9 Cataract Surgery

John R Thompson

1 Summary

Cataract surgery is safe and produces good visual outcomes that measurably improve the quality of life of the people who are treated.[1–4] The number of cataract operations per capita in the UK is lower than in many developed countries, even though epidemiological research shows that the incidence of cataract is just as high. The balance of evidence suggests that UK cataract surgery rates are lower because people are operated on later in the course of the disease.[5–11] The number of cataract operations per year has been increasing for some time in the UK, as it has in other parts of the world, but Britain still lags behind other developed countries.

The existence of a pool of people with moderate degrees of cataract whose surgery is delayed has important implications for the planning of UK health services. Not only does it mean that the number of operations per year will probably continue to grow, but it also suggests that waiting-list initiatives are unlikely to have more than a short-term effect. If waiting lists are reduced then presumably it would simply encourage earlier referral.

The reasons for the comparatively low rates of surgery in the UK are unclear, but may well be associated with the way health care is organised. A recent study in USA found that cataract surgery is twice as common when paid for on a fee-for-service basis compared with a pre-paid service.[12] It is not certain whether the difference reflects over- or under-utilisation but it is nonetheless important in showing that the organisation of care does influence the level of use.

The main problem in measuring the need for cataract surgery is that there is no objective definition of the point in the progression of the disease at which surgery is justified. Most authorities agree that surgery should be undertaken when the loss of vision due to the cataract interferes with the patient's life.[2,4] This criterion is obviously open to interpretation and gives any health service scope to control the level of surgery. Moderate delay does not appear to worsen the final outcome but does lower the quality of life of the patient while they wait for surgery. For many elderly people who are close to the end of their life, delay means that they never receive treatment.

Cataract is a particular challenge to a state health service in which access to treatment has traditionally been controlled by health professionals. In the consumer-oriented society that is developing in the UK, individuals will want to choose when and from whom they get their health care. It will be the patient who defines need and not the doctor, although of course there will always be a dialogue between the two. The consequence of the shift from medically defined need to patient-defined need will almost certainly lead to an increase in demand. Indeed, this process is already underway as doctors have become more sensitive to the wishes of their patients. Medical research tends to look at need from the doctors' perspective while in future the patients' perceptions of need may be more relevant.

Given the apparent scope that exists for increasing the number of cataract operations per year, it is vital that the NHS runs as efficiently as possible. The issue of the efficiency of cataract services has recently been

addressed by the NHS Executive.[13] In the USA, 80% of cataract surgery is performed as a day-case procedure, while in the UK the rate was until recently closer to 20%,[3] and remains low in many parts of the UK. The saving that would result from a switch from 20% to 80% day-case surgery would free up enough resources to enable the number of cataract operations performed each year to be increased by 25%. As day-case care for routine cataract surgery is just as safe and effective as inpatient care, the transition should be made as soon as possible.

Cataract surgery in the UK is changing so quickly at present that it is difficult for any review to keep up with the pace of that change. There is an inevitable gap of at least two years between the collection of evidence and its publication. Recent trends have brought the level of UK cataract surgery closer to that in other developed countries and it can therefore be assumed that the international differences are less today than they were when the latest published evidence was collected. However, modernisation is not taking place uniformly, and while it is certainly true that there are parts of the UK where a good service is already being provided and, for instance, day-case surgery rates are high, equally there are places that still have some way to go.

2 Introduction and statement of the problem

Cataract is a common condition of later life affecting the lens of the eye and it will, if untreated, eventually lead to severe vision loss. Consequently, cataract has a large impact on the quality of life of many elderly people. Currently the only effective treatment is surgery, but as the operation is relatively straightforward and safe there is no reason why cataract should be a blinding condition in a developed country. Unfortunately, the sheer scale of the problem creates its own difficulties for a health service and the real challenge is how best to provide high-quality eye care to all people affected by cataract.

Elective surgery presents a particular problem for any health service that attempts to cover all members of society. The basic dilemma is whether the service exists to maximise the quality of life of the people it serves, or whether its role is to keep them sufficiently healthy that they do not become an economic drain on society. Any assessment of the need for cataract surgery will depend critically on the answer to that question, for it is perfectly possible for people to cope with most everyday tasks despite a degree of visual impairment. However, although people can cope under such circumstances, their quality of life will be measurably reduced. It is only once the role of the health service has been clarified that questions about the stage of cataract at which to offer treatment and the amount of need can be addressed. In the past, the NHS has offered high-quality surgery but with a comparatively low level of coverage.

This review is an update and extension of the earlier needs assessment of Williams *et al.*[1] Since that original review, cataract surgery in the UK has been transformed by an increased use of local anaesthesia, day-case surgery and phacoemulsification. At the same time, the organisational reforms to the NHS have continued apace. This review concentrates on recent developments in cataract surgery and does not attempt to duplicate all the material in the earlier review.

Definition of cataract

The anatomy of the eye[14] is shown in Figure 1(a) and the structure of the lens is shown diagrammatically in Figure 1(b). The lens sits just behind the iris and its role is to help focus light on to the retina. The lens continues to grow throughout life, adding new layers to its outside. The central portion of the lens is called the nucleus and represents the part of the lens that was present at birth. The outer layers, which are added

Figure 1(a): Please supply caption.

Figure 1(b): Please supply caption.

subsequently, are known as the cortex, and this whole body sits within a membrane called the capsule. Cell growth takes place in a layer of epithelial cells at the front of the lens just inside the anterior capsule. As the cells develop they migrate to the edge of the lens, where they elongate, lose their organelles and increase their protein content. These long cells form new layers compacting those laid down earlier in life. The slow growth of the lens and the fact that, once created, lens cells and proteins are very long-lived, mean that a cataract may result from an event that affected the eye many years earlier or from chronic low-level exposures.

In its healthy state, the lens is transparent, but for a variety of reasons, many of which are not fully understood, opacities sometimes develop which stop light from reaching the back of the eye or which cause scattering of light.[15] Opacities that interfere with vision are known as cataracts. In its extreme form, a cataract will allow very little light to reach the retina and the individual will effectively be blind in that eye. In milder forms, vision loss will be experienced and the scattering can cause glare from bright lights which might, for instance, make it difficult to drive at night. People with cataract may also experience changes in refraction, double vision, loss of contrast sensitivity so that they cannot pick out light grey objects against a white background and a reduced ability to differentiate colours.

Key issues

As cataract surgery is so safe and effective, there are very few issues of quality of care relevant to a developed country. Much more important is how to ensure that people get surgery when they need it. The major problem in needs assessment for cataract is thus to define the point at which a person requires treatment. It is only once this has been done that the size of the problem can be accurately assessed and delays in treatment can be measured. Under a health care system in which the patients buy their health care, someone with sufficient resources would be able to define for themselves the point at which they want surgery. The challenge for the NHS is to provide a service for everyone equivalent to that which an individual would purchase for themselves. Without a definition of the time at which surgery can be expected, it is very easy for the provider, or the agency purchasing on behalf of the patient, to save money by delaying treatment.

Economic considerations have led some to question the benefit of operating on the second eye in a patient where both eyes are affected by cataract and vision has been successfully restored to the first eye. Since, in the UK, the individual is not in control of the timing of treatment, the service must ask itself whether its role is to get the individual's vision as close as possible to what it would have been without the cataract, or merely to return them to a state in which they can function independently within society. Although there is considerable research evidence concerning the extent of the benefit to the patient of second-eye surgery, the decision on whether or not the benefit should be delivered is a political and economic one.

There is no doubt that the method of organisation of health care has an effect on the level of provision. The first national cataract audit estimated that in the UK in 1990, there were about 580 cataract operations per 100 000 people aged 50 years or more.[5–7] The corresponding figure for the USA was about 1540 cataract operations, nearly three times as many. Yet there is no evidence of any difference in the incidence rates in the two populations. Some might argue that in the USA, the competitive nature of eye-care provision leads to some unnecessary surgery. However, the size of the discrepancy must lead us to question whether the NHS has been offering a good service to everyone with cataract.

Finally, there is the issue of how best to organise services to provide good-quality care in the most cost-effective way. This issue has recently been addressed in the NHS Executive publication, *Action on Cataracts.*[13] When many senior ophthalmologists started their training, cataract surgery was accompanied by a hospital stay of up to 2 weeks, now it has been shown that in the large majority of cases, cataract

surgery can be performed without any overnight hospital stay. A further potential reorganisation is in the delivery of postoperative care. At present, it is usual for the ophthalmologist to monitor the progress of the patient after surgery in outpatient clinics, but in a few districts ophthalmologists' time has been saved by delegating this postoperative care to community optometrists for routine cases. The argument for day-case surgery is overwhelming but the advantages or otherwise of co-management are yet to be established.

3 Sub-categories

Classification of cataract

The aetiology of most cataracts is not understood and so there are no useful schemes of classification based on cause. Congenital and other cataracts of childhood form a special sub-group, as the vast majority of cataracts do not develop until late middle or old age. A few cataracts in adults may be associated with identifiable events such as trauma, but the real difficulty is to classify the remainder, known collectively as age-related cataracts. Some early classification schemes were based on the degree of development of the cataract using vaguely defined terms such as mild and mature. Other schemes use the visual acuity of the subject to describe the degree of cataract. Most scientific studies now differentiate the location of the opacification within the lens, as this may well be related to aetiology. In modern classification schemes, the extent of the different types of cataract is gauged by comparison with standard photographs or diagrams.[16–18] Some researchers have experimented with digitisation of photographs of the lens with a view to obtaining more objective measurements,[19–21] but these methods do not have a role in current medical practice.

None of these classification schemes is particularly well-suited to needs assessment. For even the individual's visual acuity will be only loosely related to functional loss and consequent impact on quality of life. Visual acuity is usually measured by asking the individual to read letters of decreasing size on a well-lit letter chart at a distance of six metres. This measurement will not necessarily predict the individual's ability to perform everyday tasks, such as reading a telephone directory in poor light or getting around in the home. Further, it makes no attempt to capture other aspects of vision such as contrast sensitivity, glare or colour vision. Even if all aspects of vision could be measured, they would not adequately describe the impact of the cataract on the individual because each person has their own visual requirements and a cataract that might stop one person from working could be just a minor inconvenience to someone else. The ideal classification for needs assessment would be based on the impact of the cataract on that person's daily life. While researchers have tried to develop questionnaires to measure the impact of cataract, none has gained wide acceptance and quality-of-life measures have had no impact on routine eye care for cataract.

Because there is no classification of cataract that is well-suited to needs assessment, this chapter will use a pragmatic division into cataract in children, cataract in adults and posterior capsular opacification.

Cataract in children

Cataracts in children are so rare that although they may result in many years of vision loss, they do not have the same public health importance as age-related cataracts. As well as having different aetiologies,[22] infantile cataracts are special because they are present during the early years of life when the visual pathways linking the eye to the brain are in the process of development. Both bilateral and unilateral cataract can interfere with normal visual development and if treatment is delayed, the damage may be

permanent and normal vision may never be achieved, even when the cataract is removed. For this reason it is usual to operate on infantile cataracts as soon as possible after they are diagnosed, which, for congenital cataracts, means within the first few weeks of life.[23,24] In developing countries, childhood blindness due to congenital cataract is still common, often because the children do not get to the health care services soon enough.[25]

Adult cataract

Many different forms of opacification have been described, but the three main types that affect people in later life are: nuclear cataracts located in the centre of the lens; cortical cataracts in the periphery; and posterior subcapsular cataracts (PSC) located at the back of the lens just inside the capsule. It is not uncommon to find two or more of these cataract types in the same lens.

The process of formation of the cataract varies with the type. In most people as they age, the lens nucleus becomes harder and yellower.[26] When this process affects vision it is described as nuclear cataract. Breaks in the lens fibres cause spoke-like opacities to develop in the periphery of the lens, which, over time, may spread inwards. This is the typical pattern of cortical cataract. PSC starts with the migration and enlargement of epithelial cells, which congregate at the back of the eye and are often centrally located. Cataracts that lie across the visual axis of the lens, such as nuclear cataract and most PSC, will have the most severe impact on visual acuity.

Posterior capsular opacification

When the lens is surgically removed it is impossible to ensure that there are no cells left within the capsule. Sometimes, cells left behind after surgery migrate to the inner surface of the posterior capsule and form an obstruction to light reaching the back of the eye. To the patient, this effect, known as posterior capsular opacification (PCO), will be like the return of their cataract. Fortunately, PCO can be treated by using a laser to make a hole in the posterior capsule. PCO is sufficiently common to make it important that its treatment is allowed for in the assessment of the costs of treating cataract, and the small risk of complications associated with PCO needs to be combined with the risk from the original surgery.

