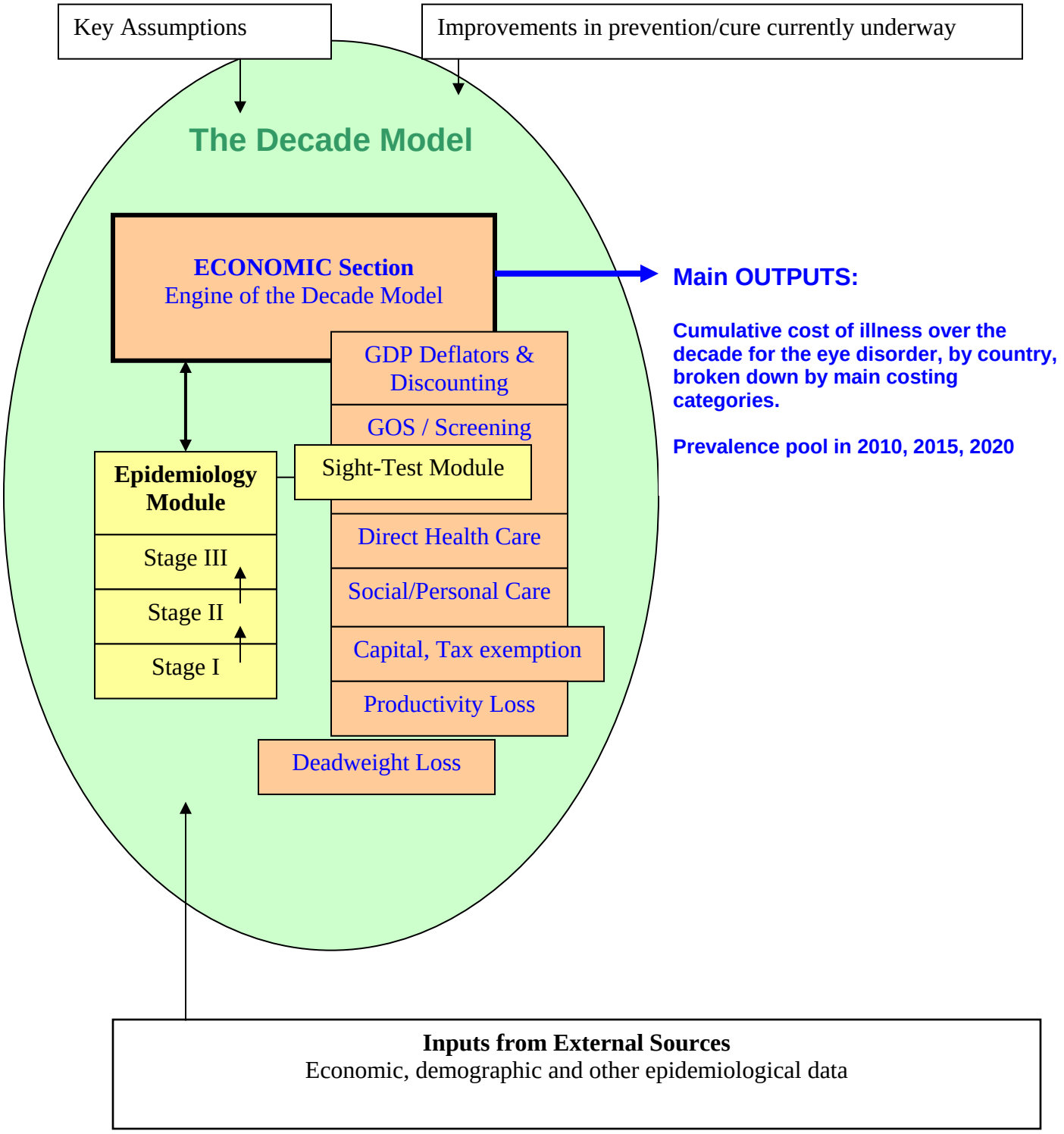
- Defines the conditions under which the model is run, according to the key assumptions.
- Instructs one of its serving sub-sections (the Epidemiology Module) as to what inputs it requires concerning epidemiological estimates.
- Takes costing and related outputs from other serving sub-sections.
- Formats the economic data so that they can be applied to the epidemiological estimates.
- Links the formatted economic data with the epidemiological estimates and computes the cost of illness over the decade.
- Prepares summaries of the cost of illness by country, and outputs the results together with some additional data of interest.

Figure M-1 shows the Model structure according to the main functions.

A ‘System Dynamics’ approach was used in constructing the decade model to simulate the dynamics of the eye disorder in large populations. ‘Level’ Variables representing pools of individuals affected by the eye disorder and by the consequent sight loss, and the pools of financial costs, are used. These are interconnected by ‘flow paths’ allowing flow in and out of the pools. ‘Rate’ variables acting as ‘taps’ determine the rates of flow into and out of the pools. ‘Auxiliary’ variables representing influence factors (determinants) open or close the ‘Rate taps’ (increase or decrease the rates of flow). The levels are influenced only by rates, and the rates only by auxiliaries and other levels.

The ‘system’ being modelled comprises the given population, and the health care and related resources therein. When the model is run for the specified simulation (projection) period, the pools grow (or shrink) with passing time, according to the population dynamics of the eye disorder and the care facility in the system. Snapshots of the main pools are outputs that give summary results of the simulation at selected (desired) calendar year points in the projection period. The defaults for the summary outputs are: affected number of individuals in the years 2010, 2015, and 2020, total cumulative cost of illness by year 2020, and the cost at base year 2010.

Figure M-1. Summary structure of the Decade Model according to main functions.



The main functional sub-sections of the Model are described below.

The Epidemiology Module

The Epidemiology Module requires incidence figures and mortality rates, in addition to prevalent numbers affected by the condition at issue at the beginning of the simulation period (year 2010). These are required, in order to compute the size of the total pool of cases in the population as years progress. The Module 'monitors' and records the changing pool, as new cases are allowed to flow in according to incidence rates, and existing cases flow out through mortality and other factors, over the 10-year simulation period. The main ECONOMIC Section of the Model links the dynamics of the prevalence pool with the economic data, to compute the cumulative cost of illness over the decade.

The processes in the Epidemiology module take place in 3 Stages, as described below.

Stage I of the Epidemiology Module

Derives **prevalence** figures (**historic prevalence proportions**) from best available prevalence data that have been reported by population-based studies. The derived proportions are then applied to the population projections provided by Government Actuary's Department (GAD), to compute the number of individuals affected by the disorder at issue. Age-specific prevalence estimates are split by gender and ethnicity when appropriate. The Stage I outputs are considered as **initial** (preliminary) projections, as they are based on the ***historic prevalence proportions,*** and are valid only if the underlying age/sex/ethnic-specific incidence rates of the disorder are stable and the same as the historic incidence rates that determined the historic prevalence. The incidence rates are unknown at this stage.

Stage II of the Epidemiology Module

Estimates the effective age-specific Cumulative Incidence of the disorder over a calendar period, for birth cohorts, by gender and ethnicity when necessary. The method used is based on the procedures described by Elandt-Johnson & Johnson (1980) for the estimation of incidence onset distribution from prevalence data, in "*Survival Models and Data Analysis*" (John Wiley and Sons 1980). The calculations use the prevalence figures derived in Stage I, mortality rates, and population projections (which include net migration figures). The mortality rates are those used by the Government Actuary's Department (GAD) to make the population projections. The decade model converts the mortality rates to conditional survival probabilities over the periods 2010 – 2015, and 2015 – 2020.

Stage III of the Epidemiology Module

Takes the historic Cumulative Incidence ($\mathbf{CI}_{historic}$) rate for a birth cohort, prepared in Stage II, modulates it according to the changes expected under a given key assumption, or expected because of improvements in preventive/curative measures currently underway. The resulting incidence ($\mathbf{CI}_{final}$) is then applied to the population at risk (i.e. to the number of individuals free of the disorder in the birth cohort at the start of a ***period***), to calculate the 'final' projected number of affected individuals in the birth cohort at the end of the ***period***. In this Stage, the number of new cases that occur and accumulate over the projection period are stored in 'temporary' variables, a permanent count being kept for some disorders of interest.

The equations used are:

$$\mathbf{CI_{final}} = (1+\mathbf{Y})\ \mathbf{CI_{historic}} \quad \textbf{and} \quad n_1 = (P_{surv}\ n_0) + \left\{(N_0 - n_0)\ \mathbf{CI_{final}}\right\}$$

Where:

n_1 = Number of affected individuals in the birth cohort at the END of the ***period***.

n_0 = Number of affected individuals in the birth cohort at the START of the ***period***. Figures for the start of the projection period (year 2010) are obtained from Stage I.

P_{surv} = The Proportion of n_0 (the prevalent cases) surviving to the end of the ***period***.

N_0 = Total number of individuals in the birth cohort at the start of the ***period***.

