

Update Le point

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Epidemiology of cataract—a major cause of preventable blindness*

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Cataract, or opacity of the lens of the eye, is the most common easily correctable cause of blindness in the world. However, little is known of its prevalence and incidence in different regions, particularly in developing countries, or of the relative importance of the various risk factors. This article describes the available knowledge on the epidemiology of cataract in both developing and industrialized countries, and reviews the methods used to obtain these data. The various predisposing factors, such as diabetes, exposure to radiation, and abnormalities of metabolism, along with the possible mechanisms of cataract formation, are also discussed.

Cataract, or opacity of the lens of the eye, is the most common easily correctable cause of blindness in developing regions of the world. In the industrialized countries, surgery for cataract constitutes one of the largest items of expense in the delivery of essential eye health care, with cataract extraction being performed about as often as appendectomy. Cataract is one of the diseases of greatest concern to a special programme, recently established by the World Health Organization, for the prevention of blindness, the aim of which is to "eliminate avoidable blindness and visual impairment", particularly in developing regions,

Considerable effort is directed towards the prevention and control of the main forms of blindness due to infection (trachoma and onchocerciasis), and nutritional blindness (xerophthalmia associated with vitamin A deficiency). In contrast, cataract is often regarded as a normal phenomenon of ageing, and control efforts are directed mainly at surgical correction, either through special surgical teams (e.g., the cataract camps in South East Asia) or through the existing health care system. Relatively little is known, however, of the prevalence and incidence of cataract in different regions and the relative importance of various causative factors.

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It is essential to obtain accurate epidemiological data on both the magnitude and distribution of the problem of cataract, in order to:

- (a) Determine the primary eye health care needs of both developing and industrialized countries and estimate the cost.
- (b) Identify the populations and occupational groups that have excessively high rates.
- (c) Elucidate the relative importance of various predictive and risk factors, such as diabetes mellitus, exposure to sunlight or ionizing radiation, nutrition, occupation, and trauma.
- (d) Supply baseline data for testing theories of cataract formation and for evaluating preventive and therapeutic measures in particular populations.

EPIDEMIOLOGY

Cataract is generally defined as any opacity of the crystalline lens of the eye. Minor lens opacities are extremely common and rarely interfere substantially with vision. More extensive lens opacities may absorb or deflect the light rays entering the eye, and thus produce a distorted image on the retina. About 85% of cataracts are classified as senile or mature and a substantial proportion of these are associated with diabetes.^a Other kinds of cataract include congenital cataracts, metabolic cataracts such as those associated with galactosaemia, endocrinological cataract associated with hypothyroidism and hypercalcaemia, cataracts associated with certain skin diseases such as atopic dermatitis, toxic cataract resulting from medication, traumatic cataract, and aftercataract, which is a recurrent growth of lens material after partial removal (extracapsular extraction).

Although the biochemistry of cataract formation has been studied extensively, there have been relatively few studies on the distribution and probable causes of cataract in human populations. However, information on the prevalence and incidence of cataract may be estimated from (a) the number of operations performed; (b) blindness registries and model reporting areas; (c) prevalence surveys.^b

Number of operations for cataract

The rate of cataract surgery in a particular population depends upon a number of factors, such as the availability of services, the visual requirements of that population, and the willingness of patients to undergo surgery. There are few data from developing countries on rates of cataract surgery, but statistics from the United States of America, Western Europe, and New Zealand provide estimates of the magnitude of the problem (Table 1). The rate of cataract extraction in the USA rose from 111 per 100 000 in 1968 to 165 per 100 000 in 1977, a yearly increase of 4.2%. In 1978 there were about 357 000 operations for lens extraction in the USA, a rate of 167 per 100 000 population. Cataract surgery accounted for 1.6% of all operations performed in that year and was done about as often as appendectomy. There were, however, marked regional differences, with rates of 174–187 per 100 000 in the north-east, north central and western regions in 1978, versus 134 per 100 000 in the south.

In the United Kingdom, the number of cataract operations increased from 55 per 100 000 population in 1962 to 68 per 100 000 in 1970, an annual increase of 2.8%. A special study in Oxford for the period 1957–62 revealed a surgery rate of 59 cases per 100 000, while another study in Coventry in 1971 revealed a rate of 76.4 per 100 000. The rate of cataract

^a LIEBOWITZ, H. M. ET AL. The Framingham Eye Study monograph. *Survey of ophthalmology*, 24 (Suppl.): 335-610 (1980).

^b SOMMER, A. Cataracts as an epidemiologic problem. *American journal of ophthalmology*, 83: 334-339 (1977).