4 The epidemiology of cataract

Cataract in children

A study of a cohort of children born in the UK in 1970 and followed until they were 10 years old showed a rate of bilateral infantile cataract of 2.7 per 10 000 children and a rate of unilateral cataract of 2.0 per 10 000 children.[27] A separate study in Oxfordshire gave an overall rate of about 6 per 10 000.[28] In 1996, the population of England and Wales was just over 50 million and there were about 650 000 live births,[29] which at the reported rates would imply that between 300 and 400 children per year develop infantile cataract. Surgery rates within the NHS are lower, as can be seen from Table 6. Only 130 cataract procedures were performed on children aged under 10 years in England in 1995/96. Presumably the less severe cataracts are not removed until later in life. The UK surveys give broadly similar results to those from other studies in Europe,[30] but two or three times higher than the rates usually quoted for the USA.[31,32] The discrepancy is almost certainly due to the reliance on hospital surveillance data for the American studies, which has led to under-recording.

Children have higher complication rates following cataract surgery than do adults. This is partly due to their much longer survival times, which give greater opportunity for long-term complications to manifest, but it is also related to the stronger inflammatory response seen in children. PCO, which affects about a quarter of adults, is almost universal in children,[33,34] glaucoma affects about 20% of children[35–37] and retinal detachment is also much more common than in adults, but may not occur until the child is in their twenties or thirties.[38,39] As well as the other complications associated with adult cataract surgery, the disruption to the developing visual system and imbalance between the eyes, especially in unilateral cataract, can create extra problems, chiefly strabismus,[40] amblyopia[41,42] and nystagmus.[43] Lambert and Drack[22] have reviewed the visual outcome in children with cataract and find that the outcome depends on the age of onset, density of the cataract and promptness of treatment. Up to a quarter of children with bilateral cataract are still blind after treatment.

Adult cataract

Prevalence

Many epidemiological studies have investigated the aetiology of cataract or described the burden of the disease in a community. Aetiological studies tend to be the more rigorous and usually measure the extent of any lens opacities on any one of a number of standardised scales, but these scales are hard to relate to the need for surgery. Descriptive studies typically summarise the number of people with a specific vision loss due to cataract, but even this will not tell us how many require surgery. Despite the limitations of the measures used, the studies of cataract surgery rates and of prevalence and incidence give the best currently available indication of need.

Perhaps the finest of the recent epidemiological studies was carried out in Beaver Dam, Wisconsin, USA (Beaver Dam Eye Study, BDES).[44] The population there is mainly of northern European descent and the results might be expected to mirror those that would be found in the UK. Much of the methodology used in that study was adopted by the Blue Mountains Eye Study (BMES) carried out in West Sydney, Australia.[45] Table 1 shows the amount of past surgery found in these two studies. A combination of published and unpublished data from two UK surveys carried out in Melton Mowbray, Leicestershire (Melton Eye Study, MES), are given for comparison. The data for the over-75s comes from a survey

Table 1: The prevalence of past surgery in the Beaver Dam Eye Study, the Blue Mountains Eye Study and the Melton Eye Study.

Age	Right eye			Either eye	
	BDES	BMES	MES	BMES	MES
49–54	0.6%	0.8%	NA	1.0%	NA
55–64	1.6%	1.5%	1.1%	1.9%	1.1%
65–74	4.2%	3.0%	1.8%	3.6%	2.9%
75–84	11.6%	12.0%	3.0%	16.1%	4.0%
85+	NA	21.6%	7.5%	31.3%	11.0%

NA = Not available.
BDES = Beaver Dam Eye Study, USA (n = 4,926).[44]
BMES = Blue Mountains Eye Study, Australia (n = 3,646).[45]
MES = Melton Eye Study, UK, combined results from separate surveys (n = 1,359).[46]

conducted in 1983[46] and the data for people under 75 comes from a survey conducted in 1996. The low surgery rate in the more elderly people may in part be explained by the dates of the surveys. The earlier UK survey was conducted 5 years earlier than the BDES and over a decade before the BMES. However, even the later UK survey of people aged under 75 years finds surgery rates for right eyes in people aged 65–74 years that are 43% of the USA rate and 60% of the Australian rate.

A general practice-based survey in inner London[47] found the aphakia (including pseudophakia) rate in people aged 65 years or more to be 5.8%, broadly in line with the data from Leicestershire. In the Leicestershire study, it was found that 63% of all visual impairment was due to cataract and that as a result of their examinations, 6% of the subjects were referred to an ophthalmologist for cataract. They compare their rates of aphakia or lens opacities reducing vision to below 6/12 with the rates from the Framingham eye study.[48,49] In people aged 65–74 years, Framingham found 0.7% and London 2%; over-75 years, Framingham found 3.8% and London 16.4%. These findings suggest that because surgery rates are lower, there is much more treatable visual impairment in the community.

When detailed lens grading was undertaken in a population-based study of people aged 55–74 years in Melton Mowbray, Leicestershire,[50] the results obtained were very similar to those found in studies in the USA. This confirms the impression that the pattern and extent of lens opacities are very similar, even if surgery rates differ.

The BDES also recorded the amount of visually significant cataract, that is cataract as defined by their grading scheme in eyes that had a logMAR visual acuity, roughly equivalent to 6/9 or worse.[44] The results are shown in Table 2 and are broadly similar to those found in the earlier Framingham Study from Massachusetts, USA (*see* Table 4), and from the BMS from Sydney Australia.[45]

Table 2: Cataract associated with a visual acuity of 6/9 or worse in the Beaver Dam Eye Study.[44]

Age	Women		Men	
	Worse eye	Better eye	Worse eye	Better eye
43–54	3%	0%	0%	0%
55–64	10%	1%	4%	0%
65–74	30%	8%	14%	3%
75+	46%	25%	39%	13%

Prevalence and ethnicity

Results from the BDES, BMES and MES surveys related mainly to white people of European origin, but 5.5% of the population of Great Britain are non-white, of whom 30% classify themselves as African-Caribbeans and 49% as South Asian.[51] Differences in the prevalence of cataract in different parts of the world are well-established and there is a lot of evidence to suggest differences between ethnic groups living in the same locality. What is unclear is the extent to which these differences reflect genetic or lifestyle factors and to what extent they are due to the generally poorer economic status of immigrant groups.

There is no UK evidence concerning cataract in African-Caribbeans, although in the USA the rate was found to be higher in Baltimore blacks than whites[54] and in Barbados the rate of cortical cataract was found to be higher than in comparable US studies of white populations.[55] The rates for nuclear cataract and PSC were similar. It is well-established that glaucoma is more common in African-Caribbeans and so cataract associated with glaucoma might be expected to be more common.[56] Several South Asian communities in the UK have been studied and in every case the prevalence of cataract has been found to be high. For people

in their sixties, a study in inner-city Leicester found cataract in 69% of Asians and 30% of Europeans.[52,53] The breakdown by age from the Leicester Study is shown in Table 3. In Southall, the corresponding prevalence of cataract in Asians was 86%.[57] Gray surveyed the Bengali population in Tower Hamlets and found an overall cataract rate of 53%. In that study, 5% of their sample needed referral for cataract surgery.[58] A large hospital-based study in Leicester[59] measured the demand incidence for cataract for a 30-month period in the early 1980s. The age-adjusted demand was 5.4 (95% CI: 4.4, 6.5) higher in people of Asian origin compared to whites. There was also some evidence of difference between sub-groups of the Asian community.

Table 3: The prevalence of age-related cataract, aphakia or pseudophakia by age and ethnic origin in the Leicester Eye Study (n = 369).[52,53]

	Asians	Europeans
40–49	17%	0%
50–59	49%	6%
60–69	69%	30%
70+	93%	64%

Incidence

In a follow-up of the Beaver Dam cohort carried out about 5 years after the original survey,[60] they found that 6.3% had subsequently had surgery, with the percentages varying with age so that in the 43–54 age group the incident surgery rate was 0.5%, in the 55–64 age group it was 4%, in the 65–74 age group it was 12% and over 75 years it was 20%. Surgery was associated with age and cigarette smoking as well as with characteristics of the lens and of vision measured in the original survey.

Although many of the large population-based eye surveys have returned to their original cohorts to measure incidence and progression of lens opacities, some of the most useful data on incidence comes from figures derived from the Framingham prevalence survey.[61] The data are set out in Table 4. The

Table 4: Measured prevalence and estimated 5-year incidence of lens opacities and cataract based on data from the Framingham Eye Study (n = 2308).[61]

Age	Any lens opacity		Lens opacity causing a loss of vision*	
	Measured prevalence	Estimated 5-year incidence	Measure prevalence	Estimated 5-year incidence
55–59	16%	10%	2%	1%
60–64	27%	16%	3%	2%
65–69	42%	23%	7%	5%
70–74	59%	31%	10%	9%
75–79	69%	37%	19%	15%
80–84	83%	–	46%	–

* Vision reduced to 6/9 or worse due to the lens opacity.

incidence rates are calculated under a set of assumptions, such as non-differential mortality, that at best will be approximations, and consequently the estimates can only be treated as guides to the true incidence.

A few studies have reported actual measurements of incidence,[62–64] although the definitions of progression are based on specified changes in the grading on standard scales rather than definitions of visually or functionally significant change. Some general features are, however, apparent. First regression is rare and is probably only seen as a result of errors in grading. The rates of progression are higher than the incidence rates for new opacities. PSC has the lowest incidence of the three main types, but once observed, it has the fastest progression rate.

Posterior capsular opacification

Posterior capsular opacification is the commonest long-term complication of cataract surgery.[33] The rate of PCO will depend on the surgical technique used, but has also been found to vary with the age of the patient, it being common in younger people, and with the type of intraocular lens (IOL) implant. IOLs that fill the capsule and present a barrier to cell migration are thought to inhibit the formation of visually disabling PCO.[65] For these reasons, the incidence of PCO has been found to vary widely, with rates ranging up to 50% by 5 years after surgery. The median time to PCO is about 2 years, by which stage 15–20% of patients will be affected. A meta-analysis of published studies of PCO found the average incidence to be 12% at 1 year, 21% at 3 years and 28% at 5 years after surgery.[66] However the meta-analysis detected significant heterogeneity between studies that they were unable to explain, which suggests that variations in patient characteristics and in local practice are important in determining incidence.

Risk factors

Study of the risk factors for cataract may eventually help in understanding the mechanisms by which cataract is formed, but in the meantime, it is more likely to suggest preventive measures. A large number of factors have been associated with cataract, but repeat studies have frequently been contradictory. The inconsistency of much of the evidence stems from the multifactorial nature of the disease and the difficulty of measuring long-term risk factors. Risk factors have been reviewed regularly.[67–72] Two of the reviews in particular[68,69] illustrate the inconclusiveness of the evidence by reaching quite opposite conclusions about the likely causes of cataract after reviewing the same literature. It is possible that a limited understanding of the genetics of cataract has meant that epidemiological studies have been inconclusive because they have pooled susceptible and non-susceptible subjects. The genetics of cataract is a potentially important area of investigation that is only just beginning to be tackled.

There is some epidemiological evidence that high levels of ultraviolet B (UV-B) radiation in sunlight may be associated with cataract. This relationship was first noticed in ecological studies that found high levels of cataract in places where UV-B exposure is high.[73–75] Attempts to reproduce this finding based on individual measurements have been largely unsuccessful, with only the Waterman Study able to demonstrate a weak association between non-nuclear cataract and UV-B(76). The lack of a measured effect is probably due to the difficulty of assessing a person's lifetime exposure, which will depend on innumerable factors, such as where they live, the amount of time that they spend outdoors and whether they wear glasses or a hat.[77] Studies based in a single locality may not have a large enough range of lifetime exposures to demonstrate an effect, and multicentre studies inevitably suffer from confounding. Perhaps the most convincing circumstantial evidence for an association is the fact that so much cortical cataract is found to start in the inferonasal quadrant of the lens[44,45,78,79] which, because of shadowing from the eyebrows and nose, is just the segment most exposed to sunlight. Although the evidence is weak, it would

seem sensible to advocate that hats and sunglasses that cut out UV-B should be worn in bright sunshine. The design of the sunglasses may be important, for there could be no benefit if the glasses lead to the widening of the pupils yet allow light in through the sides.

The next most important controllable risk factor is probably nutrition. Once again the concern is primarily with lifetime nutritional status, which is exceedingly difficult to measure. There is a lot of weak epidemiological evidence to suggest that antioxidants protect against the development of cataract.[80] This is a sensible hypothesis that might fit in with the UV-B theory. If UV-B releases free radicals in the lens which are responsible for the breakdown of proteins and the breaking of fibres, then antioxidants which help sweep up the free radicals ought to be protective. It is interesting that the human lens contains high concentrations of ascorbate, a very effective antioxidant.[81]

Taylor *et al.*[80] have reviewed the many epidemiological studies that have suggested that vitamins may play a role in preventing or delaying cataract and subsequently the same team of researchers found a protective effect of vitamin C supplements taken for 10 years or more.[82] Both multivitamin supplements and vitamin E supplements were found to be protective against nuclear cataract in a recent longitudinal study.[83] Clinical trial evidence is, however, sparse. Cataract evaluation was added to an existing randomised, double-blind trial of vitamin supplementation and cancer being conducted in Linxian, China, and there was found to be a 43% reduction in the prevalence of nuclear cataract in people aged 65–74 years.[84] A similar study piggy-backed on to a lung cancer trial in Finland found no beneficial effect from more than 5 years of supplementation.[85] Trials of the preventive use of antioxidant supplements are underway in the USA and Australia, but have not yet reported.