Y = Proportional change in the historic incidence rate expected under a given assumption (or scenario), or expected because of improvements in preventive/curative measures currently underway. The Model evaluates Y according to the Scenario or the expected improvements. For example, an expected relative risk of 'historic CI' / 'future CI' = 1.25, is translated to Y = (– 0.25), i.e. an expected 25% reduction in risk.

$\mathbf{CI_{final}}$ = The expected cumulative incidence for the birth cohort over the ***period***. Note that values of CI for a particular birth cohort change, as the cohort members advance through calendar time and become older.

The process is repeated for the remaining birth cohorts in the model, and the resulting values of $\mathbf{n_1}$ are summed up to give the total number of individuals with the disorder at the end of the ***period***, broken down by age, and gender/ethnicity where appropriate.

The subsequent (next) ***period*** is then considered and the whole process repeated, with numbers at the beginning of the new ***period*** assuming the values computed for the end of the previous ***period***…. and so on.

For AMD, the model also keeps a count of the number of Ranibizumab injections and numbers who gain visual acuity, as time progresses over the decade.

The Sight Test Module

The latest report - *General Ophthalmic Services (**GOS**): Activity statistics for England and Wales, year ending 31 March 2008* - published by the **Information Centre, Part of the Government Statistical Service**, provided the main external inputs for this module. According to GOS, for the year ending 31 March 2008 there were **16,106,528** sight tests, of which 5,058,638 were paid for privately.

The module was constructed to take the GOS data on number of sight tests (by mainly clinical need category or age), and apportion them to the 4 main eye disorders being modelled, in a sensible way. In the context of the cost of illness study, the GOS was considered as a screening service for multiple eye disorders among the general population (and for special persons such as close relatives of glaucoma patients), to identify eye disorders that should be referred to the GP or hospital services, and to provide for those requiring correction for refractive errors. Consequently, for cost of illness purposes, the time/resource spent by the optometrist looking for a particular disorder in a member of the public requesting an eye test, should have little to do with the population prevalence of the disorder, and much to do with the type of procedure used to detect the condition. For example, assessing a client for glaucoma takes longer and costs more than assessing the person for cataract. Time taken for visual acuity (and allied) measurements and slit-lamp examination are common to both conditions, but looking for glaucoma may also require measurement of visual fields and of the intraocular pressure, using up considerably more time/resource. Accordingly, a tentative schedule was developed to evaluate the proportion of the total time/resource per sight test that could be attributed to the identification of each of

the main eye disorders, including refractive error and an open category of 'others'. A schedule was constructed for each main category of attendee (as listed in the GOS report), and weighted average attributable proportions derived (weighted by the number of sight tests falling in each category). The resulting apportionments are shown below:

Disorder	Age 60+	< 60
Glaucoma	0.3702	0.1372
AMD	0.1009	0.0000
Cataract	0.1352	0.0664
DR *	0.0100	0.0000
Ref. Err.	0.1938	0.4425
Other	0.1900	0.3540
All	1.0000	1.0000

* Cost of **formal** screening for DR was included in the 'Hospital Care' cost of illness category.

For future use, the schedule should be validated through a study based in optometrist practices.

The module derived the sight tests per head of population <60 and 60+ from the GOS and GAD data, and allocated the fractions to the 4 main eye disorders according to the schedule. These were subsequently used to derive **number** of sight tests to which the unit costs would be applied.

DEMOGRAPHY

The latest projections of population estimates for the years 2010 to 2020 were obtained from the Government Actuary's Department (GAD). These give estimated numbers by 1-year and 5-year age classes, for males, for females, and for all persons, and cover the UK, and the devolved countries (constrained to the national projections). A summary of population projections is shown below.

Projected populations (in 1000s) at mid-years. 2006-based Principal projections. Source: Government Actuary's Department.

	Year: 2008	2010	2015	2020	2025	2030	2036
England	**51,488**	**52,297**	**54,319**	**56,354**	**58,311**	**60,096**	**62,033**
Wales	**2,993**	**3,023**	**3,098**	**3,172**	**3,237**	**3,288**	**3,330**
Scotland	**5,157**	**5,190**	**5,258**	**5,316**	**5,357**	**5,373**	**5,361**
N. Ireland	**1,774**	**1,799**	**1,857**	**1,911**	**1,958**	**1,993**	**2,023**
UK	**61,412**	**62,309**	**64,532**	**66,754**	**68,863**	**70,750**	**72,747**

Population Projections by Ethnic Groups

Some estimates (with limitations) were available from the Office for National Statistics (ONS), and from other groups who have developed their own simulation models to expand on the ONS estimates. There are serious problems in projecting population estimates split by ethnic group. The difficulties include lack of an ethnic dimension in the past trends of migration, fertility, and mortality. The first stage of a project initiated by the ONS involved a feasibility study for making such projections. The study, started in 1999, was undertaken by a group of experts made up of academic demographers, geographers, and other specialists in the field of quantitative ethnic demography. The findings [Haskey 2002] led to the conclusion that "projections can usefully be undertaken – albeit

with larger uncertainty than with traditional projections – when prepared for individual ethnic communities …"

For the decade model concerning glaucoma and ocular hypertension, we have derived ethnic split projections, taking the latest ONS population estimates by **ethnic** group for England for the year 2005 (published in October 2007), as the base year. The ONS estimates are said to be 'experimental'. The methodology is described by Large & Ghosh [Large P 2006].

AMD – Methods for Epidemiological Estimates

AMD - Prevalence

The following sources were considered for selection of the most appropriate prevalence data to be used as inputs for the Decade Model:

- **The European Eye Study (EUREYE)** [Augood CA 2006]. Multicentre study in 7 European countries (Norway, Estonia, UK, France, Italy, Greece, and Spain).

- **The Eye Disease Prevalence Research Group** 2004 [EDPRG 2004]. Meta-analysis of large population-based studies in: Europe (Rotterdam); USA (Beaver Dam, Baltimore, Salisbury); Australia (Blue Mountains-Sydney, Melbourne-Victoria); and Barbados.

- **Evans** J.R. et al 2004. “Age-related macular degeneration causing visual impairment in people 75 years or older in Britain”. A population-based cross-sectional study [Evans JR 2004].

- **Owen** C.G. et al 2003. Meta-analysis of data requested and obtained from: Beaver Dam Eye Study, Melbourne VI Project, Blue Mountains Eye Study, Copenhagen City Eye Study, Rotterdam Study, and the North London Eye Study [Owen CG 2003].

- **Rotterdam Study** 1995. Reporting the prevalence of age-related macular degeneration, including estimates for early ARM [Vingerling JR 1995].

For early ARM estimates, the **Rotterdam Study** data were used, as this gave a mutually exclusive categories of Early ARM and AMD.

For AMD prevalence, the estimates from the **Eye Disease Prevalence Research Group** were used. These were similar to the estimates from the European Eye Study, but included younger age groups, was focused on obtaining robust estimates for Neovascular AMD and the 'dry' form of AMD (Geographic Atrophy), and on balance, was considered more suitable for our purpose. In both studies (and in others e.g. Owen), the Neovascular AMD and Geographic Atrophy were not mutually exclusive categories, in so far as the Geographic Atrophy group included some persons with Neovascular AMD in the fellow eye. All persons classified as Neovascular AMD had the disorder in at least one eye, some having the 'dry' form in the fellow eye. Since estimates were also given for 'Any AMD', i.e. the 'dry' and/or 'wet' forms, we were able to obtain the prevalence for 2 **mutually exclusive** categories: i.e. a) Neovascular AMD in one or both eyes, and b) **Only** 'dry' AMD in one or both eyes. The data are shown below:

		% Prevalence			
	Age	Any AMD *	NV-AMD *	GA-AMD *	**Exclusive GA-AMD**
Males	50-54	0.34	0.23	0.15	**0.11**
	55-59	0.41	0.28	0.22	**0.13**
	60-64	0.63	0.42	0.37	**0.21**
	65-69	1.08	0.73	0.66	**0.35**
	70-74	1.98	1.33	1.19	**0.65**
	75-79	3.97	2.49	2.16	**1.48**
	80+	11.9	8.28	6.6	**3.62**
Females	50-54	0.2	0.14	0.11	**0.06**
	55-59	0.22	0.16	0.12	**0.06**
	60-64	0.35	0.26	0.19	**0.09**
	65-69	0.7	0.51	0.37	**0.19**
	70-74	1.52	1.09	0.81	**0.43**
	75-79	3.44	2.4	1.85	**1.04**
	80+	16.39	11.07	9.37	**5.32**

* Original data, Source: **Eye Disease Prevalence Research Group**

AMD – Proportions with Sight Loss

For proportions with sight loss due to AMD, we used the **Owen** and the **Evans** estimates. The Owen estimates covered all the desired age groups, but did not give estimates for the required levels of sight loss. The estimates were for visual acuities of 6/18 to >6/60, 6/60 to 3/60, and poorer than 3/60. The Evans estimates did give the proportions for the required levels of sight loss (<6/12-6/60 and poorer than 6/60), but did not cover the younger age groups. The relative proportions Owen/Evans for the common age groups were used to derive proportions for the required levels of sight loss for the younger age groups. This adjustment did not affect the estimates for 'any sight loss' (<6/12).