Table 1. Cataract extraction rates per 100 000 population

Year	USA ^{a, b}	UK				New Zealand ^e	Denmark ^f
		All ^c	Oxford ^d	Coventry ^c	Wales ^c		
1957-62		55	58.9				
1969-70	113	68			90		90.8
1971	121			76.4		} 46.6	
1972	127						
1973	133						
1974	142						
1975	144						
1976	153						
1977	165						
1978	167						

^a NADLER, D. J. & SCHWARTZ, B. Cataract surgery in the United States 1968-1976. A descriptive epidemiological study. *Ophthalmology*, **87** (2): 10-18 (1980).

^b Utilization of short stay hospitals. Annual summary for the United States, 1978. DHEW publication No. (PHS) 80-1797, 1980 (National health survey, series 13, No. 46).

^c BRENNAN, M. E. & KNOX, E. G. The incidence of cataract and its presentation. *Community health*, **7**: 13-20 (1975).

^d CAIRD, F. I. ET AL. Cataract extraction in an English population. *British journal of preventive and social medicine*, **19**: 80-84 (1965).

^e SUCKLING, R. D. Survey of ophthalmic surgery in North Canterbury and Westland (1970-1975). *New Zealand medical journal*, **84**: 193-194 (1976).

^f BRADENSTRUP, P. Senile cataract. Account of cataract extractions performed in an urbanized population during the third quarter of the present century. *Acta ophthalmologica*, **55**: 337-346 (1977).

surgery in Copenhagen, Denmark, was about 90.8 per 100 000 in 1969. Among the predominantly European population in the South Island of New Zealand, the rate was 46.6 per 100 000. The higher rates of cataract surgery in the USA have been attributed to the visual requirements and expectations of the population and to the easy availability of cataract surgery.

The steady 4% annual increase in cataract surgery in the USA cannot be attributed to an increase in the proportion of older persons in the population, because the age-specific rates also show a progressive rise. From 1970 to 1976, annual cataract surgery rates rose by 3.2% in the 40-59-year age group, by 5.7% in the 60-64-year age group, and by 5.5% for those aged over 65. In the UK, the difference between the 1957-62 survey in Oxford and the 1971 survey in Coventry represents a yearly increase in surgery of 3.8% (Table 2).

Table 2. Age-specific rates of cataract extraction per 100 000 population, in the USA and Europe

Age	USA ^a (1974)	UK		Denmark ^d (1972)
		Oxford ^b (1957-62)	Coventry ^c (1971)	
40-59	94.3	25.3	48.1	26.5
60-64	306.7			
60-69		131.7	198.2	136.3
≥ 65	849.1			
≥ 70		335.5	712.7	344.1

^a NADLER, D. J. & SCHWARTZ, B. Cataract surgery in the United States 1968-1976. A descriptive epidemiological study. *Ophthalmology*, **87**: 10-18 (1980).

^b CAIRD, F. I. ET AL. Cataract extraction in an English population. *British journal of preventive and social medicine*, **19**: 80-84 (1965).

^c BRENNAN, M. E. & KNOX, E. G. The incidence of cataract and its presentation. *Community health*, **7**: 13-20 (1975).

^d BRADENSTRUP, P. Senile cataract. Account of cataract extractions performed in an urbanized population during the third quarter of the present century. *Acta ophthalmologica*, **55**: 337-346 (1977).

There appear to be marked differences in the rates of surgery in men and women. Of the 357 000 operations for cataract extraction in the USA in 1978, the male:female ratio was 39:61. The Coventry study also revealed a higher rate for women, with 59 per 100 000 in men and 99 per 100 000 in women. There was also an earlier average age of presentation for cataract in women (66 years) than in men (71 years) in the Coventry study. In the Oxford study, the sex-specific rates did not differ greatly in patients under 60 years of age, but for those aged over 60 the rate among women was about 25% higher than that for men. Hence, there would appear to be an absolute increase in the rate of cataract extractions among females over the age of 60.

Blindness registries and model reporting areas

The second approach to the study of cataract epidemiology is the examination of blindness registries and model reporting areas. Unfortunately, blindness registries are almost always incomplete, but in industrialized countries, they can give some idea of the relative importance of the different causes of blindness. The Canadian National Institute for the Blind (CNIB) reported that cataract accounted for 15% of registered cases, of which 36% were congenital, 6% were in diabetics, and 5% were traumatic.

The Model Reporting Area for Blindness Statistics (MRA) was a volunteer association of 16 states in the USA that agreed to use uniform definitions and procedures in reporting blind persons. In 1970, the MRA reported a blindness rate of 161.6 per 100 000 for its population of 99 million people. Cataract accounted for 19.2 per 100 000, with 5.7 due to prenatal causes, and 13.5 due to other causes; the rate for whites was 16.1, and for all other races, 40.7. The age-specific prevalence of blindness due to cataract not associated with prenatal causes rose steadily after age 45 years. The annual rates of new registrations for blindness due to cataract were 2.1 per 100 000 overall, 1.8 for whites, and 4.1 for other races. These data undoubtedly underestimate the number of senile cataracts, because most patients with cataract are never registered, since they do not consider themselves blind.