Smoking[86–89] and alcohol[90–94] are exposures amenable to intervention that have been linked with cataract. Again the epidemiological evidence is contradictory[95] and with these exposures the routes by which they might affect the lens are less clear, although cigarette smoking is known to lower antioxidant levels. Both of these exposures may be confounded with nutrition and be indirect measures of social class, which in turn is associated with general health, life expectancy and many factors important for a disease of ageing.

The association between corticosteroid use and the risk of PSC was demonstrated in a series of studies in the 1960s.[71] This finding has raised the question of whether the increased incidence of asthma in children and the resulting use of corticosteroids as a treatment may put more children at risk of cataract in later life. One large Australian study has confirmed an association between inhaled corticosteroids and both PSC and nuclear cataract.[96] Unfortunately, little is known about the importance of dose or duration of use of corticosteroids on cataract risk. Other drugs, such as diuretics and tranquillisers, have been linked with cataract in epidemiological studies but the studies are not consistent and it is difficult to tell whether the risk is associated with the drug, the underlying disease or some other factor associated with the disease. It has been suggested that aspirin is protective against cataract,[91] although not all studies find this[90,97] and it seems unlikely that prophylactic use would be an effective method of preventing cataract.

People with diabetes have been found to be at increased risk of cataract in many studies,[86,98,99] although this finding has been questioned.[70,100] In a survey in Wisconsin of people with diabetes diagnosed after 30 years of age, the prevalence of past cataract surgery in either eye by age was found to be: 20–54, 2.9%; 55–64, 5.0%; 65–74, 10.7%; and 75+, 13.5%.[101] Comparison of these figures with those given in Table 1 shows that for people aged under 75 the rate of surgery is two to three times greater. There may be bias in this comparison due to the people with diabetes having increased contact with health services, so increasing the likelihood that they will be offered surgery, but the difference is found in too many studies for it to be dismissed. The likelihood of a causal association is further increased by the laboratory evidence that lenses incubated in high-sugar media will develop cataract. Indeed, the importance of diabetes-related conditions as a cause of cataract may be being underestimated because of the difficulty of defining diabetes and the omission of conditions such as insulin resistance. Various other medical conditions have been associated with cataract in epidemiological studies, including hypertension,[48,49,102] renal failure,[98,103]

glaucoma, uveitis and myopia.[104] The evidence is, in each case, rather weak. Severe or prolonged episodes of diarrhoea have been suggested as a possible cause for some cataracts.[98,104,105] The evidence is not conclusive, and even if this is a risk factor it is unlikely to be of major importance in a developed country.

It has been noticed in studies from many countries that cataract extraction is more common in women than in men but this discrepancy has never been explained. Part of the difference may be explained by the larger proportion of very elderly women, but even the age-adjusted figures show more surgery on women and further research is still needed.

Mortality

A number of studies have identified poorer survival in people with cataract or people undergoing cataract extraction.[106–109] There was some suggestion that this was due to an association between cataract and diabetes,[110] but subsequent studies have found that the poorer survival extends to people without diabetes[111,112] and that it is particularly associated with nuclear cataract. The typical finding of these studies is that the age-adjusted risk of death in people with advanced cataract is about twice that in the general population. This effect is important when assessing the benefits of cataract surgery in terms of years of good vision resulting from the treatment, and survival patterns are also important when assessing the impact of delays in treatment, either through long waiting lists or delays in listing.

According to the First National Cataract Audit,[5–7] the average age at surgery was 76 years. A number of independent studies of private patients in the USA have found the average age at surgery to be about 72 years. So a 4-year delay in surgery might greatly reduce the amount of cataract surgery that is performed because that proportion of patients die in the interim. This would go a long way to explaining why the rate of surgery in the USA is nearly three times that in the UK.[5] It also indicates that earlier surgery and shorter waiting lists could have a dramatic impact on the amount of surgery required.

Based on the age structure for cataract procedures in the UK shown in Table 6 and national statistics on mortality,[113] it is possible to calculate the expected life of a person operated on for cataract. Basing the calculations on people age 50 years or more at surgery, so as to exclude non-age-related cataract, and assuming that the survival pattern of patients with cataract is the same as that of the rest of the population, the life expectancy after surgery is 10.2 years for men and 11 years for women. If the death rates in people with cataract are 1.5 times the national rate, then the life expectancy falls to 8 years and 8.6 years and if it is twice the national rate, 6.7 years and 7.2 years. These differences are clearly important in calculating the benefits of surgery in an economic or cost–benefit analysis.

Analysis of mortality patterns also allows us to estimate how many people die soon after surgery. If the death rate for cataract patients is the same as the national rate, 14% will die within 2 years of surgery, if it is 1.5 times as great 21% will die and at twice the national rate 27% will die. It is easy to see how delayed surgery has acted to reduce the amount of surgery that is performed.

International comparisons

International comparisons are fraught with problems because of the difficulty of standardising for confounding factors and variation in case definition. Nonetheless they are important, not just because of possible relevance to ethnic minorities living in Britain but also because a lot can be learnt from studies of cataract surgery rates in places such as Western Europe, North America and Australasia, where the incidence of cataract is similar to that in the UK but health services are differently organised. Such studies allow us to see the impact of changing the definition of need. Although attempts are underway to try to objectify the criteria for cataract surgery, need is still subjectively defined. In countries where there are

fewer economic restraints on health care, less conservative definitions of need have resulted in much higher rates of surgery. Information, particularly from places where the patient is more able to define his or her own need, gives a clue to the UK health services as to just how far the level of surgery may grow.

Some of the most interesting surgery data come from Sweden. In 1991, Sweden introduced a health care guarantee that a cataract patient with a visual acuity of 0.5 (6/12) or less in the better eye could expect surgery within 3 months of listing. In an effort to monitor this guarantee, a national cataract register was set up and run by a small group of enthusiastic ophthalmologists.[114,115]

By 1995, the Swedish cataract register covered 95% of all cataract surgery in that country. A recent analysis[115] has shown that the immediate impact of the guarantee was to reduce waiting times, but after a couple of years the waiting times started to increase again. The guarantee did not have the anticipated effect of removing variations between districts within Sweden, which were still evident in 1995.

The Swedish cataract register collects a minimal set of information on each treated patient, including waiting time, age, sex, employment status, visual acuity, two simple questions of visual function, previous surgery and ocular co-morbidity. Based on 1992 data, they estimated that in Sweden there were 4.5 operations per 1000 inhabitants, compared to 5.4 per 1000 in the USA, 2.8 per 1000 in Denmark, 2.7 per 1000 in Norway and 1.8 per 1000 in Britain.[10] The comparatively low rate of surgery in the UK had been noted earlier,[11] and possible explanations have been proposed,[116] but none has satisfactorily explained the discrepancy. Although unexplained, the international comparisons do probably demonstrate the extent to which the NHS needed to expand its service.

An important analysis of time trends in the rates of surgery was made in North Jutland, Denmark,[9] where the rate in 1990 was found to be three times that for the same area in 1980. They found no increase in the proportion of second-eye operations and very little change in the average age at surgery. The increased proportion of very elderly people may have contributed slightly to the rise, but by far the most important factor was the tendency to operate at better levels of visual acuity.

5 Current service provision

Treatments for cataract

There are no medical treatments that have been proved to reverse or even slow down the progress of cataract. If there were, their impact would be dramatic, for it has been estimated that since cataract affects people towards the end of their life, a 10-year delay in the onset would reduce the prevalence in society by 45%.[117] There is some weak evidence to suggest that antioxidant vitamins may be protective against cataract and that avoiding bright sunlight may be beneficial, but these possible preventive measures have not been conclusively demonstrated to work and in any case they may be of limited use in a well-nourished population from a country with a temperate climate. Consequently the only currently established treatment is surgically to remove the cataractous lens and replace it with a plastic IOL.[118] Prior to surgery, a person with cataract may be helped by ensuring that their spectacle correction is correct and by sensible adjustments to ambient illumination.

There are three main techniques for cataract surgery. Intracapsular cataract extraction (ICCE) involves the removal of the entire lens, including its capsule. In countries where operating microscopes are available, this technique has been superseded by extracapsular cataract extraction (ECCE) in which the nucleus and cortex are removed through the anterior capsule, leaving the posterior capsule in place. This technique produces faster visual rehabilitation and fewer complications. Over the last decade, a form of ECCE known as phacoemulsification (PE) has become very popular. This technique requires only a very

small incision, around 4 mm compared to 10 mm for standard ECCE, and uses a probe that fragments the lens by ultrasound so that it can be removed through a narrow tube. Theoretically, once the surgeon has become skilled in this technique, the smaller incision should lead to even faster visual rehabilitation and even fewer complications. There is, however, little trial evidence of real benefits from PE over ECCE.[4]

There are many types of general anaesthetic (GA) that are suitable for use with day-case surgery, but whichever is used the recovery time from a GA will be longer than that for a local anaesthetic (LA). Because of this, GAs are more suited to use on morning day-case theatre lists[119] and the running of an efficient day-case unit will require that a large proportion of cataracts be operated on under LA. In one hospital, it was found that consultants who frequently used LAs were the same ones who performed a lot of day-case surgery[119] and so a switch to local anaesthesia is an important accompaniment to increasing the amount of day-case cataract surgery. LAs have other advantages; they have been stated to be safer than GAs,[120–122] although the evidence for this is weak, and to be preferred by patients and medical staff.[120,123] Despite the advantages of LAs, there are some patients for whom they are not recommended, such as those with dementia, communication problems or those who have a problem lying still.[121]

The standard modern treatment for PCO is neodymium:yttrium–aluminum–garnet (YAG) laser capsulotomy. The laser is focused on the posterior capsule and causes a shockwave that breaks the capsule and hence removes the opacification. The procedure is very effective and safe, although it does have its own rare complications. These include the elevation of intraocular pressure, damage to the IOL, retinal detachment and cystoid macular oedema.

Visual acuity at the time of surgery

Some of the best data on cataract surgery in the UK come from the first national cataract audit conducted in 1990.[5–7] A second cataract audit was performed in 1997 and first reports from that work are just becoming available.[8] The first audit attempted to collect data on all cataract surgery conducted in a single week in November 1990 by inviting all NHS consultants to make a return. The second audit relied on volunteering hospitals to collect information of cataract surgery over the period September to December 1997 and to return that information to a central registry. Although both audits may be expected to be broadly representative of current UK practice, the differences in methodology make comparison a little difficult. Among other things, the audits gives us a picture of the visual acuity of patients at the time of surgery. The visual acuity of the better eye gives an indication of the visual impairment suffered by the subject, and the visual acuity in the operated eye reflects the stage of the cataract at which surgery takes place. Results for both audits are set out in Table 5.

The first audit[5] showed that even when the best visual acuity in either eye was considered, 16% of patients were blind by the US criterion (best corrected visual acuity less than 3/36) at admission, 6%

Table 5: Visual acuity in the national cataract audits.

Visual acuity	First cataract audit (1990)				Second cataract audit (1997)	
	Better eye		Operated eye		Operated eye	
	At listing	At surgery	At listing	At surgery	At listing	At surgery
6/12 or better	56%	49%	11%	7%	31%	27%
6/18 to 6/24	25%	29%	32%	27%		
6/36 to 6/60	11%	12%	25%	24%	54%	52%
3/60 or worse	8%	10%	32%	42%	15%	21%

despite having no other ocular pathology; and a further 37% were visually impaired (better than 6/60 but worse than 6/12), 21% despite having no other ocular pathology. Comparison with the results of the national study of cataract outcomes in the USA are instructive. At surgery in the USA, the percentages with visual acuities of 20/80 (6/24) or less were 8% in the better eye and 34% in the operated eye. If half of the 6/18–6/24 category in the UK audit have a visual acuity of 6/24, the corresponding percentages of patients 6/24 or less in the UK would be 34% and 79%. These figures suggest much later surgery in the UK.

In the first UK audit, 7% had a visual acuity better than 6/18 in the operated eye at surgery. In one international comparison of four countries, the 1990 UK pattern of pre-operative visual acuity was closest to that of Spain, where 8% had visual acuities in the operated eye better than 0.33 (6/18). The corresponding figure for the USA was 53%, for Canada 36% and for Denmark 36%.[124] An earlier Danish study using 1992 data found only 13% better than 6/18, but even then 44% had a visual acuity of 6/24 or 6/18(9) compared to the 27% found in the first UK audit.

The second audit shows a dramatic shift towards surgery at better visual acuity. From the 7% with visual acuity of 6/12 or better in the operated eye seen in 1990, there had been a rise to 27% by 1997, giving rates much closer but still lower than the earlier figures for the USA, Canada and Denmark.[124]

Numbers of cataract operations

A steady growth in the number of cataract operations has been noted from many parts of the world.[9,125–127] Some of this increase is undoubtedly due to the ageing of the population, but that effect alone will not explain the dramatic increases that have been noticed. In Denmark, between 1980 and 1991 the number of cataract operations per year increased by 350%, at a time when the size of the elderly population was increasing by 17%.[124] The real explanation for the growth in cataract surgery throughout the developed world has been the tendency to operate earlier. In the Danish study, only 4% of patients in 1981 had a visual acuity of 6/18 or better, while in 1992 this had risen to 42%.