AMD – Ranibizumab (Lucentis) Treatment

The assumptions for the model concerning eligibility and indications for Ranibizumab treatment in Neovascular AMD were based on the guide in the report by National Institute for Health and Clinical Excellence [NICE 2008], and The Royal College of Ophthalmologists clinician's guide [RCOphth 2008]. The model assumptions were:

- 75% of cases of Neovascular AMD with corrected visual acuity of **< 6/12-6/60** in the better seeing eye would be eligible (clinically suitable) for treatment.
- 10% of cases of Neovascular AMD with corrected visual acuity of **< 6/60** in the better seeing eye would be eligible (clinically suitable) for treatment.
- Treatment coverage: 75% of the eligible will be treated. The model also used 2 variations of this assumption: 90% treated to reflect improvements in treatment coverage, and 50% treated to reflect possible limitations in access to treatment or patient concerns.
- Ranibizumab treatment: on average, 8 injections would be given in the first year, followed by 6 injections in the second year of treatment.

Published data from the ANCHOR [Brown DM 2006] and MARINA [Rosenfeld PJ 2006] studies were used to derive values for the treatment effect: relative risk of progression to blindness, and of the proportion among the treated who gain visual acuity of 15 or more letters (3+ Snellen lines). The derived values were: 0.17 and 0.25 respectively. In the model, the reduced risk of progression was allowed to persist for 2 years from start of treatment, and gradually return to baseline in 5 years.

CATARACT – Methods for Epidemiological Estimates

A substantial portion of cost of illness for cataract relates to treatment and clinical management, i.e. cost of cataract surgery (and management of adverse post-operative events). Accordingly, we have used number of cataract extractions rather than number of persons with cataract, for estimation of treatment costs. For calculation of costs relating to partial sight or blindness attributable to cataract, and for other cost components, we have estimated the number of affected persons.

Number of Cataract Extractions

Number of Finished Consultant Episodes were obtained from the *NHS - The Information Centre (England), Hospital Episode Statistics - 2006-07 (HES).* These also provided number of capsulotomies performed following cataract surgery. The original data were by very broad age classes, unsuitable for our purpose. In order to refine these to 5-year age classes, proportions falling in each age-class, by gender, were derived from a large study of cataract surgery in the UK, involving more than 100 hospitals and 19000 patients [Desai P 1999]. These proportions were applied to the HES data to obtain numbers by age and gender. Population ‘rates’ were then computed by using the age/sex-specific population

of England (2006). These 'rates' were then applied in our model to the populations in year 2010 onwards, to obtain the expected number of cataract extractions and capsulotomies.

Sight Loss Attributed to Cataract

Our estimates for bilateral sight loss are based on an extended analysis of the North London Eye Study [Reidy A. 1998], where individuals were classified according to the principal cause(s) of the visual impairment, by ophthalmologists, **at the time of the clinical examination,** rather than being derived entirely from recorded disease status and visual acuity data. Individuals who had bilateral cataract / pseudophakia and had poor vision were not classified as 'sight loss attributed to cataract' if the principal cause of the sight loss was judged to be macular degeneration or end-stage primary open angle glaucoma or central corneal opacity etc. Those with poor vision but awaiting surgery or waiting to be listed for surgery were also excluded, since their sight loss was deemed temporary and short-lived. Thus, the main bulk of the 'VI attributed to cataract' comprised:

- Cataract cases deemed to be unsuitable for surgery or unwilling to have surgery in the foreseeable future (as indicated by the "No Action Needed" recording);
- Those with bilateral pseudophakia with no other apparent cause for the poor vision (apart from possible cognitive deficit, or the retina being 'old and tired'); and
- Persons with 'irreversible' sight loss due to complications following cataract surgery (e.g. endophthalmitis, secondary end-stage glaucoma, retinal detachment, etc.).

As always, there were some borderline cases (with a mix of co-existing disorders) that were hard to classify.

The population prevalence of partial sight (corrected visual acuity <6/12-6/60 in the better eye) attributable to cataract, by age and gender, were taken from the North London Eye Study data. These age/sex-specific prevalence figures were smoothed by a best-fit curve (exponential) applied to males and females separately. The curve equations were used to estimate the number of affected persons in the population. The smoothed prevalence figures are shown below:

Prevalence of partial sight attributable to cataract. Estimated from the North London Eye Study (NLES).

		NLES
	Age	**Smoothed**
MALES	50-54	**0.002764**
	55-59	**0.003558**
	60-64	**0.004579**
	65-69	**0.005895**
	70-74	**0.007588**
	75-79	**0.009768**
	80-84	**0.012573**
	85+	**0.017023**
FEMALES	50-54	**0.000851**
	55-59	**0.001330**
	60-64	**0.002078**
	65-69	**0.003248**
	70-74	**0.005076**
	75-79	**0.007933**
	80-84	**0.012399**
	85+	**0.019377**

The overall prevalence of bilateral blindness (VA<6/60) attributable to cataract, from the North London Eye Study analysis was estimated at approximately 0.129%.

Endophthalmitis

Infectious (proven or presumed) endophthalmitis following cataract surgery is a very rare event but is of major concern because in a substantial proportion of cases it lead to serious visual impairment or loss of the eye, in spite of improved modern management strategies. From a public health perspective, the condition is also of concern because substantial number of cases are accrued annually from the huge volume of cataract surgery in large populations. The condition is often difficult to treat and can be very costly to manage.

The 1-year cumulative incidence of endophthalmitis following cataract surgery was taken from our earlier work – meta-analysis of 13 European studies, including 6 studies in the UK. Two rates were computed according to the prophylaxis strategy in widespread use: a) 1.31 per 1000 under conditions of routine prophylaxis, and b) 0.51 per 1000 with additional intracameral antibiotics at the time of surgery. The former rate was used in our model for 2008, but the lower rate was considered more appropriate for future projections. The lower incidence reflects the expected widespread use of intracameral antibiotics (e.g. second-generation cephalosporins, such as cefuroxime) in addition to the routine prophylaxis with povidone-iodine eye preparation and topical antibiotics. The additional prophylaxis was suggested by the ESCRS (European Society of Cataract & Refractive Surgeons) revised guidelines. The guidelines were informed by the ESCRS randomised controlled trial, on prophylaxis to prevent endophthalmitis following cataract surgery [ESCRS 2007].

Cystoid macular oedema

Cystoid macular oedema, first reported by Irvine in 1953, may occur typically 3-12 weeks after cataract surgery. Angiographic evidence of leakage and accumulation of fluid in the macula, and macular thickening as evidenced by optical coherence tomography are observed in a large proportion of

pseudophakic eyes, but most of these are not associated with any loss of visual acuity (though they may result in some loss of contrast sensitivity). When the macular oedema is associated with clinically significant loss of visual acuity, the condition is termed **clinical CMO**, and this is an area of major concern, because it may seriously delay the expected gain in visual function or negate the earlier gains, causing substantial anxiety and inconvenience to the patient and places additional demand on eye services. The condition is largely self-limiting and may resolve in up to 90% of patients by 3-12 months. Some of the few persistent chronic cases may suffer permanent sight loss due to irreversible damage to the macula.

In our previous extensive work on published data, the cumulative incidence of CMO within 4 months of cataract surgery was estimated at **3.0%**. This estimate, however, is subject to considerable uncertainty, as indicated in the summary quoted from our previous work:

"In Summary: No epidemiologically sound estimate of incidence is available for clinical CMO following cataract surgery in the UK, and no reliable estimate could be derived from reported data. The findings and arguments presented above suggest a likely incidence of around **3%** within 4 months of cataract surgery in the UK, with a minimum expected incidence of around **2%** and a maximum of about **4%**. These figures are higher than the often quoted minimum of 1%, which was based on earlier studies and related only to **uncomplicated** cataract surgery…"

Retinal detachment

Detachment of the retina is uncommon in the general population, the incidence being around 0.02% per year in mid-late life. The risk is increased after cataract surgery, partly due to some complications at surgery, such as posterior capsule

tear, and also because of the patient's characteristics, such as high myopia (axial length of the eye > 23mm), male gender, and younger age [Tuft SJ 2006].

The most reliable cumulative incidence rate (**0.16%)** for retinal detachment within 3 months of cataract surgery was given by the National Cataract Surgery Survey [Desai P 1999]. This was applied in our Model.

DR - Methods for Epidemiological Estimates

Prevalence of Diabetes (Diagnosed)

Prevalence estimates for diagnosed diabetes by age and gender were obtained from the Joint Health Surveys Unit (2008) Health Survey for England 2006. Extracts are shown in the table below.