Prevalence surveys

Surveys for eye disease and blindness provide a direct means of acquiring data on cataracts. Technical problems in such surveys include selection of sample, methods of examination, and standardization of clinical and diagnostic criteria. A major study in the USA was carried out in a population sample in Framingham, Massachusetts, that had previously been well studied for heart conditions and possible associated factors.^{c,d,e} In the Framingham eye study (FES) 2631 persons over 52 years old received a screening eye examination. A diagnosis of senile cataract was made if the visual acuity was 20/30 or worse, and senile lens changes were present or the lens had been removed (aphakia). Senile cataract was diagnosed in 12.3% of all persons examined. There was a significant difference in the rates in men (10.3%) and women (13.8%) ($P < 0.01$), which was most marked in those over 75 years of age. In this study, standardized clinical and diagnostic criteria were used and attempts were made to reduce inter-observer variation. Individual factors determined during the original Framingham heart study that were significantly associated with cataract formation included: elevated blood sugar, elevated blood pressure, increased serum phospholipids, decreased pulmonary vital capacity, small stature, and less than seven years of schooling.^e

^c LIEBOWITZ, H. M. ET AL. The Framingham Eye Study monograph. *Survey of ophthalmology*, **24** (Suppl.): 335-610 (1980).

^d KAHN, H. A. ET AL. The Framingham Eye Study. I. Outline and major prevalence findings. *American journal of epidemiology*, **106**: 17-32 (1977).

^e KAHN, H. A. 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*, **106**: 33-41 (1977).

Table 3. Senile cataract and aphakia rates in the Framingham eye study (FES) and the national health and nutrition examination survey (HANES)

Age	FES ^a				HANES ^b			
	No. examined	Aphakia (%)	Senile cataract (%)	Total (%)	No. examined	Aphakia (%)	Senile cataract (%)	Total (%)
50-64	1188	1.4	1.3	2.7	1009	1.0	3.9	4.9
65-74	753	2.0	7.3	9.3	1638	3.7	21.4	25.1
75-85	376	9.0	22.6	31.6	—	—	—	—
Total	2317	2.8	6.7	9.5	2647	2.6	14.7	17.4

^a LIEBOWITZ, H. M. ET AL. The Framingham Eye Study monograph. *Survey of ophthalmology*, 24 (Suppl.): 335-610 (1980).

^b EDERER, F. ET AL. Senile lens changes and diabetes. Two population studies. *American journal of ophthalmology* (in press).

Another population-based survey of eye disease was done as part of the health and nutrition examination survey (HANES) in 1971-72, and included 10 127 persons aged 4-94 years in 35 areas of the USA.^f This was a national probability sample of the civilian, non-institutionalized population, but was weighted more heavily toward low-income groups, older people, preschool children, and women of childbearing age. The lens of the eye was examined through a dilated pupil with a slitlamp (biomicroscope). In one assessment of the HANES data, senile cataract was defined as the presence of senile lens changes consistent with a best visual acuity of 20/30 or worse. Senile cataract or aphakia in the HANES population occurred in 4.9% of those aged 50-64 years and in 25% of those aged 65-74 years (Table 3). Using these criteria, the respective rates in the Framingham study were considerably lower, at 2.7% and 9.3%. The rates for surgical aphakia in the two studies were similar (2.5% and 2.8%) and accounted for 15-30% of the cases labelled senile cataract.

A population-based prevalence survey for blindness (defined as visual acuity of 6/60 or less) in northern Egypt in 1970 revealed rates of 4.7% in the rural population, and 1.5% in the urban population; cataract accounted for 33% of the rural blind and 37% of the urban blind.^g A survey in northern India detected cataract, defined as an absence of red reflex on direct ophthalmoscopy, in 4.2-7.2% of the population in the plains, and 1.5-3.8% in the Himalayas.^h In one Himalayan village, cataract accounted for 70% of the blind eyes.

More than 6000 persons were examined in a cluster survey of the rural population of the Behera governorate in northern Egypt in 1979 and 1980. A total of 1.8% of the population was blind (visual acuity less than 3/60) and cataract contributed to this visual loss in 0.8% of the total population, i.e., in 41% of the blind population. Thus cataract is a major cause of blindness in this population, which suffers also from hyperendemic trachoma.