The sharpness of the increase in numbers of operations and the marked shift towards offering surgery at better visual acuities must make us cautious in comparing studies that are even a few years apart. The NHS data for England shows 139 356 cataract procedures for the year 1995/96 (Table 6). One year earlier the

Table 6: Number of cataract procedures performed under the NHS in England for the year 1995/96.

Age	Phacoemulsification	Other cataract extractions	Total
0–9	49	85	130
10–39	848	723	1,571
40–44	475	459	934
45–49	865	912	1,777
50–54	1,334	1,499	2,833
55–59	2,317	2,719	5,036
60–64	3,935	4,697	8,632
65–69	6,318	8,171	14,489
70–74	10,123	13,203	23,326
75–79	11,771	15,929	27,700
80–84	11,912	17,336	29,248
85+	8,804	14,767	23,571
Missing age	33	72	105
Total	58,784	80,572	139,356

number was 128 334 and before that 112 148, which represents a 24% increase between 1993 and 1995. By 1998/99 the number of NHS cataract procedures had risen to about 170 000 and a target of 250 000 has been set to be achieved by 2003.[128] This would be equivalent to 350 cataract operations per 100 000 people.

Primary care

Ophthalmic conditions are responsible for between 2% and 5% of all general practice consultations, but despite this GPs lack confidence in diagnosing and treating eye disease. It has been suggested that the chief reason for this is a lack of instruction to medical students in the specialised skills of ophthalmology.[129] Although there is a general lack of confidence in handling ophthalmic conditions, cataract seems to be an exception. In one survey, GPs were asked if they felt confident in diagnosing common eye conditions.[130] The percentages expressing confidence were for senile macular degeneration 30%, diabetic retinopathy 44%, chronic glaucoma 36%, but for cataract 90%. In the same survey, only 19% said they would immediately refer on a case of cataract while the remainder felt happy to manage the case themselves until the vision loss became a problem to the patient or when the visual acuity dropped to 6/18 or less.

The fact that GPs are more confident at diagnosing cataract than most other ophthalmic conditions is reflected in their accuracy. A survey of the accuracy of referrals to Burton District General's eye department[131] found 98% accuracy (42/43) in referrals from GPs for cataract, which was even better than the accuracy for optometrist-initiated referrals, which was 88% (52/59). The inaccuracy reflects a disagreement between the ophthalmologist and the referrer as to whether or not the cataract was clinically significant rather than whether or not there was any lens opacity.

Sheldrick *et al.*[132,133] studied the 2587 consultations with primary care services made by patients from selected general practices in Nottingham. The consultations comprised contacts with both GPs themselves and those with eye casualty. The survey covered a population of just over 36 000 people and lasted for 1 year. In that time 69 patients presented with cataract, defined as a lens opacity reducing the vision to 6/9 or less. This is equivalent to 1.9 new cases per 1000 population per year. Some cases were of bilateral cataract and so the rate can also be expressed as 2.8 eyes per 1000 population per year. If the definition of cataract were restricted to those lens opacities that reduce visual acuity to 6/18 or less, the rate would be 1.8 eyes per 1000 population per year. The rate of cataract surgery locally was, at that time, about 1.4 eyes per 1000 population, so that cataract surgery was being provided for between 50% and 78% of those who could potentially benefit, depending on where the visual acuity threshold was drawn. Age-specific demand incidence for cataract were: 50–59 years, 0.8 cases per 1000 population; 60–69, 3.6; 70–79, 8.1; and 80+, 16.4.

General practitioners are obliged to offer an annual health check to all patients age 75 years or more, which should include an assessment of vision. The Royal of College of General Practitioners has advocated the use of a simple question[134] about visual function, but the details of any vision test are not specified in the GP contract.[135] The value of including a vision test has been assessed in a number of trials and these have been reviewed by Smeeth and Iliffe.[136] They looked for evidence of better visual acuity as a result of screening the vision of elderly people and found no indication of any benefit. This disappointing finding conflicts with the evidence from community surveys that show a high level of treatable vision loss due to cataract and refractive errors.[47,137] It may be that the randomised trials merely show that there is no benefit in discovering vision loss if you then do nothing about it.

About half of all cataract referrals are initiated by an optometrist. Even before the introduction of fees for eye tests, a survey found that a quarter of elderly people had not seen an optometrist in the last 3 years.[138] After the introduction of fees, it was suggested that visits to optometrists dropped by a third.[139] It will be interesting to see what effect the removal of these fees will have, for, irrespective of sight-test fees, some elderly people are undoubtedly put off from visiting an optometrist for fear of the far greater cost

involved in replacing their glasses.[135,138,140,141] Optometrists are an important resource that could be used more to supplement the care offered by ophthalmologists, but while optometrists are seen by the public as business people selling expensive glasses, there will be a reluctance by some to take advantage of their services.

The UK has fewer consultant ophthalmologists per head of population than most other developed countries but just as much eye disease. It is not surprising therefore that people in the UK are operated on later in the progress of their disease and that there are long waiting lists. Since it is unlikely that the number of ophthalmologists within the NHS will grow dramatically, it is important to consider whether some of their non-surgical work could be delegated to other health professionals. Within hospitals this might mean giving greater responsibility to nurses or technicians, outside of hospitals optometrists offer a potential, locally based resource of people already trained in eye care. Optometrists could take on some of the routine aftercare of cataract patients, referring back to the ophthalmologist only those cases that need specialist care.

A model of co-managed care has been reported from the USA in which patients were assessed by an ophthalmologist after surgery and if they had no immediate complications or other pre-existing ocular pathology were discharged to the care of an optometrist.[142] Of 2390 cases, 87% were considered appropriate for co-management, and of these, 93% had no complications. Using ophthalmologists as the standard, the optometrists had a sensitivity of 59% and a specificity of over 99% for detecting complications. Unfortunately this was not a randomised trial so it is not possible to compare outcomes between co-managed and ophthalmologist-managed patient groups. Lichter gave an American ophthalmologist's view of this study in which he pointed out many of the methodological limitations of the work and questioned whether the patient had anything to gain from such a system.[143] The situation is not quite the same in UK, where there are proportionately far fewer ophthalmologists and therefore more potential benefit from reducing their workload. Partly in response to the comments made about the original report, the researchers returned to examine in more detail the 41% of cases with complications that they had originally classified as missed by the optometrist.[144] Detailed review by an ophthalmologist and two optometrists raised questions about the quality of care in only four cases. That is, four out of 2458 may not have received adequate care.

It is an open question as to whether the saved ophthalmologists' time resulting from shared management would translate into more patients being treated and whether this would compensate for any poorer outcomes that might result from less highly qualified aftercare. This is an area full of professional rivalry that might make implementation very difficult, as two essentials of co-management are co-operation and communication. There is, however, a lot of experience from the USA of schemes that have developed good protocols.[145]

6 Effectiveness of services

Day-case surgery

Twenty years ago, a cataract patient would have spent up to 2 weeks as an inpatient. Today, patients are unlikely to spend more than a couple of days in hospital and in some units, a large proportion of cataract patients are treated as day-cases, that is the patient is admitted, treated and discharged on the same day. It has been estimated that this saves about 30% of the cost of treatment. In North Yorkshire in the early 1990s, the estimated cost of day-case surgery was £222 compared to £366 for inpatient care.[146] A similar saving was found in a case-series in London.[147]

Both randomised trials[146,148–150] and case-series[119,151–154] have shown that in straightforward cases, day-case surgery is just as safe and effective as inpatient care. The key requirement is to identify which

patients can safely be treated as day-cases. Since 1985, it has been the norm in the USA for cataract surgery under Medicare to be done as an outpatient procedure. Economic pressures combined with patient preference have meant that about 80% of cataract surgery in the USA is carried out as day-cases. European rates are not as high as this, but in several countries they remain higher than those achieved in the UK where, in 1993/94, only 20% of cataract surgery was carried out as day-cases. In a few UK districts, the day-case percentage approaches 80, but the overwhelming majority of districts range between 0 and 35%.[3]

The major determinants for suitability for day-case surgery relate to the patient's ability to care for himself or herself in the first few days after the operation. Thus patients with psychiatric or social problems may be better off staying in hospital and so, in some cases, may patients who live a long way from the unit. To this list, the Royal College of Ophthalmologist Guidelines[2] add patients with pre-existing pathology, such as uveitis, that need close postoperative supervision and patients expressing a preference for inpatient care.

Cooper has reviewed the development of day-case cataract surgery.[123] Some patients like the security of inpatient care, but the majority would either prefer to go home or are indifferent and happy to accept the advice of the consultant.[155] It is important that time is spent explaining to patients how they should care for themselves after surgery so that they feel confident and can avoid harm. If day-case surgery were portrayed to the patient as the norm, there is no reason to suppose that many would express any concern. In a study in Yorkshire, 11% of patients preferred not to have day-case surgery and a further 6.5% were thought by the consultant to be unsuitable, leading to a potential day-case figure very close to the 80% seen in the USA.

Rose *et al.*[156] have reported a randomised trial looking at the use of trained nurses for the pre-operative assessment of day-case cataract surgery cases. They found the nurses to be equally good and more cost-effective than ophthalmologists. However, the trial was very small and although it supports the increased use of co-management within the hospital setting, larger studies are needed before the evidence can be considered conclusive.

The case for switching the vast majority of cataract surgery to day-cases is overwhelming and the change will inevitably take place over the coming years alongside the much wider use of local anaesthesia. Overcoming the resistance of consultants who are used to a combination of general anaesthesia and inpatient care and speeding up the change to day-case surgery is a management problem that should be tackled urgently. The Audit Commission's target of 20% day-case surgery has been achieved, but this target was very conservative.[157] In 1992, the Scottish Health Service Advisory Council recommended a target of 30% by the end of 1993 and 80% by 1997.[158] There is no reason why a target of 80% should not achieved by every district in the UK, yet a third of hospitals still have day-case rates below 50%.[13] The experience of North Yorkshire in attempting to implement a 60% rate for all elective surgery, including cataract, could serve as a useful model for change.

Local versus general anaesthesia

A joint working party of the Royal College of Ophthalmologists and the Royal College of Anaesthetists produced guidelines on the use of LAs.[159] The guidelines specify that all patients should receive a preoperative assessment that includes full history, examination, blood pressure measurement and urinalysis, and that most should also get blood tests and electrocardiography (ECG). During the operation, verbal contact should be maintained and the patient should be monitored by pulse oximetry, ECG and blood pressure measurement. Intravenous access should be obtained and an anaesthetist should be present in case resuscitation is required.

To monitor the practice of LAs in ophthalmology, in 1996, the Royal College of Ophthalmologists organised an audit which, for 1 week in September that year, collected information on every eye operation that used a LA and then for 3 months collected information on adverse events.[160,161] Theatre records from validation units were used to check the accuracy of the data provided to the audit and to collect some information on the use of GAs.

When initially contacted for the audit, 71% of ophthalmologists said they preferred LAs for cataract surgery and 29% preferred GAs. The proportion preferring LAs was lower, at 59%, in consultants with 20 or more years' experience. In the audit itself, LAs were used in 87% of PE surgery and 67% of conventional ECCE. PE was the most common type of cataract surgery in this audit and the overall rate of LA use was 80%.

The audit has demonstrated a marked shift in the use of local anaesthesia. In 1984, 63% of ophthalmologists only ever used GAs for cataract surgery. In 1991, 37% said that they used GAs for more than 75% of their cataract surgery. The audit suggests that the rate of GA use has continued to drop.

The audit shows that the joint College guidelines are not being followed completely. For instance, although 96% of patients were monitored during surgery, only 35% had all three forms of monitoring recommended in the guidelines. However, severe systemic adverse events were very rare, 0.034% of operations, and occurred with all forms of LA.

PE versus ECCE

There is no convincing evidence of a difference in visual outcome between PE and ECCE. Because the majority of the studies included in Powe *et al.*'s meta-analysis[162] were American, and by 1991 PE was already popular in the USA, that meta-analysis was able to compare the visual outcome from ECCE and PE. They found no significant difference despite the very large overall sample size. However, the studies included were not randomised trials and it is likely that the PE studies were the more recent, so the comparison must be treated with caution. The opportunity for a definitive randomised trial is probably now gone because PE has already become so widely used. A Medical Research Council trial is underway in the UK, but it is relatively small and unlikely to influence practice.

The rationale behind the use of PE is that the smaller incision might lead to fewer complications and faster rehabilitation. The American guidelines[4] reviewed the literature and concluded that although the possible benefits are 'intuitively appealing', there is no definitive evidence to support them.

Complications of surgery

According to the First UK National Cataract Audit, 7% of patients have some complication during surgery, 22% experience some complication in the immediate postoperative period and 20% have some complication at 3 months, including 6% who already have posterior capsular thickening. The rates tended to be higher in patients with some pre-existing ocular pathology.[6]

A literature review of 90, mostly US, studies covering the period 1979 to 1991 gives pooled complication rates based on data for over 68 000 eyes.[162] However, few, if any, of these studies is representative of a general population in the way that the UK audit attempts to be and, as such, may underestimate some of the complication rates. A comparison of the pooled rates with those from the UK audit are given in Table 7.