Prevalence of diagnosed diabetes by sex and age, 2006 England

	All ages %	16–24 %	25–34 %	35–44 %	45–54 %	55–64 %	65–74 %	75+ %
Men	5.6	0.8	1.2	2.4	6.0	8.5	15.7	13.5
Women	4.2	0.9	1.2	1.2	3.6	6.0	10.4	10.6

The model allowed an average 1% annual increase in the underlying age/gender-specific risk of diabetes over the projection period. This was in addition to increasing numbers expected because of demographic changes over the projection period.

Prevalence of Diabetic Retinopathy

Estimates were based on the data from 27,178 individuals attending for first screening at the ***Wales Diabetic Retinopathy Screening Service*** (EASDEC

Rome 2007). The summary prevalence figures for each of the main stages of DR among the diabetic population were: Background DR 28%, Non-proliferative DR 2.5%, Proliferative DR 0.7%, and Diabetic Maculopathy 7.0%.

Partial Sight Attributed to DR

The Wales data did not give estimates for sight loss specifically attributable to DR, since the focus of analysis was all vision loss in diabetic persons attending the screening programme. Population-based figures on cause-specific prevalence of visual impairment were taken from the findings of 'The Visual Impairment Project', Australia [VanNewkirk MR 2001]. The summary prevalence figures of partial sight attributable to DR were: 9 per 10,000 people for age <65, and around 22 per 10,000 people for age 65 or older.

Blindness Attributed to DR

A different approach had to be used here, since the Australian study had found no blindness attributable to DR among the random sample of 4,744 participants. Blind and partial sight registration data for 2008 [Source: NHS - The Information Centre – National Statistics] were used to estimate age-specific rates of blindness (all causes) per head of population, as shown in the table below:

NHS-Information Centre ENGLAND-2008			England Popul. 2008		RATE per head of population	
Age	**PS**	**Blind**			**PS**	**Blind**
0-4	**700**	**805**	0-4	3,125,989	**0.000224**	**0.000258**
5-17	**5140**	**3975**	5-19	9,227,944	**0.000557**	**0.000431**
18-49	**16845**	**19330**	20-49	21,634,211	**0.000779**	**0.000893**
50-64	**14105**	**15655**	50-64	9,219,590	**0.001530**	**0.001698**
65-74	**16055**	**14805**	65-74	4,277,673	**0.003753**	**0.003461**
75+	**103345**	**98270**	75+	4,002,159	**0.025822**	**0.024554**
age ?	100	145				
Totals	**156190**	**152840**				

PS = partial sight

Proportions attributable to DR were taken from an analysis of registration certificates [Bunce C 2006]. Prevalence figures for sight loss attributable to DR were then derived.

GLAUCOMA & Ocular Hypertension (OH)

In this report, the term ‘glaucoma’ is used to indicates Primary Open-angle Glaucoma (POAG), characterised by slow death of ganglion cells in the retina and degeneration of their axons. The diagnostic features are loss of functional visual fields (particular patterns of loss), and degeneration of nerve fibres at the optic disc rim, causing diminution of the rim area relative to the deeper central area of the disc (‘cupping’ or enlarged cup/disc ratio). In late stages, the whole of the optic disc may appear atrophic, with less than 10 degrees of functional visual field remaining (tunnel vision). Raised intraocular pressure is not a necessary feature for diagnosis, but is a risk factor (is associated with increased risk of POAG). Sight loss from this condition is insidious, so that many patients present only when the disease is advanced. At any one time, about half of affected cases remain undetected.

Secondary glaucoma due to damage from other conditions or surgical complications is not included in our estimates, nor is angle closure glaucoma which is very uncommon in European populations. Congenital glaucoma is also excluded from our estimates for adults.

Ocular hypertension (OH) is defined as intraocular pressure of more than 21 mmHg, without any accompanying signs of POAG. The risk of developing glaucoma is increased in eyes that have ocular hypertension. There is some evidence that treatments to reduce the intraocular pressure may reduce the risk of POAG in patients with ocular hypertension. Generally, once detected, the OH

cases are monitored (about annually), some being treated with hypotensive eye drops.

GLAUCOMA – Prevalence Estimates

The following sources were considered for selection of the most appropriate prevalence data to be used as inputs for the Model.

- **The North London Eye Study** [Reidy A 1998] and our meta-analysis using few but most relevant epidemiological studies. These were based on relatively small numbers and were not as robust as the estimates from some of the larger meta-analyses listed below, but were considered more relevant for the UK.

- **Tuck & Crick:** Meta-analysis and predictive equations, based on the European studies and others of predominantly 'white' populations [Tuck MW 1998 & 2003].

- **Quigley & Vitale**: Meta-analysis and predictive equations based on large number of studies in diverse populations, giving a separate predictive equation for 'black' populations [Quigley HA 1997].

- **Rudnicka et al:** A very extensive and detailed meta-analysis covering 46 published observational studies, largely non-European. This gave age-specific prevalence of glaucoma for white, black, and Asian ethnic groups [Rudnicka AR 2006].

- **The Barbados Eye Study**. Predictive equation developed by fitting best curve (power function) to the survey data, to give age-specific prevalence for Black persons [Wu S-Y 2001].

For estimation in the non-black population (mainly white Caucasians + Asians), we selected the updated predictive equation developed by **Tuck and Crick** [Tuck MW 2003] to apply to our model. The equation was based on a logistic curve fitted to age-specific prevalence data from a balanced mix of European and other well-conducted epidemiological studies. The studies used by Tuck and Crick are listed below:

UK:

North London Eye Study – [Reidy A 1998]

Roscommon glaucoma survey, Ireland – [Coffey M 1993]

Ferndale glaucoma survey, UK – [Hollows FC 1966]

Europe:

Casteldaccia eye study, Italy – [Giuffre G 1995]

Egna-Neumarkt study in Northern Italy – [Bonomi L 1998]

Rotterdam Eye Study – [Dielmans I 1994]

Australia:

Victoria survey – [Weih LM 2001]

Blue Mountains Eye Study – [Mitchell P 1996]

USA:

Beaver Dam eye study – [Klein BEK 1992]

Baltimore eye study – [Tielsch JM 1991]

Framingham Eye Study – [Leske MC 1981]

The updated Tuck-Crick predictive equation used in our model was:

Prevalence = 0.1160/(1+(2139 x EXP(-0.0873 x age))).

For the black (African-Caribbean) population estimates, we selected the predictive equation based on the Barbados Eye Study data [Wu S-Y 2001]. The equation was:

Prevalence = 1.0E-07 x age$^{4.3440}$

In our Model, these predictive equations were applied to the adult population in the UK and in devolved countries, to obtain the number of glaucoma cases for each of the 5-year age classes, in non-black (predominantly white) and in African-Caribbean ethnic groups. The prevalence of POAG in adults younger than 40 years was considered to be negligible.

GLAUCOMA – Proportions with Visual Impairment

The partial sight prevalence proportions used in the model were derived from the North London Eye Study database, the overall figure being around 13% among glaucoma cases. Estimates for proportion **blind** due to glaucoma among glaucoma cases had to be derived from larger datasets. These included the Melbourne and Victoria studies in Australia [Wensor MD 1998] [VanNewkirk MR 2001], the Rotterdam Study [Dielmans I 1994], and the Copenhagen City Eye Study [Buch H 2004]. We used the pooled data from these studies to derive weighted average estimates (using the sample sizes as weights). Proportion blind among the African-Caribbean cases was estimated at 8%, based on the Baltimore Eye Survey [Sommer A 1991].

The Roscommon study in Ireland also reported the proportion blind among glaucoma patients, but this was not useful for our purpose because the blindness was due to **any cause.**

GLAUCOMA – Disease Stages

For cost of treatment and clinical management, we have used a European multi-centre study which gives costs in relation to the disease stage [Traverso CE 2005]. Accordingly, we had to classify our estimated number of affected persons (glaucoma and OH cases), by disease stage. Proportions falling in each of the

main stages were derived from the North London Eye Study data, the stage definitions being loosely in line with those proposed by the European cost study.

GLAUCOMA – Proportion Detected

Several cross-sectional studies have consistently estimated that only about 50% of the glaucoma cases in a population may be known, leaving half the cases undetected. These include studies in Ireland (Roscommon), Netherlands (Rotterdam), Australia (Melbourne & Blue Mountains), USA (Baltimore), and Barbados. Lower estimates of previously detected cases, however, come from The North London Eye Study [Reidy A 1998] (26%), the older study by Hollows and Graham [Hollows FC 1966] in Wales (30%), and the Egna-Neumarkt study in Italy [Bonomi L 1998] (22%).