Table 7: Complication rates associated with cataract surgery, at 3 months for the UK audit and at an average of about 1 year for the meta-analysis.

	UK First National Cataract Audit[6]	**Meta-analysis[162]**
Peroperative		
Capsule rupture	3.9%	3.1%
Vitreous loss	1.1%	0.8%
Early postoperative		
Corneal oedema	9.6%	–
Raised IOP	5.3%	–
Endophthalmitis	0.1%	0.13%
Late postoperative		
Cystoid macular oedema	1.2%	1.4%
Retinal detachment	0.1%	0.7%
Dislocation of IOL	0.3%	1.1%
Raised IOP	2.3%	1.4%
Uveitis	1.1%	1.8%
Posterior capsular opacification	6.3%	19.7%

Costs and cost-effectiveness

Studies that purport to compare the benefits of different medical procedures should be treated with extreme caution. In comparing, say, cataract surgery with hip replacement, a measure must be placed on the comparative benefits of good vision and improved mobility, and the result will depend critically on the assumptions that are made. Only clear-cut differences that are robust to changes in the assumptions can be relied on. One attempt to perform such an economic analysis[163] found that, under their assumptions, cataract surgery costs around £500 (at 1983 prices) for every quality-adjusted life year saved. This figure compares favourably with the cost per quality-adjusted life year given for other procedures, such as £750 for hip replacement or £3000 for a kidney transplant. Although this is far from an exact science, cataract surgery comes out well from such economic comparisons.

The impact of economic analyses that seek to compare the treatment of different conditions is limited because health care workers appreciate the strong dependence of the conclusions on subjective prior assumptions.

7 Models of care

Criteria for referral to an ophthalmologist

The referral process is an integral part of health service organisation and, as such, it is difficult to generalise to the UK, research based on referral processes in other countries where the organisation of health care is different. Such research can at best give pointers to possible approaches, the effectiveness of which would need to be confirmed within the NHS.

Although the process whereby a patient is first seen by an ophthalmologist is vital to the provision of effective care, it has received very little attention from researchers. Cataract referrals are initiated either when a patient notices a deterioration in their vision, or when a problem is detected during a health check. The relative importance of the two routes has not been measured. Improvement in patient-initiated referral is partly a matter of education, so that the public understands the nature of cataract and that it is treatable, and partly a matter of attitude change, so that poorer vision is not accepted as an inevitable consequence of old age. These patient-related factors would also act to improve health service-initiated referral by encouraging attendance for regular eye checks.

Ideally, primary care workers should be able to check a patient's visual acuity and confirm the presence of lens opacities which might be affecting vision. Optometrists, but not all GPs, have the facilities to measure visual acuity accurately at the standard distance of six metres with good lighting. The hospital ophthalmic services are not equipped to cope with a lot of false referrals for cataract and so it is preferable that preliminary checks and first discussions about the advisability of surgery take place in primary care, although final consideration of a patient's suitability for surgery must, of course, remain with the ophthalmologist. Questions of the type used in VF-14 (*see* Table 9) are suitable for use in primary care, as they identify functional vision loss without the need for any special equipment or specialised knowledge. They could, for instance, be incorporated in routine health checks by a practice nurse.

Informal discussion of the need for cataract surgery based on the patient's perception of the importance of their own vision loss would appear to be the best way of deciding whether someone should be referred to an ophthalmologist. However, in a health care system where the patient is not paying directly for the treatment, it is important that they have some idea of when they have a right to surgery. In Sweden, patients were told that they could expect treatment within 3 months if they had a visual acuity of 6/12 or worse due to cataract.[114,115] An alternative approach adopted in New Zealand[164] was to prioritise all patients who want surgery based on reasonably objective criteria. This latter approach may not offer such a good service, but has the advantage of rationing care in a way that can be seen to be fair. In both the informal and the more formal systems, control of access to care is concentrated with the ophthalmologist and there has not been any systematic attempt to co-ordinate the criteria used for initial referral with those used for surgery. Similarly there is no research on the impact that changing the criteria for either referral or surgery would have on the other.

Criteria for first-eye surgery

According to the Guidelines for Cataract Surgery issued by the Royal College of Ophthalmologists in 1995,[2] cataract extraction is justified when the cataract interferes with visual function and the surgeon expects improvement from surgery; or when it will facilitate examination of lesions affecting the posterior segment; or to avoid lens-induced disease. The US guidelines[4] acknowledge similar reasons but try to be a little more objective differentiating between people with poor visual acuity, defined as 20/50 (6/15) or

worse, those with good visual acuity, better than 20/40 (6/12), and those in between with moderate vision. They stress the importance of educating the patient about the likely risks and benefits of surgery. The likely benefits are clearly less for patients with a visual acuity better than 20/40. At 20/40 they consider that surgery is justified if the patient complains of other visual problems, such as glare or if the vision loss is interfering with the patient's lifestyle.

Neither the UK[2] or US[4] guidelines are based on research evidence but rather they reflect the expert opinion of experienced ophthalmologists. Research into objective criteria for cataract surgery is urgently needed, for without them the measurement of need remains highly subjective. Currently, patients do not know when they have a right to expect treatment and commissioners cannot be sure whether the service is meeting the needs of the community. This issue will become more important in the UK when the level of provision approaches that being offered in other industrialised countries. At present it is probably sufficient to know that there is a pool of unmet need, even if it cannot be quantified.

An interesting attempt to study criteria for surgery was made in the Northern Region.[165] They gave semi-structured interviews to consultant ophthalmologists from that region and, as with the US guidelines, came to the conclusion that visual acuity can be usefully categorised as good, defined as 6/9 or better; moderate, 6/12 or 6/18; or poor, 6/24 or worse. They identified the patient's ability to manage with their current vision, coexisting eye disease, general patient health, patient attitude to surgery and the degree of conservatism of the consultant as important in deciding whether or not to operate. The availability of theatres or beds were not seen as important, but consultant time needed for outpatient follow-up was. Limiting the numbers offered surgery was seen as a way of managing personal workload. Two consultants said that they might list someone early when the waiting list was long, in anticipation of the patient needing surgery by the time that they were offered it. The consultants described the moderate visual acuity category as the typical level for advising listing. However, an examination of case notes found that three-quarters of first eyes fell into the poor category at listing.

As a part of the health reforms introduced in New Zealand in 1992, a committee was formed to advise the minister on priorities and criteria for elective surgery.[164] The first topic that they considered was cataract extraction. A Delphi process was used to allocate scores to particular patient characteristics that were thought to be related to the need for cataract surgery. Using the results of this investigation they devised a system whereby a patient's priority is judged by summing their score for visual acuity, glare, ocular co-morbidity, ability to work, visual function and other disabilities. The weights allocated are set out in Table 8.

The factors chosen, the weights allocated and the very idea of adding together numerical scores can all be criticised,[166] but the basic idea of attempting to define a person's need in an objective way is important, for without such an agreed definition any attempt at needs assessment is futile.

It has been suggested that methods based on a patient's reported visual problems will be open to manipulation by patients who exaggerate their difficulties in order to obtain earlier surgery.[167] This is undoubtedly a real problem, but at its heart is the view that the role of the provider is to police a system of rationing rather than to work with the patient to define the point when surgery would best suit them.

Table 8: New Zealand priority criteria for cataract surgery adjusted from Hadorn *et al.*[164]

Visual acuity	6/9+	6/12	6/18	6/24	6/36	6/60	CF*
6/9+	0	1	2	3	4	5	6
6/12		7	8	9	10	11	12
6/18			14	15	16	171	18
6/24				21	22	23	24
6/36					28	29	39
6/60						35	36
CF*							40
1 Glare							
None							0
Mild–moderate							5
Severe							10
2 Ocular co-morbidity							
None							0
Mild–moderate							5
Severe							10
3 Ability to work or care for dependants							
Not threatened/not applicable							0
Not threatened but more difficult							2
Threatened but not immediately							6
Immediately threatened							15
4 Extent of impairment							
None							0
Mild							5
Moderate							10
Severe							20
5 Other substantial disabilities							
No							0
Yes							5

* CF = count fingers or worse.

Second-eye surgery

People with one eye are at very little disadvantage in their everyday life. Consequently it has been suggested that once the cataractous lens has been removed from the first eye and vision has been successfully restored, there is little advantage in operating on the second eye. Certainly such a policy would offer a great cost saving; the first UK National Cataract Audit[5–7] found that about one-third of all surgery was to the second eye and the second UK audit found a similar result of 35%.[124] In America, two insurers separately proposed imposing severe restrictions on second-eye surgery, although these proposals were subsequently withdrawn.

Both the UK[2] and US[4] guidelines for cataract surgery conclude that the criteria for second-eye surgery should be broadly the same as those for the first eye, even though the evidence for this conclusion was weak. Second-eye surgery should, in theory, improve visual acuity, stereopsis and the field of vision, but it is an open question whether this will translate into marked functional gain. Javitt *et al.*[168] compared patients

undergoing first-eye, second-eye and bilateral surgery using a short questionnaire on visual function. They found a similar improvement in subjective visual function from second-eye surgery as was obtained from first-eye surgery, despite starting from a higher baseline. A subsequent report[169] found greater improvement from bilateral surgery compared to unilateral surgery as measured by VF-14 and subjective reports of trouble with vision and satisfaction with vision. Similar results were found in a UK study[170] and a Spanish study.[171]

In Bristol, a randomised trial was used to measure the short-term effects of second-eye surgery.[172] In the trial, one group were given immediate surgery, while the control group went on to the normal waiting list. At 6 months, when one group had had surgery and the other not, they found little difference in binocular visual acuity but clear benefits in terms of stereoacuity and self-reported visual problems that impact directly on quality of life.

The balance of evidence is that there is an improvement in the patient's subjective assessment of their vision from second-eye surgery, although the gain may be a little smaller than that obtained from first-eye surgery. Whether this translates into any improved functional ability is less clear. The question of the justification of second-eye surgery depends on the view that is taken about the purpose of the health service; should it try to maximise individual health or merely seek to maintain a minimum standard? The consensus among UK eye-care workers remains strongly in favour of second-eye surgery.

Developing a local policy

Waiting list length and waiting times receive a lot of attention in the press and are politically sensitive, but they are susceptible to alteration by short-term measures and they do not give a true indication of the extent of unmet need. A better guide is the fact that, at surgery, UK patients tend to be older and have worse vision than in many other developed countries. This would suggest that in the short term, any increase in resources will merely encourage more, earlier referrals. Unless some attempt is made to control the level of visual disability at which cataract surgery is to be offered, it is likely that demand will grow to soak up the extra resources. Any reasonable attempt to define the level of visual disability which requires cataract surgery would almost certainly result in a sudden increase in demand. Short-term policies aimed at controlling waiting lists must be introduced along with long-term plans which acknowledge that the level of cataract surgery is likely to continue to grow steadily as the population ages and, more importantly, as patients demand earlier surgery.

One way to release resources to meet this anticipated growth in demand is to move towards cheaper but equally effective forms of treatment. Day-case surgery is thought to be about 30% cheaper than inpatient care and suitable for 80% of patients. Transition from an average of 20% day-case care to the realistic target of 80% day-case care would save over 20% of the cataract budget or, alternatively, allow the number of patients treated to increase by over 25% without extra resources. Whether the use of optometrists to manage patients after surgery would offer a saving has not been established, although it would go some small way to freeing up the time of ophthalmologists, enabling them to concentrate on surgery and the care of non-routine cases.

8 Research priorities

The overall quality of surgery and the treatment of complications are probably as good in the UK as they are anywhere in the world. The problems for the NHS are how to ensure that good standards are

maintained equally throughout the service, and how to ensure that this high-quality service reaches everyone who needs it within a reasonable length of time. The need for cataract surgery is, in the final reckoning, a matter for the patient, as it depends on their personal visual requirements and the extent to which they feel visually disabled by their cataract. The NHS, however, effectively rations the number of cataract operations that can be performed by controlling the number of ophthalmologists, the amount of theatre time and the budget available. It is not surprising that this leads to delays in listing for surgery and long waiting times. The existence of a small parallel system of private health creates a way of avoiding NHS delays for people who can afford it and is also a source of extra income to many NHS ophthalmologists. As such, private care reduces the pressure on the NHS to improve.

The key research issue for cataract care in the UK is how to structure the service to maximise the number of patients treated. This must mean even more day-case surgery, perhaps with some aftercare provided by optometrists. In all likelihood, a more efficient cataract service would find more work to do, since the freeing of resources would just lead to a broader definition of need. The more logical route of defining need and then planning services to meet that definition is unlikely to be practical, because any reasonable definition would require too great an expansion of services, as can be seen by comparing surgery rates in the UK with those in other developed countries.

Research effort should attack the problem from both directions, by seeking to define need and by looking for greater efficiency. Useful approaches to the definition of need might be to survey ophthalmologists to discover the criteria they would ideally use when deciding whether to offer surgery. Alternatively, it would be interesting to study the stage of disease at which private patients choose to have surgery. It might reasonably be argued that that represents the target at which the NHS should aim.

Day-case surgery has been shown to work effectively in many hospitals and needs to be extended rather than investigated. Co-management is a much less clear issue and although it has operated successfully in other parts of the world, a large, multicentre trial of optometrist aftercare in the UK would seem to be justified.

Major changes in the monitoring and auditing of the care provided by the NHS are already underway and there might well be a role for a cataract register of the type that has been introduced in Sweden. A register is not something that should be introduced lightly for it would involve a considerable amount of work and might just result in increased monitoring without improved care.[173] A requirement is being introduced for trusts to supply information on the quality of care they provide. This will mean that much of the information needed for such a register will be collected by each trust and a cataract register could provide a vehicle for the standardisation of that collection and the pooling of results. A respected body such as the Royal College of Ophthalmologists might be funded to take responsibility for collating the information, especially if the data were sent electronically from trusts. A register would be very valuable in showing trusts how they are performing in relation to others. It would also be helpful for monitoring the effectiveness of future interventions, particularly those that relate to the organisation of care.

Much can be learnt from international comparisons, especially when outcome is related to the organisation of services. Although it is sufficient to audit medical outcomes within the UK, aspects of coverage and the timing of surgery would be better studied on a Europe-wide basis so that there would be variation in the organisation of services. Information on the relative performance of health services in other parts of the European Union might help target setting within the NHS.

9 Outcome measures and audit

Powe *et al.* have published a systematic meta-analysis of mostly American studies published between 1979 and 1991, which reported the visual outcome of cataract surgery.[162] They found that 90% of eyes

achieved 20/40 (6/12) or better visual acuity and that this figure rose to 95% when eyes with pre-operative co-morbidity were excluded.

The first national audit of cataract surgery in the UK detailed the visual outcome of 959 patients treated in a single week in 1990. The usual surgical technique at that time was ECCE. The audit found that overall, 80% of patients achieved 6/12 or better at 3 months after surgery and that this figure rose to 90% in the 537 patients who had no ocular co-morbidity. The higher figures from the meta-analysis may just reflect the fact that published case-series are frequently not generalisable to all patients because they tend to be collected by specialists. An international study covering the USA, Canada, Denmark and Spain found no international differences in final visual acuity after adjustment was made for the pre-operative visual acuity and the characteristics of the patient, despite there being considerable differences in methods of surgery between countries.[9]

Fewer studies have reported on measures of outcome from cataract surgery other than visual acuity, although research in this area is increasing. In the USA, Magione *et al.* used the Activities of Daily Vision Scale (ADVS) and SF-36 measure of health-related quality of life to assess the benefit of cataract extraction in 464 patients.[174] As these scores are compiled from answers to a questionnaire, it is difficult to interpret changes, but one way is to compare the average change with the standard deviation of baseline scores; this is known as the treatment effect. Results given in Magione *et al.* show a treatment effect of about 0.75 for ADVS at 12 months after surgery, regardless of whether the surgery was to the first eye, the second eye or bilateral.[174] Despite this, health-related quality of life showed a transient improvement at 3 months, but then declined. Unfortunately, there was no control group to show the expected decline in SF-36 over a year in people of this age. The decline was most marked in those patients whose ADVS did not improve after surgery.

Steinberg *et al.* compared various measures of visual function pre- and postoperatively in 552 first-eye cataract patients.[175] VF-14, a questionnaire measure of visual impairment, improved with a treatment effect of about 1, and 85% of patients reported an improvement in their satisfaction with their own vision. VF-14 is a simple tool for measuring visual function that has been shown to be reliable, valid and sensitive to change. It has been translated from the original US version and used in Canada, Denmark and Spain with comparable results.[176] The questionnaire asks about difficulties due to vision when wearing glasses with each of the 14 activities set out in Table 9. The respondent replies: no difficulty (4), a little (3), moderate (2), great deal (1), unable (0). Their average score over the 14 questions is then multiplied by 25 to get a score out of 100. Any items not applicable are excluded from the average. The translated versions

Table 9: Activities included in the VF-14 scale.

1	Reading small print such as a labels on medicine bottles, a telephone book, food labels
2	Reading a newspaper or a book
3	Reading a large-print book or large-print newspaper or numbers on a telephone
4	Recognising people when they are close to you
5	Seeing step, stairs or curbs
6	Reading traffic signs, street signs, store signs
7	Doing fine handwork like sewing, knitting, crocheting or carpentry
8	Writing cheques or filling out forms
9	Playing games such as bingo, dominoes, card games or mah jong
10	Taking part in sports like bowling, handball, tennis, golf
11	Cooking
12	Watching television
13	Driving during the day
14	Driving at night

made minor alterations, such as adding crossword puzzles to question 9 and changing the sports in question 10.

Numerous alternatives to VF-14 have been proposed, each using slightly different questions to try to assess functional visual problems. There is no evidence that any of these questionnaires is any better than the others. There is a temptation to design new questionnaires linked to specific study requirements, but the small benefits that might result are likely to be outweighed by the work involved in pre-testing and the lack of comparability with other studies.

The working group on outcome indicators for cataract[177] reported to the Department of Health in 1997. They suggested four measures for routine use and a further ten that should be recorded whenever local circumstances allow. These indicators are listed in Table 10. Other indicators were suggested for use in periodic surveys. The majority of the suggested indicators relate to surgery and its outcome, but a few, included under the heading, 'to be developed further', extend to include the referral process. In particular, they suggest collection of the rate of referrals to a consultant ophthalmologist per 1000 GPs and the rate of referral to a GP per 1000 NHS eye tests.

Table 10: Cataract outcome indicators for routine use.[177]

Basic set of measures
Cataract extractions rate per 10,000 population
Time spent on the waiting list for elective surgery
Capsulotomy rate per 1,000 cataract extractions at 1 year
Capsulotomy rate per 1,000 cataract extractions at 5 years
Desirable wherever possible
Waiting time between GP referral and outpatient appointment
Visual acuity at referral to a hospital ophthalmologist
Visual acuity assessed pre-operatively
Rate of postoperative complications detected before discharge
Rate of postoperative complications detected between discharge and first outpatient appointment
Rate of postoperative complications detected between first outpatient appointment and 4 months after surgery
Re-admission rate for care of the operated eye within 30 days of cataract surgery
Visual acuity at 1 week post-operation
Visual acuity at 4 months post-operation
Difference in visual acuity between the pre-operative and 4-month measurements

Outcome measures play a key role in the development of a good health service, for, in general, no service should be commissioned without specification of standards that are to be achieved. Although the recommendations of the working group are naturally oriented towards surgery, there is scope for extending these ideas into primary care even if at present the infrastructure for data collection does not exist. If optometrists, for instance, are to be commissioned to contribute to routine postoperative care then a way must be found for them to supply information on the quality of their performance.

Process measures also have a role in assessing quality of care. Features such as the time spent waiting to be seen in an outpatient clinic, the time spent discussing the need for surgery and the grade of the ophthalmologist are all important indicators of a well-run service.

One obvious danger from an over-reliance on a few indicators is that they may become targets for manipulation. For instance, if limits are placed on the time between listing for surgery and the operation itself, there will be a temptation to delay listing for surgery. For this reason outcome measures need to cover the whole patient experience and be kept under constant review.

References

1 Williams M, Frankel S, Nanchahal K, Coast J, Donovan J. Cataract Surgery. In: Stevens A, Raftery J (eds). *Health Care Needs Assessment.* Oxford: Radcliffe Medical Press, 1994.
2 The Royal College of Ophthalmologists. *Guidelines for Cataract Surgery*. London: The Royal College of Ophthalmologists, 1995.
3 Nuffield Institute for Health and NHS Centre for Reviews and Dissemination. *Effective Heath Care: management of cataract*. Edinburgh: Churchill Livingstone, 1996.
4 US Department of Health and Human Services. *Clinical Practice Guideline Number 4: Cataract in adults: management of functional impairment*. Rockville: AHCPR, 1993.
5 Courtney P. The National Cataract Surgery Survey I. Method and descriptive features. *Eye* 1992; **6**: 487–92.
6 Desai P. The National Cataract Surgery Survey II. Clinical outcomes. *Eye* 1993; **7**: 489–94.
7 Desai P. The National Cataract Surgery Survey III. Process features. *Eye* 1993; **7**: 667–71.
8 Desai P, Reidy A, Minassian D. Profile of patients presenting for cataract surgery in the UK: national data collection. *British Journal of Ophthalmology* 1999; **83**: 893–6.
9 Norregaard J, Hindsberger C, Alonso J, Bellam L, Bernth-Petersen P, Black C *et al.* Visual outcomes of cataract surgery in the United States, Canada, Denmark and Spain. *Archives of Ophthalmology* 1998; **116**: 1095–100.
10 Ninn-Petersen K. Cataract patients in a defined Swedish population 1986–1990. *Acta Ophthalmologica Scandinavia* 1997; **75**: Supplement 221.
11 McPherson K, Strong P, Epstein A, Jones L. Regional variations in the use of common surgical procedures: with and between England and Wales, Canada and the United States of America. *Social Science Medicine* 1981; **15A**: 273–88.
12 Goldzweig C, Mittman B, Carter G, Doyo T, Brook R, Lee P *et al.* Variations in cataract extraction rates in Medicare prepaid and fee-for-service settings. *Journal of the American Medical Association* 1997; **277**: 1765–8.
13 NHS Executive. *Action on Cataracts. Good Practice Guidance*. London: Department of Health, 2000.
14 Shun-shin G. Anatomy of the lens. In: Easty D, Sparrow J (eds). *The Oxford Textbook of Ophthalmology*. Oxford: Oxford University Press, 1999, pp. 453–6.
15 Sparrow J, Frost A. Physical aspects of lens clarity and image degradation. In: Easty D, Sparrow J (eds). *The Oxford Textbook of Ophthalmology*. Oxford: Oxford University Press, 1999, pp. 463–5.
16 Klein B, Klein R, Linton K, Magki Y, Neider M. Assessment of cataract from photographs in the Beaver Dam Eye Study. *Ophthalmology* 1990; **97**: 1428–33.
17 West S, Rosenthal F, Newland H, Taylor H. Use of photographic techniques to grade nuclear cataracts. *Investigative Ophthalmology and Vision Science* 1988; **29**: 73–7.
18 Chylack L, Wolfe J, Singer D, Leske M, Bullimore M, Bailey I *et al.* The lens opacities classification system III. *Archives of Ophthalmology* 1993; **111**: 831–6.
19 Sparrow J, Brown N, Shun-shin G, Bron A. The Oxford modular cataract image system. *Eye* 1990; **4**: 638–48.
20 Vivino M, Mahurkar A, Trus B, Lopez M, Datiles M. Quantitative analysis of retroillumination images. *Eye* 1995; **9**: 77–84.
21 Vivino M, Chintalagiri S, Trus B, Datiles M. Development of a Scheimpflug slit lamp camera system for quantitative densitometric analysis. *Eye* 1993; **7**: 791–8.
22 Lambert S, Drack A. Infantile cataract. *Survey of Ophthalmology* 1996; **40**: 427–58.
23 Lloyd I, Goss-Sampson M, Jeffrey B *et al.* Neonatal cataract: aetiology, pathogenesis and management. *Eye* 1992; **6**: 184–96.