On balance, and in view of the expected improvements in detection rates that might have come about due to 'case finding' by optometrists in the UK, the following assumptions were made:

- In glaucoma cases with no sight loss, 50% are expected to be known. This assumption was varied in the model (increased to 75% and also 90%) to reflect possible improvements in detection over the projection period.
- All persons with partial sight or blindness from glaucoma are expected to be known to the hospital services.

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Appendix 2

Methods – Economics

Methods - Economics

The brief for this project was that

- four eye diseases singly, should be covered
- there should be epidemiological estimates of the amount of each condition and related sight loss
- these estimates should be for the population of the UK and the devolved countries over a decade to the Year 2020
- and the cost of each disease to society should be estimated for the countries and for the Decade.

The four specified diseases were: Age related macular degeneration, glaucoma, diabetic retinopathy and sight impairing cataract. Conditions of accepted best routine clinical practice along agreed pathways to treatment and social care were to be followed within professional guidelines, where available.

This project was to be disease specific and forward looking for the Decade to inform the UK Vision Strategy to the year 2020. It was commissioned alongside a report from the Australian Access Economics which could be seen as considering the “burden of sight loss” using costs and quality of life measured for 2008 but without final differentiation by each eye disease.

The disease specific requirement led to the decision to use a system dynamics approach which would identify and then incorporate the secondary sources from demography, epidemiology, clinical staging and economics.

Type and amount of resources used and costing

Based upon the observations in the literature [Maynard A 2003] [Williams J 2002] [RCP:HIU] and the team’s knowledge it was agreed with the advisory

committee that government provided aggregate data at the most reliable coding level was not suitable for single disease resource use estimation. Furthermore these data were even less suitable for “stage of disease” costing necessary in the case of age related macular disease, glaucoma and diabetic eye disease.

Agreement was reached that while a mixed method approach to costing would be suitable, the main one would be “bottom up costing”. This would be particularly relevant for the stages of disease and also for the estimation of social care use where costs were incurred specifically related to sight loss.

In pharmaco- economics and in NHS funded Health technology research numerous cost effectiveness studies present costs for such inputs as drugs and diagnostic testing for glaucoma. In the main the focus has to be the measuring of the comparative level of outcome of the use of the drug or technology rather than linking treatment costs to severity of sight loss e.g. in DR [James M 2000] glaucoma [Poulsen P 2005], [BurrJ 2007] and AMD [Smith D 2004] [Raftery J 2007]. More recently these researchers, and others with access to clinical settings [Peeters A 2008] have co-ordinated multi country resource data collection for a specific eye disease. Published resource use studies that specifically provide “stage based costing” for vision related use of health and social care amount to five articles including those for the UK alone, and for the UK in Europe [Traverso C 2005] [Soubrane G] [Bonastre J 2002], [Lotery A 2007], [Lafuma A 2006]. Given this scarcity and the very limited application of these costs in UK research at eye disease level, validation of our inputs is not possible at present.

The nature of the differentiation by stage of disease makes it inappropriate to try to validate these costs from aggregate data split for broad ophthalmic categories. These latter sources are broad category returns of inpatient and day case procedures and as yet, very unreliable for identification of outpatient diagnostic type by specific clinical attendance [HES 2007. 2008]. The Access Economics

Cost of Visual Impairment Study for the UK has a prime focus on sight loss in total within the countries of the UK, with disease process quantification and costing as secondary. That allows more reliability in the use of aggregate data with less disadvantages from its limitations for differentiation. Because of the scope of the commissioning briefs and the necessary choice of methods, our two reports cannot validate each other in terms of costs or utilization data inputs to the models. They are however co-operative in aspects of methods in broader epidemiology and economics, e.g. the calculations on “dead weight” loss and the common use of vision related unemployment statistics adapted from the calculations of Access Economics.

Our method for the overall project was that of constructing system dynamics models covering the coming decade for each of the four visually impairing diseases. To ensure basic comparability of economic method with other general UK cost of illness studies, consulting the work of the PSSRU and the Oxford University group was of particular relevance [Bower P 2003] [Allen C] [Costa-i-Font J 2008]. “Paying the Price” [McCrone P 2008] which has an overall framework of Mental Health and is focused on individual disease, deals with adjustment of price and cost within a changing demographic time frame. Access Economics publication site, which has Cost of Visual Impairment reports for several countries, was consulted for examples of Vision specific Cost of illness studies [www. Accesseconomics 2008]. The four existing “cost of blindness” studies in the UK were consulted to ensure comprehensive coverage of items. [Meads C] [Meads C 2003] [Winyard S. 2005] [GDBA2003]. Their methods while valid, have alternative basis of calculation for disease prevalence to the one used in the modelling of eye disease for this report.

The perspective on the cost of the disease within the Future Sight Loss Model is that of a societal one. The approach is mainly that which is known as “bottom up” with some aspects of costing from the aggregate level of Hospital Episode data, and some substantial use of tariff or unit costs for health and for social care. The

pathways to treatment are followed within guidelines where available, while at the same time note is taken of new developments in the location of clinical care in community settings as proposed and piloted through the National Eye Care Services Steering Group (ECSSG) [Ricketts, B.2004] [DOAS Glaucoma] [Scotland 2005] [ECSSG internet].

Key points on Costing

The cost schedules in the next section of this appendix are included to indicate the thinking in the use of costed items and the proportions of use.

Following the pathways:

Primary care

At primary care level for optometry, a time allocation schedule was developed based, upon a clinician's assessment of the contribution of the diagnostic tasks within the sight test for the detection of each disease, as outlined in Appendix 2. This was one way in which the sight test charge could be allocated "pro rata " as a cost attributable to opportunistic screening for previously undetected conditions.

At general practice level the time component allocated for referral onwards from primary care to ophthalmology was based mainly on some individual community or hospital practice reports [Mac Kenzie G 2009].

Referral onwards which does not result in treatment was costed based upon levels of premature or unsuitable referrals reported in the literature [Azuara B 2007] [Bowling B 2005] [Salmon N 2007] [Ang G 2007][Banes M 2006].

Outpatient care

All patients who in the model appeared as diagnosed in one year, were costed as outpatients either as first or follow-up. In the case of cataract, all patients were given an outpatient appointment. Those operated on had their related appointment included in the tariff FCE (Finished Consultant Episode).

The NHS “targets for old and new” formed the basis of the yearly percentage of ongoing patients followed up where they were not in an identifiable costed stage of treatment category e.g. partially sighted or blind from geographic atrophy AMD [Leeds 2008].

Treatment

Glaucoma: For glaucoma, European study costs are used, since the samples in the studies have some recruits from the United Kingdom [Traverso 2005]. These samples of recruits are small overall and even more limited when single country sections are used. They are, however, based upon strict protocols, disease definition, and item coverage for cost collection on each patient. More work of this type is expected and this will allow cost inputs here to be firmed up over time. While there are clinical variations in treatment across Europe, there are also considerable similarities in the clinical pathways for glaucoma treatment. In the main, the variation in reported costs can reflect the differences not only in pricing of drugs and labour costs across Europe but also the filtering through of the changes that have come about in drug and surgical therapy within countries. Attempts to validate the bottom up costs taken from these studies by disaggregating the HES Statistics for treatments were not fruitful. Owen et al [2006] point to some of the difficulties of costing surgical procedures in a time of substitution of drugs for surgical interventions. Reporting of the UK country specific innovations that increase the substitution of community based staff for hospital based ophthalmologists are particularly useful in bottom up costing by

disease. Validation of these against wider data, however, was not possible beyond comparative broad categories. While these schemes produce useful individual patient based costs [Sheen N 2009], it is not possible as yet to disaggregate them for “ophthalmology by specialty” for their budget share of the top down "community services" category.

Diabetic Retinopathy: As the formal screening programme for diabetic retinopathy is more established the initial variations in service and costs are being addressed. Apart from the costing of primary care and General Practice allocations, the resource inputs for ongoing detection and treatment of diabetic eye disease follow the Garvican costing guidelines and resource use calculations [Garvican L 2004] (updated for inflation) and supplemented by Scanlon [2005].

Age- related Macular Disease: The basis of the treatment costing method was decided upon for the quantity of drugs and the numbers of treatment from the final NICE guidelines and Lotery et al.[NICE 155. 2008],[Lotery A 2007]. Before the final NICE guidance was issued the model used initial costs from the commissioning documents of the Scottish PCTs that had estimated likely uptake and costs per commissioned treatment [Highlands Health Authority 2008]. More recently PCT contracts with eye hospitals were searched for the best "all in" FCE price. Moorfields Eye Hospital with Haringey PCT was chosen as the most inclusive for a course of treatment [Haringey PCT 2008]. Unit costs for diagnostic procedures were applied separately and obtained from the NICE report (adjusted) [NICE 155 2008].

For the Blind and Partially Sighted: Those whose condition required ongoing monitoring to prevent further deterioration, are included in the related disease costing. Those who are newly registered blind are allocated an entitlement to an ophthalmologist consultation for registration, the option of a social work interview for referral to social services and a low vision assessment clinic appointment. Literature points to the use of hospital eye services by those irremediably blind

for eye care as well as for low vision [Responses to NICE 2006-8]. For newly blind persons, some reports [Burr J 2007] and [Smith D 2004] consider the costing of registration and hospital consultation around that process and suggested a combined cost which was updated for use here.

Vision related excess costs in health and social care

At this point the issue arises of excess of routine service use where this use is attributable to an eye disease and/or sight loss in general. Costing here requires extrapolation from "bottom up" patient based costing mainly from Age-related Macular Degeneration [Ke K 2007] [Douglas G 2006]. As indicated in the cost schedules, the key service areas are non ophthalmic medical care, social care, paid and informal, and residential care.

Cost of illness studies consider broad categories of sight loss, attributing excess rate of falls and depression as well as mortality to groups with poor visual acuity [GDBA Grainger; 2003] [www.accesseconomics.com]. An issue here is the degree to which the epidemiological literature holds up for excess mortality related directly to an eye disease and blindness. Similarly for excess non ophthalmic hospital treatment related to an eye morbidity. Though the study was for a very limited time period, Sach et al found no less and even greater usage of non vision related eye services amongst those who had undergone cataract surgery than amongst those with the same level of vision, not operated on within that year [Sach T 2007]. Excess non-medical costs used here for the visually impaired and blind are per patient and come from Lotery et al from their study of Neovascular AMD [Lotery A 2007].

Vision-related residential care use and cost is also taken from an European study which included the UK [Lafuma 2006]. Evans recently suggests that the evidence is not strong for excess residential care due to visual impairment [Evans J 2008].

Excess Mortality: The epidemiologists on the team and the ophthalmic epidemiologist on the advisory committee were not convinced of the amount of mortality, if any, that could be attributable to visual impairment. A value for lost resources due to possible excess mortality therefore was not included in the model.

Excess Paid Care and Excess Informal Care: The “bottom up” costing studies which consider this [Ke K 2007] [Lafuma A 2006] compare visually impaired with non visually impaired, though in the case of Ke's report the comparison group is those with AMD who have good vision. A combination of sources and insights from the summary of Bosanquet and Mehta [2008] are used in the model. Ke in particular is used, supplemented by work of researchers with direct access to blind persons from a broader population sample [Douglas G 2006] [Pey T 2005]. The rate per hour applied for the costs of paid care is from the Unit costs of Health and Social Care [Curtis L 2008]. The informal care sources estimate hours of inputs of care in general and do not specify the type or level of care. Should outputs of the care have been specified, these could have been costed at market value per type and unit of output. An opportunity cost approach is taken to allocating a value to these hours (earnings foregone) [Carers UK 2007].

Productivity loss: The value of resources lost due to unemployment related to sight loss are considered and costed, as are days absent from work due to vision problems. Work here follows the standard method of costing by weekly wage rates, gender, and age. The sources for levels of unemployment amongst the visually impaired are from an RNIB commissioned report [Meager N 2008]. Results were derived using similar sources and methods as those used by Access Economics who gave us sight of their calculations for RNIB in 2008 [LFS ONS 2008] [ASHE]. A preliminary consideration of the use of the effect of using the "friction period" approach [Koopmanschap MA 2007] rather than the human

capital approach is modelled. The overall cost of illness tables present lost productivity costed from the orthodox economics human capital perspective. This allows comparison, however limited, with other cost of illness studies in sight loss and other areas of disability. The friction method was calculated for a friction period of 13 weeks, and the difference in the value of lost resources for the two methods is indicated for diabetic retinopathy at the end of DR cost schedule in this methods section.

Taxation: Exemptions for blind persons are costed as indicated and referenced on the cost schedule charts. Eligibility is based upon the expected low levels of earnings and pensions of blind persons and especially older women. The amount declared by the Government is approx £10 million in total, undifferentiated by cause of blindness.

Capital costs: This component is applied to all direct health and social care costs. Those areas where Health Resource Groupings are used may have initially included a capital cost element. Changes in the location and form of delivery of services, e.g. for diabetic eye disease and glaucoma follow-up in the community, may require technology substitution. The choice of 2%, though informed by UK literature (PSSRU), is mainly arbitrary.

Deadweight loss: This is based upon an innovative approach to government borrowing and taxation primarily reported in cost of illness by Access Economics, and is included here to provide a comprehensive coverage of the call on resources used for health and social care [www.accesseconomics 2008Access].

Discounting and Inflation

The Base level prices at 2008/9 are used for the Decade model and discounted at 3.5.% per annum which is considered normal practice in UK cost of illness projection to future years.

Where costs were transferred from pounds sterling to Euros by authors, we returned them to their initial pound value by the method originally used in the transfer .i.e. purchasing power parity was used or country currency rate of exchange**.** [Wordsworth S.2005] [www.oecd.org/document]

All prices from previous years were updated to 2008/9 using the GDP deflator. The NHS GDP and Social Care Deflators recommended by the PSSRU are not used. One reason for this was that the stage based costing sources did not differentiate between labour and drugs and technology inputs for the NHS.

Within the UK with the exception of the General Ophthalmic Services, no single country cost changes were made.

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Cost Schedule: Adjusted cost inputs to Decade Model 2010-2020 **Age- related Macular Disease *(with References)*** All Unit Costs are Current Prices (available at 2008 for 2008/9)	
General Ophthalmic Services Costs (1,2)	
Payment to Optometrist per Eye-Test - England & Wales and N.Ireland	£20.70
Payment to Optometrist per Eye-Test - Scotland	£38.00
Pears & Weci Cost (WALES ONLY) - additional to above for Wales (3)	
General Practice Consultation Costs	
Cost per consultation (4)(20)	£21.93
Proportion of all new AMD having GP consultation in the Year	0.333
Treatment Costs (Current Prices) (8, 25,26, 27,28)	
All in Cost per Injection (PCTwith Moorfields)–includes Admin & 1 Angio	£1,275.00
Cost of ONE Ranibizumab Injection	£761.20
Possible negotiated procurement discounts (Overall mean Rate of drug price Discount)	15.00%
PDT & Laser: Largely being phased out	
Cost of Administering IV Injections - Day Case	£395.00
Cost of Administering IV Injections - Out-Patient	£90.20
Proportion having IV Injection as Day-Case	1.00
Monitoring of Cases under Treatment	
Included in ALL-in cost of treatment above **(24)**	
Other Hospital Activities	
Fundus Fleuorescene Angiography (FFA) Unit Cost	£520.74
Proportion Having Angiography in the Year (1st assess): apply to new Sight loss Neovascular	1.0000
Proportion Having Angiography in the Year: GA	0.0000
Proportion Having Angiography in the Year: apply to old SLNV	0.2000
Early ARM: Proportion having First Assessment	0.3000
First Appointment Unit Cost (Medical Ophthalmology) (5)	£119.00
Follow-up Appointment Unit Cost (Medical Ophthal)	£68.00
Follow-Up Appointment (General Ophthalmology)	£48.00
Trip to Hospital	
Trip Cost per Visit	£10.00
Trip Cost per Visit - NV having treatment	£30.00
Number of Visits by New Cases, in Year (additional to those under Ranibizumab treatment)	2.00
Number of Visits by Old Cases, in Year	1.00
Of the AMD attending Hospital, Proportion that are New Cases (6)	0.697

Cost Schedule Continued: Age- related Macular Disease	
LV Health Service Consultation	
Cost per head for New (applies to all Blind & 1/2 partially sighted) (includes Registration for BL/PS + LV Consultation)(7)	£190
Cost per head for Old	£30
Direct Non-ophthalmic related medical cost – (includes falls and depression) (8,23)	
Mean health resource utilisation Cost per head (excess attributed to Sight Loss)	£19.75
Low-Vision Devices & Rehabilitation (9)	
Cost per head of VI & BL Cases	£304.22
Excess Paid Care (4,10,11, 21,22)	
Proportion among partially sighted	0.167
Proportion among Blind	0.217
Extra Hours per day for partially sighted	0.3
Extra Hours per day for Blind	1.47
Cost per hour for partially sighted	£19.84
Cost per hour for Blind	£19.84
Excess Informal Care (4, 10,11,12, 21,22)	
Proportion among partially sighted	0.326
Proportion among Blind	0.516
Extra Hours per day for partially sighted	2
Extra Hours per day for Blind	3.2
Cost per hour for partially sighted	£10.08
Cost per hour for Blind	£10.08
Excess Res Care: (13,21,22,33)	
Cost per head for partially sighted & Blind persons	£246.06
Capital Costs	
A % of Direct Health care and social care costs (- informal care)	2.00%
Deadweight Loss (14,15)	
A % of Direct Health care and social care costs (- informal care)	£0.12
TV Licence Exemption (Blind up to Age 74 inclusive) (16)	
Allowance per year: apply to age <75 (16)	£69.75
Tax Exemption (Blind persons) (17, 18. 19)	
Total tentative amount £10,000,000	
Blind person potential amount (A)	£360.00
Age < 65 MEN: proportion getting (A)	0.3400
Age < 65 WOMEN: proportion getting (A)	0.1500
Age 65+ MEN: proportion getting (A)	0.1800
Age 65+ WOMEN: proportion getting (A)	0.0750