24 Elston J, Timms C. Clinical evidence for the onset of the critical period in infancy. *British Journal of Ophthalmology* 1992; **76**: 327–8.
25 Jain I, Pillay P, Gangwar D *et al.* Congenital cataract etiology and morphology. *Journal of Pediatric Ophthalmology and Strabismus* 1983; **20**: 238–46.
26 Weale R. Ageing changes in the lens. In: Easty D, Sparrow J (eds). *The Oxford Textbook of Ophthalmology*. Oxford: Oxford University Press, 1999, pp. 465–9.
27 Stewart-Brown S, Haslum M. Partial sight and blindness in children of the 1970 birth cohort at 10 years of age. *Journal of Epidemiology and Community Health* 1988; **42**: 17–23.
28 Stayte M, Reeves B, Wortham C. Ocular and vision defects in preschool children. *British Journal of Ophthalmology* 1993; **77**: 228–32.
29 Office of National Statistics. *Birth Statistics 1996*. London: Stationery Office, 1998.
30 Kohler L, Stigmar G. Vision screening of four year old children. *Acta Paediatrica Scandanavia* 1973; **62**: 17–27.
31 James L, McClearon A, Walters G. Congenital malformations surveillance data for birth defects prevention. *Teratology* 1993; **48**: 545–709.
32 Edmonds L, Layde P, James L *et al.* Congenital malformation surveillance: two American systems. *International Journal of Epidemiology* 1981; **10**: 247–52.
33 Apple D, Solomon K, Tetz M, Assia E, Holland E, Legler U *et al.* Posterior capsule opacification. *Survey of Ophthalmology* 1992; **37**: 73–116.
34 Markham R, Bloom P, Chandra A, Newcomb E. Results of intraocular lens implantation in pediatric aphakia. *Eye* 1992; **6**: 493–8.
35 Keech R, Tongue A, Scott W. Complications after surgery for congenital and infantile cataracts. *American Journal of Ophthalmology* 1989; **108**: 136–41.
36 Mills M, Robb R. Glaucoma following childhood cataract surgery. *Journal of Pediatric Ophthalmology and Strabismus* 1994; **31**: 355–60.
37 Simon J, Mehta N, Simmons S *et al.* Glaucoma after pediatric lensectomy/vitrectomy. *Ophthalmology* 1991; **98**: 670–4.
38 Kanski J, Elkington A, Daniel R. Retinal detachment after congenital cataract surgery. *British Journal of Ophthalmology* 1974; **58**: 92–5.
39 Toyofuku H, Hirose T, Scheoens C. Retinal detachment following congenital cataract surgery. *Archives of Ophthalmology* 1980; **98**: 669–75.
40 France T, Frank J. The association of strabismus and aphakia in children. *Journal of Pediatric Ophthalmology and Strabismus* 1984; **21**: 223–6.
41 Lewis T, Maurer D, Brent H. Development of grating acuity in children treated for unilateral or bilateral congenital cataract. *Investigative Ophthalmology and Vision Science* 1995; **36**: 2080–95.
42 Birch E, Stager D. Prevalence of good visual acuity following surgery for congenital unilateral cataract. *Archives of Ophthalmology* 1988; **106**: 40–2.
43 Bradford G, Keech R, Scott W. Factors affecting visual outcome after surgery for bilateral congenital cataracts. *American Journal of Ophthalmology* 1994; **117**: 58–64.
44 Klein B, Klein R, Linton K. Prevalence of age-related lens opacities in a population: The Beaver Dam Eye Study. *Ophthalmology* 1992; **99**: 546–52.
45 Mitchell P, Cumming R, Attebo K, Panchapakesan J. Prevalence of cataract in Australia: the Blue Mountains Eye Study. *Ophthalmology* 1997; **104**: 581–8.
46 Gibson J, Rosenthal A, Lavery J. A study of the prevalence of eye disease in the elderly in an English community. *Transactions of the Ophthalmological Societies of the UK* 1984; **104**: 196–203.
47 Wormald R, Wright L, Courtney P, Beaumont B, Haines A. Visual problems in the elderly population and implications for services. *BMJ* 1992; **304**: 1226–9.

48 Kahn H, Leibowitz H, Ganley J, Kini M, Colton T, Nickerson R *et al.* The Framingham Eye Study I. Outline and major prevalence findings. *American Journal of Epidemiology* 1977; **106**: 17–32.
49 Kahn H, Leibowitz H, Ganley J, Kini M, Colton T, Nickerson R *et al.* The Framingham Eye Study II. Association of ophthalmic pathology with single variables previously measured in the Framingham Heart Study. *American Journal of Epidemiology* 1977; **106**: 33–41.
50 Deane J, Hall A, Thompson J, Rosenthal A. Prevalence of lenticular abnormalities in a population-based study: Oxford clinical cataract grading in the Melton Eye Study. *Ophthalmic Epidemiology* 1997; **4**: 195–206.
51 Office of Population Census and Surveys. *1991 Census General Report: Great Britain*. London: Her Majesty's Stationery Office, 1995.
52 Das B, Thompson J, Patel R, Rosenthal A. The prevalence of age-related cataract in the Asian community in Leicester: a community based study. *Eye* 1990; **4**: 723–6.
53 Das B, Thompson J, Patel R, Rosenthal A. The prevalence of eye disease in Leicester: a comparison of adults of Asian and European descent. *Journal of the Royal Society of Medicine* 1994; **87**: 219–22.
54 Tielsch J, Somer A, Witt K, Katz J, Royall R. Blindness and visual impairment in an American Urban population. *Archives of Ophthalmology* 1990; **108**: 286–90.
55 Leske M, Connell A, Wu S, Hyman L, Schachat A. Prevalence of lens opacities in the Barbados Eye Study. *Archives of Ophthalmology* 1997; **115**: 105–11.
56 Leske M. The epidemiology of open-angle glaucoma: a review. *American Journal of Epidemiology* 1983; **118**: 166–91.
57 Rauf A, Ong P, Pearson R, Wormald R. A pilot study into the prevalence of ophthalmic disease in the Indian population of Southall. *Journal of the Royal Society of Medicine* 1994; **87**: 78–9.
58 Gray P. The prevalence of eye disease in elderly Bengalis in Tower Hamlets. *Journal of the Royal Society of Medicine* 1996; **89**: 23–6.
59 Thompson J. The demand incidence of cataract in Asian immigrants to Britain and their descendants. *British Journal of Ophthalmology* 1989; **73**: 950–4.
60 Klein B, Klein R, Moss S. Incident cataract surgery: the Beaver Dam Eye Study. *Ophthalmology* 1997; **104**(4): 573–80.
61 Podgor M, Leske C, Ederer F. Incidence estimates for lens changes, macular changes, open-angle glaucoma and diabetic retinopathy. *American Journal of Epidemiology* 1983; **118**: 206–12.
62 The Italian-American Cataract Study Group. Incidence and prevalence of cortical, nuclear and posterior subcapsular cataracts. *American Journal of Ophthalmology* 1994; **118**: 623–31.
63 Leske M, Chylack L, He Q, Wu S, Schoenfeld E, Friend J *et al.* Incidence and progression of nuclear opacities in the longitudinal study of cataract. *Ophthalmology* 1996; **103**: 705–12.
64 Leske M, Chylack L, He Q, Wu S, Schoenfeld E, Friend J *et al.* Incidence and progression of cortical and posterior subcapsular opacities. *Ophthalmology* 1997; **104**: 1987–93.
65 Coombes A, Seward H. Posterior capsular opacification prevention: IOL, lens design and material. *British Journal of Ophthalmology* 1999; **83**: 640–1.
66 Schaumberg D, Dana M, Christen W, Glynn R. A systematic overview of the incidence of posterior capsular opacification. *Ophthalmology* 1998; **105**: 1213–21.
67 Leske M, Sperduto R. The epidemiology of senile cataracts: a review. *American Journal of Epidemiology* 1983; **118**: 152–65.
68 Harding J. *Cataract: biochemistry, epidemiology and pharmacology*. London: Chapman and Hall, 1991.
69 Young R. *Age-related Cataract*. New York: Oxford University Press, 1991.
70 Hodge W, Whitcher J, Satariano W. Risk factors for age-related cataracts. *Epidemiologic Reviews* 1995; **17**: 336–46.
71 West S, Valmadrid C. Epidemiology of risk factors for age-related cataract. *Survey of Ophthalmology* 1995; **39**: 323–34.

72 West S. Age-related cataract – epidemiology and risk factors. In: Easty D, Sparrow J (eds). *The Oxford Textbook of Ophthalmology*. Oxford: Oxford University Press, 1999, pp. 469–74.
73 Hillier R, Giacometti L, Yuen K. Sunlight and cataract: an epidemiologic investigation. *American Journal of Epidemiology* 1977; **105**: 450–9.
74 Hillier R, Sperduto R, Ederer F. Epidemiologic associations with nuclear, cortical and posterior subcapsular cataracts. *American Journal of Epidemiology* 1986; **124**: 916–25.
75 Wen-shu M, Tian-sheng H. An epidemiological survey of senile cataract in China. *Chinese Medical Journal* 1982; **95**: 813–18.
76 Taylor H, West S, Rosenthal F, Munoz B, Newland H, Abbey H *et al.* Effect of ultraviolet radiation on cataract formation. *New England Journal of Medicine* 1988; **319**: 1429–33.
77 Rosenthal F, Bakalian A, Taylor H. The effect of prescription eyewear on ocular exposure to ultraviolet radiation. *American Journal of Public Health* 1986; **76**: 1216–22.
78 Brown N, Harris M, Shun-shin G, Vrensen G, Willekens B, Bron A. Is cortical spoke cataract due to fibre breaks ? The relationship between fibre folds, fibre breaks, waterclefts and spoke cataract. *Eye* 1993; **7**: 672–9.
79 Schein O, West S, Munoz B. Cortical lenticular opacification distribution and location in a longitudinal study. *Investigative Ophthalmology and Vision Science* 1994; **35**: 363–6.
80 Taylor A, Jacques P, Epstein E. Relations among aging, antioxidant status and cataract. *American Journal of Nutrition* 1995; **62** (Suppl.): 11439–47.
81 Taylor A, Jacques P, Nadler D *et al.* Relationship in humans between ascorbic acid consumption and levels of total ascorbic acid in the lens, aqueous humor and plasma. *Current Eye Research* 1991; **10**: 751–9.
82 Jacques P, Taylor A. Long term vitamin C supplementation and prevalence of early age related lens opacities. *American Journal of Nutrition* 1997; **66**: 911–16.
83 Leske M, Chylack L, He Q, Wu S, Schoenfeld E, Friend J *et al.* Antioxidant vitamins and nuclear cataract. The longitudinal study of cataract. *Ophthalmology* 1998; **105**: 831–6.
84 Sperduto R, Hu T-S, Milton R *et al.* The Linxian cataract studies: two nutrition invention trials. *Archives of Ophthalmology* 1993; **111**: 1246–353.
85 Teikari J, Virtamo J, Rautalahti M, Palmgren J, Liesto K, Heinonen O. Long-term supplementation with alpha-tocopherol and beta-carotene and age-related cataract. *Acta Ophthalmologica Scandinavia* 1997; **75**: 634–40.
86 Leske M, Chylack L, Wu S, The L, Opacities C-C, Study G. The Lens Opacities Case-Control Study. Risk factors for cataract. *Archives of Ophthalmology* 1991; **109**: 244–51.
87 West S, Munoz B, Emmett E, Taylor H. Cigarette smoking and risk of nuclear cataracts. *Archives of Ophthalmology* 1989; **107**: 1166–9.
88 Klein B, Klein R, Linton K, Franke T. Cigarette smoking and lens opacities: the Beaver Dam Eye Study. *American Journal of Preventive Medicine* 1993; **9**: 27–30.
89 Hillier R, Sperduto R, Podgor M, Wilson P, Ferris F, Colton T *et al.* Cigarette smoking and the risk of development of lens opacities: the Framingham Studies. *Archives of Ophthalmology* 1997; **115**: 1113–18.
90 West S, Munoz B, Newland E, Emmett E, Taylor H. Lack of evidence for aspirin use and prevention of cataract. *Archives of Ophthalmology* 1987; **105**: 1229–31.
91 Harding J, van Heyningen R. Drugs, including alcohol, that act as risk factors for cataract, and possible protection against cataract by aspirin-like analgesics and cyclopenthiazide. *British Journal of Ophthalmology* 1988; **72**: 809–14.
92 Munoz B, Tajchman U, Bochow T, West S. Alcohol use and risk of posterior subcapsular opacities. *Archives of Ophthalmology* 1993; **111**: 110–12.
93 Ritter L, Klein B, Klein R, Mares-Perlman J. Alcohol use and lens opacities in the Beaver Dam Eye Study. *Archives of Ophthalmology* 1993; **111**: 113–17.