Cost Schedule: Adjusted cost inputs to Decade Model 2010-2020

Cataract *(with References)*

All Unit Costs are Current Prices (available at 2008 for 2008/9)

General Ophthalmic Services Costs (1,2)	
Payment to Optometrist per Eye-Test - England, Wales and N. Ireland	£20.70
Payment to Optometrist per Eye-Test - Scotland	£38.00
Pears & Weci Cost (WALES ONLY) - additional to above for Wales (3)	
General Practice Consultation Costs	
Cost per consultation (4)(20)	£21.93
Proportion of all new cataract patients having GP consultation in Year	0.333
Treatment Costs (Current Prices) (26, 27,29,30,31)	
Planned Elective Day Case	£750.00
Spectacle Unit cost	£170.00
Capsulotomy Unit cost	£570.21
Endophthalmitis	£3,320.98
First Appointment Unit Cost (Medical Ophthalmology) (5)	£119.00
Follow-up Appointment Unit Cost (Medical Ophthalmology)	£68.00
First Appointment (General Ophthalmology)	£109.00
Follow-Up Appointment (General Ophthalmology)	£48.00
Trip to Hospital	
Trip Cost per Visit	£10.00
Trip Cost per Visit - NV having treatment	£30.00
Number of Visits by New Cases, in Year	2.00
Number of Visits by Old Cases, in Year	1.00
LV Health Service Consultation (7)	
Cost per head for New (applies to all Blind & 1/2 partially sighted) (includes Registration for BL/PS + LV Consultation)	£190
Cost per head for Old	£30
Direct Non-ophthalmic related medical cost - (8,23)	
Mean health resource utilisation Cost per head (excess attributed to Sight Loss)	£19.75
Low-Vision Devices & Rehabilitation (9)	
Cost per head of partially sighted & Blind Cases	£304.22
Excess Paid Care (4,10,11, 21,22) (31,32)	
Proportion among Blind	0.217
Extra Hours per day for partially sighted	0.3
Extra Hours per day for Blind	1.47
Cost per hour for partially sighted	£19.84
Cost per hour for Blind	£19.84
Excess Informal Care (4, 10, 11, 12, 21, 22)	
Proportion among Blind	0.516
Extra Hours per day for partially sighted	2
Extra Hours per day for Blind	3.2
Cost per hour for partially sighted	£10.08
Cost per hour for Blind	£10.08

Cost Schedule Continued: Cataract	
Excess Residential Care: (13,21,22,32, 33)	
Cost per head for partially sighted & Blind persons	**£246.06**
Capital Costs	
A % of Direct Health care cost	**2.00%**
Deadweight Loss (14,15)	
Marginal cost of raising additional funds (multiply by total Direct Health care and social care costs, excluding informal care costs)	**£0.12**
TV Licence Exemption (Blind up to Age 74 inclusive) (16)	
Allowance per year: apply to age <75	**£69.75**
Tax Exemption (Blind persons) (17, 18. 19)	
Total tentative amount £10,000,000	
Blind person potential amount (A)	**£360.00**
Age < 65 MEN: proportion getting (A)	**0.3400**
Age < 65 WOMEN: proportion getting (A)	**0.1500**
Age 65+ MEN: proportion getting (A)	**0.1800**
Age 65+ WOMEN: proportion getting (A)	**0.0750**

Cost Schedule: Adjusted cost inputs to Decade Model 2010-2020 **Diabetic Retinopathy *(with References)*** All Unit Costs are Current Prices (available at 2008 for 2008/9)	
General Ophthalmic Services Costs (1,2)	
Payment to Optometrist per Eye-Test - England & Wales	**£20.70**
Payment to Optometrist per Eye-Test) - Scotland	**£38.00**
Payment to Optometrist per Eye-Test - N. Ireland	**£20.70**
Pears & Waci Cost (WALES ONLY) - additional to above for Wales (3)	**£0.00**
GP Consultation Costs	
Cost per consultation (4, 20)	**£21.93**
Proportion of all Diabetics having consultation in the Year	**0.5**
Screening & Clinical management (cost per diabetic) (34, 35, 36)	
Screening	£20.15
Referrals	£5.27
Treatment	£18.32
Symptomatic work	£4.58
Tertiary grading	£1.30
Total cost per head diabetic	**£49.62**
Screening uptake	**85%**
Trip to Hospital	
Trip Cost per Visit (apply to Diabetics)	**£10.00**
LV Health Service Consultation	
Cost per head for New (to all Blind & 1/2 partially sighted) (6, 7)	**£190**
(includes Registration for BL/PS + LV Consultation)	
Cost per head for Old	**£30**
Proportion New, among persons with sight loss attending	**0.69**
Direct Non-ophthalmic related medical cost -	
Mean health resource utilisation Cost per head (excess attributed to Sight Loss) (8,23)	**£19.75**
Low-Vision Devices & Rehabilitation (9)	
Cost per head of partially sighted & BL Cases	**£304.22**
Paid Care (excess) (4, 10, 11, 21,22)	
Proportion among partially sighted	**0.167**
Proportion among Blind	**0.217**
Extra Hours per day for partially sighted	**0.3**
Extra Hours per day for Blind	**1.47**
Cost per hour for partially sighted	**£19.84**
Cost per hour for Blind	**£19.84**
Informal Care (excess) (4, 10, 11, 12,21,22)	
Proportion among partially sighted	**0.326**
Proportion among Blind	**0.516**
Extra Hours per day for partially sighted	**2**
Extra Hours per day for Blind	**3.2**
Cost per hour for partially sighted	**£10.08**
Cost per hour for Blind	**£10.08**
Residential Care (excess) (13,21,22,33)	
Cost per head for partially sighted & Blind persons	**£246.06**

Cost Schedule Continued: Diabetic Retinopathy	
Capital Costs	
A % of Direct Health care cost	**0.020000**
Deadweight Loss(14, 15)	
Marginal cost of raising additional funds (multiply by total Direct Health care and social care costs, excluding informal care costs)	**£0.12**
TV Licence Exemption (Blind up to Age 74 inclusive)(16)	
Allowance per year: apply to age <75	**£69.75**
Tax Exemption (Blind persons) (17,18,19)	
Total tentative amount £10,000,000	
Blind person potential amount (A)	**£360.00**
Age < 65 MEN: proportion getting (A)	**0.3400**
Age < 65 WOMEN: proportion getting (A)	**0.1500**
Age 65+ MEN: proportion getting (A)	**0.1800**
Age 65+ WOMEN: proportion getting (A)	**0.0750**

Cost of productivity loss in the UK in 2010. Comparing the 'Human Capital' and 'Friction' methods.

Diabetic Retinopathy	Human Capital	Friction	Difference
Underemployment (excess) *	**107,256,358**	**26,814,089**	**107,256,358**
Absence from work (excess)	**8,904,354**	**7,123,483**	**8,904,354**
Total	**116,160,712**	**33,937,573**	**116,160,712**

* excess due to sight loss

Cost Schedule: Adjusted cost inputs to Decade Model 2010-2020 **Glaucoma *(with References)*** All Unit Costs are Current Prices (available at 2008 for 2008/9)	
GOS Costs (1,2)	
Payment to Optometrist per Eye-Test (upgraded 2009) – England & Wales and N. Ireland	**£20.70**
Payment to Optometrist per Eye-Test (assumed primary eye exam &age adjustment – Scotland	**£38.00**
Pears & Weci Cost (WALES ONLY) - additional to above for Wales (3)	
GP Consultation Costs	
Cost per consultation % of GP contact rate per hour. (Apply to all new GL cases) or (1/3 of all GL cases) (4) (20)	**£21.93**
Treatment & Clinical management: Direct Cost of treatment, for UK, Per person year: 2008 (37,38, 39). Recalculated using GDP Deflator	
OH	**£313**
Early	**£362**
Mid	**£455**
Late	**£720**
Untimely Referrals	
Proportion of Tested Referred to Hospital	**0.04**
Of the Referred, Proportion referred for Glaucoma	**0.18**
Proportion of Glaucoma Referrals sent home (False +Vs)	**0.33**
First Appointment Unit Cost (Medical Ophthalmology) (5)	**£119.00**
Follow-Up Appointment Unit Cost (Medical Ophtha))	**£68.00**
Number of Follow-up Appointments per Case	**1.3**
Transport to Visit Hospital	
Cost per Trip for Mid & Late (accompanied by 1 person)	**£10.00**
Cost per Trip for Early	**£5.00**
LV Health Service Consultation	
Proportion New among partially sighted & Blind (6)	**0.69**
Cost per head for New (7)	**£190**
Cost per head for Old	**£30**
Direct Non-vision related medical cost – (includes falls and depression) (8) (23)	
Mean health resource utilisation Cost per head (excess attributed to Sight Loss)	**£19.75**

Cost Schedule Continued: Glaucoma	
Low-Vision Devices & Rehabilitation (9)	
Cost per head of partially sighted & BL Cases	£304.22
Excess Paid Care (4,10,11, 21,22)	
Proportion among partially sighted	0.167
Proportion among Blind	0.217
Extra Hours per day for partially sighted	0.3
Extra Hours per day for Blind	1.47
Cost per hour for carer for the Blind person	£19.8
Excess Informal Care (4, 10,11,12,21,22)	
Proportion among partially sighted	0.326
Proportion among Blind	0.516
Extra Hours per day for partially sighted	2
Extra Hours per day for Blind	3.2
Cost per hour for carer for the Blind person	£10.08
Excess Res Care: (13, 21, 2233)	
Cost per head for partially sighted & Blind persons	£246.064
Capital Costs	
A % of Direct Health care cost and Direct social care cost (minus the Informal Care costs	2.00%
Deadweight Loss (14, 15)	
Marginal cost of raising additional funds associated with (taxation revenue foregone and welfare payments, but EXCLUDE Informal care costs.	£0.12
TV Licence Exemption (Blind up to Age 74 inclusive) (16)	
Allowance per year: apply to age <75	£69.75
Tax Exemption (Blind persons) (17, 18,19)	
Government reported Total tentative amount UK per annum	£10million
Blind person potential amount (A)	£360.00
Age < 65 MEN: proportion getting (A)	0.3400
Age < 65 WOMEN: proportion getting (A)	0.1500
Age 65+ MEN: proportion getting (A)	0.1800
Age 65+ WOMEN: proportion getting (A)	0.0750

Sources and Notes.

All Unit Costs are Current Prices (available at 2008 for 2008/9)

(1) Used for rates and costs: Association of Optometrists website Notice with reference General Ophthalmic Services: Increases to NHS Sight Test Fee for the period 1 April 2008 and 31 July 2008 DH letter January 2009 validated by access to DH Gateway Reference: 11184

(2) Used for rates and costs:FODO *Optics at a glance*

(3) Consulted :Wales Eye Care Initiative. National Assembly for Wales. URL: http://new.wales.gov.uk/topics/health/healthservice/nhs/eye_care/?lang=en. Accessed April 2006.

(4) Used for costing; Curtis L. Unit Costs of Health and Social Care 2008. Personal Social Services Research Unit. University of Kent, 2008. http://www.pssru.ac.uk/pdf/uc/uc2008/uc2008.pdf

(5) Tariff information: confirmation of Payment by Results (PbR) arrangements for 2008/09 DH Gateway ref 9181

(6) Adopted the targets of “new /old” for out-patients in Trusts.(Leeds University teaching Hospital Trust Document 2008.

(7)Assumption of registration fee at face to face consultant tariff (5) plus one optometric low vision entitlement for new cases and the latter pr year for already registered

(8) Used for costing: Lotery, A., Xu, X., Zlatava, G., Loftus, J., (2007) Burden of illness, visual impairment and health resource utilization of patients with neovascular age-related macular degeneration: results from the UK cohort of a five-country cross-sectional study, *British Journal of Ophthalmology* 91:1303-1307

(9) Costing approach and updated rates: Smith DH, Fenn P, and Drummond M (2004), ‘Cost effectiveness of photodynamic therapy with verteporfin for age related macular degeneration: the UK case’, *British Journal of Ophthalmology*, Vol. 88, pp. 1107-1112

(10) Used for Costing: Ke, K.M., Montgomery, A.M., Stevenson, M., O’Neill, C.,Chakravarthy, U., (2007) Formal and informal care utilization amongst elderly persons with visual impairment, *British Journal of Ophthalmology* 91:1279-1281

(11) Used for rates: Douglas, G., Corcoran, C., and Pavey, S., (2006) Network 1000. Opinions and circumstances of visually impaired people in Great Britain:

report based on over 1000 interviews, Visual Impairment Centre for Teaching and Research (VICTAR), School of Education, University of Birmingham

(12) Consulted: Raftery J, Clegg A, Jones J, Tan SC, Lotery A**:** Ranibizumab (Lucentis) versus bevacizumab (Avastin): modelling cost effectiveness. *Br J Ophthalmol* 2007**,** 91:1244-1246

(13) Used for Costing: Lafuma A, Brezin A, Lopatriello S, Hieke K, Hutchinson J, Mimaud V, and Berdeaux G (2006), 'Evaluation of non-medical costs associated with visual impairment in four European countries – France, Italy, Germany, and the UK', *Pharmacoeconomics*,Vol. 24, No. 2, 2006, pp. 193-205

(14) Consulted: Access Economics the Economic Impact of Visual Impairment in the UK

(15) Consulted: Taylor HR, Pezzullo ML, Keeffe JE. The calculation and use of economic burden data Br J Ophthalmol. 2006 Mar;90(3):272-5.

(16) Used: http://www.direct.gov.uk/en/DisabledPeopleEverydaylifeandaccess/for (TV licence)

(17) Consulted: Family Resources Survey, Great Britain, 1999-2000 to 2005-06

(18) Consulted :Cost of Minor Tax Allowances and Reliefs hmrc.gov.uk.stats/tax expenditures/tableb1-pdf.

(19) Used: RNIB and Guide Dogs, and Action for Blind People internet sites on report on unemployment of the Blind

(20) Used: General Practice Consultation Costs Mac Kenzie Graham D Out of date costs in health economics analysis; *bmj.com*, 2 Mar 2009

(21) Used for costing: Excess Res Care: (from Lafuma 13)

(22) Consulted; Sach, T. H, Foss, A. J E, Gregson, R. M, Zaman, A., Osborn, F., Masud, T., Harwood, R. H (2007). Falls and health status in elderly women following first eye cataract surgery: an economic evaluation conducted alongside a randomised controlled trial. *Br. J. Ophthalmol.* 91: 1675-1679

(23) Used for itemisation: Pey T, Nzegwu F, Dooley G. Functionality and the Needs of Blind and Partially Sighted Adults in the UK. Guide Dogs for the Blind Association Rehabilitation Group 2007

(24) Used for Costing: Haringey PCT report of meeting of the Trust Board; Paper on AMD commissioning with Moorfields Eye Hospital. September 2008

(25) Used for costing: National Institute for Health and Clinical Excellence: Pegaptanib and ranibizumab for the treatment of age-related macular degeneration Guidance type: Technology appraisal 155 Date issued**:** August 2008

(26) Used for cataract: HES online 2007. 2008.

(27) Used: NHS reference Costs and Reference Cost Guidance 2007 and 2008

(28) Used for costing: Ke K, Chakravarthy U, O Neill C. Economic cost of age-related macular degeneration : a review of recent research. Drugs Aging. 2006;23(3):217-25 Highlands Health Authority 2008

(29) Tariff information: confirmation of Payment by Results (PbR) arrangements for 2008/09 DH Gateway ref 9181

(30) Consulted: Minassian DC, Rosen P, Dart JKG, Reidy A, Desai P, Sidhu M Extracapsular cataract extraction compared with small incision surgery by phacoemulsification: a randomised trial *Br J Ophthalm*ol 2001, Vol85, No7, p822 829

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(32) Consulted :Desai P, Reidy A, Minassian DC, Vafidis G. et al Gains from Cataract Surgery: Visual Function and Quality of Life.
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(33) Consulted: Evans JR, Smeeth L, Fletcher AE. Risk of Admission to a Nursing Home Among Older People With Visual Impairment in Great Britain. *Arch Ophthalmol*. 2008;**126**(10):1428-1433

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(36) Consulted : James M, Turner DA, Broadbent DM, Vora J, Harding S. Cost effectiveness analysis of screening for sight threatening diabetic eye disease. BMJ 2000; 320: 1627–1631

(37) Used for costing: Traverso C E, Walt J G, Kelly S P et al (2005), 'Direct costs of glaucoma and severity of the disease: a multinational long term study of resource utilisation in Europe', *British Journal of Ophthalmology*, Vol. 89, pp. 1245-1249

(38) Consulted: Poulsen P.B., Buchholz P., Walt J.G., Christensen T.L., Thygesen J..Cost analysis of glaucoma-related-blindness in Europe 2005) *International Congress Series*, 1282, pp. 262-266

(39) Consulted: Peeters A, Schouten JS, Webers CA, Prins MH, Hendrikse F, Severens JL. Cost-effectiveness of early detection and treatment of ocular hypertension and primary open-angle glaucoma by the ophthalmologist. *Eye*. 2008;22:354-362