94 Cumming R, Mitchell P. Alcohol, smoking and cataracts. The Blue Mountain study. *Archives of Ophthalmology* 1997; **115**: 1296–303.
95 Schwab I, Armstrong M, Friedman G, Wong I, Carpenterieri A, Dawson C. Cataract extractions. Risk factors in a health maintenance organization population aged under 60 years of age. *Archives of Ophthalmology* 1988; **106**: 1062–5.
96 Cummings R, Mitchell P, Leeder S. Use of inhaled corticosteroids and the risk of cataracts. *New England Journal of Medicine* 1997; **337**: 8–14.
97 Seigel D, Sperduto R, Ferris F. Aspirin and cataracts. *Ophthalmology* 1982; **89**: 47–9.
98 van Heyningen R, Harding J. A case-control-study of cataract in Oxfordshire: some risk factors. *British Journal of Ophthalmology* 1988; **72**: 804–8.
99 Ederer F, Hillier R, Taylor H. Senile lens changes and diabetes in two population studies. *American Journal of Epidemiology* 1981; **91**: 381–95.
100 Sommer A. Diabetes and senile cataract. *American Journal of Ophthalmology* 1981; **92**: 134–5.
101 Klein B, Klein R, Moss S. Prevalence of cataract in a population based study of persons with diabetes mellitus. *Ophthalmology* 1985; **92**: 1191–6.
102 Chen T, Hockwin O, Eckerskorn U *et al.* Cataract and health status. a case-control study. *Ophthalmic Research* 1988; **20**: 1–9.
103 Shun-shin G, Ratcliffe P, Bron A *et al.* The lens after renal transplantation. *British Journal of Ophthalmology* 1990; **74**: 267–71.
104 Harding J, Harding R, Egerton M. Risk factors for cataract in Oxfordshire: diabetes, peripheral neuropathy, myopia, glaucoma and diarrhoea. *Acta Ophthalmologica* 1989; **67**: 510–17.
105 Minassian D, Mehra V, Jones B. Dehydrational crises from severe diarrhoea or heatstroke and risk of cataract. *Lancet* 1984; **i**: 751–3.
106 Hirsch R, Schwartz B. Increased mortality among elderly patients under going cataract extraction. *Archive Ophthalmology* 1983; **101**: 1034–7.
107 Benson W, Farber M, Caplan R. Increased mortality rates after cataract surgery. A statistical analysis. *Ophthalmology* 1988; **95**: 1288–92.
108 Podgor M, Cassel G, Kannel W. Lens changes and survival in a population-based study. *New England Journal of Medicine* 1985; **313**: 1438–44.
109 Cohen D, Neil H, Sparrow J, Thorogood M, Mann J. Lens opacity and mortality in diabetes. *Diabetic Medicine* 1990; **7**: 615–17.
110 Podgor M, Williams B, Cassel G, Sperduto R. Lens changes and incidence of cardiovascular events among persons with diabetes. *American Heart Journal* 1989; **117**: 642–8.
111 Thompson J, Sparrow J, Gibson J, Rosenthal A. Cataract and survival in an elderly non-diabetic population. *Archives of Ophthalmology* 1993; **111**: 675–9.
112 Klein B, Klein R, Moss S. Age-related eye disease and survival. The Beaver Dam Eye Study. *Ophthalmology* 1995; **113**: 333–9.
113 Office of National Statistics. *Mortality statistics: general – England and Wales 1993, 1994, 1995.* London: The Stationery Office, 1997.
114 Stenevi U, Lundstrom M, Thorburn W. A national cataract register. 1. Description and epidemiology. *Acta Ophthalmologica Scandinavica* 1995; **73**: 41–4.
115 Hanning M, Lundstrom M. Assessment of maximum waiting time guarantee for cataract surgery. The case of a Swedish policy. *International Journal of Technology Assessment in Health Care* 1998; **14**: 180–93.
116 Drummond M, Yates J. Clearing the cataract backlog in a (not so) developing country. *Eye* 1991; **5**: 481–6.
117 Kupfer C. The conquest of cataract: a global challenge. *Transactions of the Ophthalmological Society of UK* 1984; **104**: 1–10.

118 Seward H. Cataract surgery. In: Easty D, Sparrow J (eds). *The Oxford Textbook of Ophthalmology*. Oxford: Oxford University Press, 1999, pp. 1197–204.
119 Strong N, Wigmore W, Smithson S *et al.* Day case cataract surgery. *British Journal of Ophthalmology* 1991; **75**: 731–3.
120 Forrest F. Local anaesthesia or general anaesthesia? In: Johnson R, Forrest F (eds). *Local and General Anaesthesia for Ophthalmic Surgery*. Oxford: Butterworth-Heinemann, 1994.
121 Hamilton R, Gimbel H, Strunin L. Regional anaesthesia for 12,000 cataract extraction and intraocular lens implantation procedures. *Canadian Journal of Anaesthesia* 1988; **35**: 615–23.
122 Campbell D, Lim M, Kerr M *et al.* A prospective randomised study of local versus general anaesthesia for cataract surgery. *Anaesthesia* 1993; **48**: 422–8.
123 Cooper J. Development of day case cataract surgery: a literature review. *British Journal of Nursing* 1996; **5**: 1327–33.
124 Norregaard J, Bernth-Petersen P, Andersen T. Changing threshold for cataract surgery in Denmark between 1980 and 1992. *Acta Ophthalmologica Scandinavia* 1996; **74**: 604–8.
125 Batterbury M, Khaw P, Hands R, Elkington A. The cataract explosion: the changing pattern of diagnoses of patients attending an ophthalmic outpatient department. *Eye* 1991; **5**: 369–72.
126 Jay J, Devlin M. The increasing frequency of surgery for cataract. *Eye* 1990; **4**: 127–31.
127 Baratz K, Gray D, Hodge D, Butterfield L, Ilstrup D. Cataract extraction rates in Olmstead County, Minnesota 1980 through 1994. *Archives of Ophthalmology* 1997; **115**: 1441–6.
128 Mudd D. A vision of improvement. *Health Management* 1999; **3**: 14–15.
129 Vernon S. Eye care and the medical student: where should emphasis be placed in undergraduate ophthalmology. *Journal of the Royal Society of Medicine* 1988; **81**: 335–7.
130 Featherstone P, James C, Hall M, Williams. General practitioners' confidence in diagnosing and managing eye conditions: a survey in south Devon. *British Journal of General Practice* 1992; **42**: 21–4.
131 Harrison R, Wild J, Hobley A. Referral patterns to an opthalmic outpatient clinic by general practitioners and ophthalmic opticians and the role of professionals in screening for ocular disease. *BMJ* 1988; **297**: 1162–7.
132 Sheldrick J, Vernon S, Wilson A, Read S. Demand incidence and episode rates of ophthalmic disease in a defined urban population. *BMJ* 1992; **305**: 933–6.
133 Sheldrick J, Wilson A, Vernon S, Sheldrick C. Management of ophthalmic disease in general practice. *British Journal of General Practice* 1993; **43**: 459–62.
134 Williams E, Wallace P. *Health Checks for People Aged 75 Years and Over*. London: Royal College of General Practitioners, 1993.
135 Grindley S, Winyard S. *Losing Sight of Blindness*. London: RNIB, 1997.
136 Smeeth L, Iliffe S. Effectiveness of screening older people for impaired vision in community setting: systematic review of evidence from randomised controlled trials. *BMJ* 1988; **316**: 660–3.
137 Klein B, Klein R, Linton K, De M. The Beaver Dam Eye Study: visual acuity. *Ophthalmology* 1991; **98**: 1310–15.
138 Webster E, Barnes G. Eye tests in the elderly: factors associated with attendance and diagnostic yield in non-attenders. *Journal of the Royal Society of Medicine* 1992; **85**: 614–16.
139 Rosenthal A. The demand for ophthalmic services. *BMJ* 1992; **305**: 904–5.
140 Landes R, Popay J. 'My sight is poor but I'm getting on now.' The health and social care needs of older people with visual problems. *Health and Social Care* 1993; **1**: 325–35.
141 Reinstein D, Dorward N, Wormald R, Graham A, O'Connor L, Charlton R *et al.* Correctable undetected visual acuity deficit in patients aged 65 and over attending an accident and emergency department. *British Journal of Ophthalmology* 1993; **77**: 293–6.

142 Revicki D, Brown R, Adler M. Patient outcomes with co-managed post-operative care after cataract surgery. *Journal of Clinical Epidemiology* 1993; **46**: 5–15.
143 Lichter P. Different providers and different error rates in health care outcomes: cataract co-management at what price? *Ophthalmology* 1993; **100**: 445–6.
144 Revicki D, Poe M. Quality of care in cataract surgery cases experiencing post-operative complications with co-managed care. *Journal of the American Optometric Association* 1995; **66**: 268–73.
145 Classe J, Alexander L. Protocols for co-management. *Optometry Clinics* 1994; **4**: 101–22.
146 Percival S, Setty S. Prospective audit comparing ambulatory day surgery with inpatient surgery for treating cataracts. *Quality in Health Care* 1992; **1**: 38–42.
147 Aylward G, Larkin D, Cooling R. Audit of costs and clinical outcome of cataract surgery. *Health Trends* 1993; **25**: 126–9.
148 Lowe K, Gregory D, Jeffery R *et al.* Suitability for day case surgery. *Eye* 1992; **6**: 506–9.
149 Galin M, Boniuk V, Obstbaum S *et al.* Hospitalization and cataract surgery. *Annals of Ophthalmology* 1981; **13**: 365–7.
150 Ingram R, Banerjee D, Traynar M *et al.* Day case cataract surgery. *Transactions of the Ophthalmological Society of UK* 1980; **100**: 205–9.
151 Vernon S, Cheng H. Comparison between the complications of cataract surgery following local anaesthesia with short stay and general anesthesia with a five day hospitalisation. *British Journal of Ophthalmology* 1985; **69**: 360–3.
152 Schanzer M, Wilhelmus K. Outpatient cataract surgery by ophthalmology residents in a county hospital. *Annals of Ophthalmology* 1985; **7**: 480–2.
153 Elsas T, Guldahl J, Blika A *et al.* Outpatient anterior chamber lens implantation. *Acta Ophthalmologica* 1988; **66**: 214–16.
154 Holland G, Earl D, Wheeler N *et al.* Results of inpatient and outpatient cataract surgery. A historical cohort comparison. *Ophthalmology* 1992; **99**: 845–52.
155 Lowe K, Gregory D, Jeffery R, Easty D. Patient perceptions and social impact: preliminary results of the Bristol MRC study. *Eye* 1991; **5**: 373–8.
156 Rose K, Waterman H, Toon L, McLeod D, Tullo A. Management of day-surgery patients with cataract attending a peripheral ophthalmic clinic. *Eye* 1999; **13**: 71–5.
157 Audit Commission. A short cut to better services: day surgery in England and Wales. London: Audit Commission for Local Authorities and the NHS in England and Wales, 1990.
158 Medicine SFfPH. *Cataract Surgery*. Glasgow: Scottish Forum for Public Health Medicine, 1993.
159 Joint Working Party on Anaesthesia in Ophthalmic Surgery. *Report of the Joint Working Party on Anaesthesia in Ophthalmic Surgery*. London: Royal College of Ophthalmologists, 1993.
160 Eke T, Thompson J. The National Survey of Local Anaesthesia for Ocular Surgery. I: Survey methodology and current practice. *Eye* 1999; **13**: 189–95.
161 Eke T, Thompson J. The National Survey of Local Anaesthesia for Ocular Surgery. II: Safety profiles of local anaesthesia techniques. *Eye* 1999; **13**: 196–204.
162 Powe N, Schein O, Gieser S, Tielsch J, Luthra R, Javitt J *et al.* Synthesis of the literature on visual acuity and complications following cataract extraction and intraocular lens implantation. *Archives of Ophthalmology* 1994; **112**: 239–52.
163 Drummond M. Economic aspects of cataract. *Ophthalmology* 1987; **95**: 1147–53.
164 Haddorn D, Holmes A. The New Zealand priority criteria project. Part 1: overview. *BMJ* 1997; **314**: 131–4.
165 Mordue A, Parkin D, Baxter C, Fawcett G, Stewart M. Thresholds for treatment in cataract surgery. *Journal of Public Health Medicine* 1994; **16**: 393–8.
166 Mordue A, Parkin D. The New Zealand priority criteria project (letter). *BMJ* 1997; **314**: 1765.

167 Smith A. Criteria for cataract surgery: the role of visual acuity and visual function. *British Journal of Ophthalmology* 1999; **83**: 510–11.
168 Javitt J, Brenner M, Curbow B, Legro M, Street D. Outcomes of cataract surgery. Improvements in visual acuity and visual function after surgery in the first, second and both eyes. *Archives of Ophthalmology* 1993; **111**: 686–91.
169 Javitt J, Steinberg E, Sharkey P, Schein O, Tielsch J, West M *et al.* Cataract surgery in one eye or both a billion dollar per year issue. *Ophthalmology* 1995; **102**: 1583–93.
170 Elliott D, Patla A, Bullimore M. Improvements in clinical and functional vision and perceived visual disability after first and second eye surgery. *British Journal of Ophthalmology* 1997; **81**: 889–95.
171 Castells X, Alonso J, Ribo C, Casado A, Bail J, Badisa M *et al.* Comparison of the results of first and second cataract eye surgery. *Ophthalmology* 1999; **106**: 676–82.
172 Laidlaw D, Harrad R, Hopper C, Whitaker A, Donovan J, Brookes S *et al.* Randomised trial of effectiveness of second eye cataract surgery. *Lancet* 1998; **352**: 925–9.
173 Thompson J. The role of registers in epidemiology: a discussion paper. *Journal of the Royal Society of Medicine* 1989; **82**: 151–2.
174 Magione C, Phillips R, Lawrence M, Seddon J, Orav J, Goldman L. Improved visual function and attenuation of declines in health-related quality of life after cataract extraction. *Archives of Ophthalmology* 1994; **112**: 1419–25.
175 Steinberg E, Tielsch J, Schein O, Javitt J, Sharky P, Cassard S *et al.* The VF-14: an index of functional impairment in patients with cataract. *Archives of Ophthalmology* 1994; **112**: 630–8.
176 Alonso J, Espallargues M, Andersen T, Cassard S, Dunn E, Bernth-Petersen P *et al.* International applicability of the VF-14: an index of visual function in patients with cataracts. *Ophthalmology* 1997; **104**: 799–807.
177 Working Group on Outcome Indicators for Cataract. *Outcome Indicators For Cataract.* London: Royal College of Ophthalmologists, 1997.

Acknowledgements

Preliminary work on this review was carried out by Dr Rhian Evans, with help from Mr Nigel Kirkpatrick. My thanks are due to them, to the NHS Executive, National Case-mix office in Winchester for supplying the data in Table 5, to Dr T Smith for writing to me on behalf of the Royal College of General Practitioners describing the GP's viewpoint and to Mr I Anderson, who did the same of behalf of the College of Optometrists. However, the views expressed are my own and are not necessarily those of any other individual or organisation.