As part of a collaborative project, a survey of blinding conditions was carried out in an oasis village in southern Tunisia with endemic trachoma. Altogether, 3172 persons were screened, and those whose corrected vision was worse than 3/10 (20/60) in the better eye were examined by an ophthalmologist. The definitive examination included a slitlamp examination of the lens and anterior eye, direct ophthalmoscopy through a dilated pupil, measurement of intraocular pressure, and, when necessary, determination of refractive

^f EDERER, F. ET AL. Senile lens changes and diabetes in two population studies. *American journal of ophthalmology*, 91: 381-395 (1981).

^g SAID, M. E. ET AL. Prevalence and causes of blindness in urban and rural areas of Egypt. *Public health reports*, 85: 587-599 (1970).

^h CHATTERJEE, A. ET AL. Vision survey in Himalayan area. *American journal of ophthalmology*, 66: 113-116 (1968).

error. Of the 3000 persons examined, 92 (3.1%) had a visual acuity of less than 3/10, and 32 (1%) had an acuity of less than 3/60. Of the 92 with any visual disability, 32 had cataract alone and 8 had cataract and corneal scarring. Only 9 of the cataract cases (0.3% of the total sample), however, had a visual acuity of less than 3/60. Cataracts accounted for visual loss in the better eye of 2% of those aged 41–60 years, and in 11.6% of those aged 61 years and over. The other major cause of visual loss was trachomatous corneal opacity, which contributed to decreased vision in 43 subjects (1.4%), and tended to occur early in life (3.2% of those aged 41–60 years and 8.8% of those aged 61 years and over). Thus, even in this region with severe endemic trachoma, untreated cataract constitutes a serious cause of visual disability.

To determine the eye care needs in six southern and central gouvernorats (provinces) in Tunisia, a randomized cluster survey was carried out in 1979–80. This survey was limited to the rural population which comprised 70% of the 1.5 million persons in the region. Visual acuity was tested and the anterior ocular segment examined with the aid of a telescopic loupe (2.5x magnification) and a handheld light in more than 8000 persons. Preliminary analysis showed that 3.9% had some visual loss (i.e., an acuity of less than 3/60). Although trachoma was endemic in three of the six gouvernorats, cataract and its consequences contributed to visual loss in 60% of cases.

Predictive and risk factors in cataract formation

Diabetes

There appears to be a 5–10-fold excess of diabetics in studies of cataract surgery. Sommer has pointed out that this may simply reflect the greater access of diabetics to medical care and may not be related to a higher prevalence of cataracts.ⁱ There is a true diabetic cataract characterized by subcapsular white spots, needle-shaped cortical opacities, and posterior subcapsular opacities, but the vast majority of cataracts in diabetic adults are of the ordinary senile type. Surveys for lens opacities have shown that they are no more frequent in diabetics than in non-diabetics. In a case–control study in the USA, there was a high rate of cataract surgery in diabetics aged 40–59 years, but normal rates in those aged over 70 years. In a British study of cataract surgery, however, there was an excess of diabetics at all ages as well as significantly more diabetic women undergoing surgery.

In the Framingham Eye Study,^j there was a significant difference in the prevalence of senile cataract in subjects with diabetes (19.1%) and in non-diabetics (11.6%) ($P < 0.01$). This difference was due largely to a high rate of cataract in diabetics under 65 years of age and was not significant in the older subjects. Although senile cataract occurred more frequently in diabetic women (24%) than in diabetic men (15%), the difference was not significant. There was also a statistically significant association between diabetes and cataract in the HANES data.^k It has been proposed that lens opacities progress more rapidly in diabetics, and particularly in diabetic women.

One possible mechanism of cataract formation in diabetics is the formation of excessive sorbitol and fructose in the lens, mediated by lens aldose reductase (EC 1.1.1.21) in the presence of high glucose levels. The accumulated polyol and fructose lead to osmotic overhydration with leakage of cell constituents and cataract formation. The presence of sorbitol in the diabetic lenses has been confirmed. Moreover, the sorbitol accumulation can be reduced by aldose reductase inhibitors in diabetic experimental animals and in human diabetic lenses *in vitro*. There is also a preliminary report that cataract formation is

ⁱ See footnote *b*, page 494.

^j See footnote *a*, page 494.

^k See footnote *f*, page 497.

more frequent in diabetics treated with oral hypoglycaemics than in those treated with insulin or diet alone.

Solar radiation

Ultraviolet light and sunlight have long been felt to be factors leading to cataract formation. In the USA, one study based on data from the MRA and from the National Health and Nutrition Examination Survey showed significantly more cataracts in persons over 65 years of age living in regions with more hours of sunshine. Another study, which compared human lenses removed for cataract in Rochester, New York, Tampa, Florida, and Manila, The Philippines revealed a significant correlation between the prevalence of black cataracts, proximity to the equator, and outdoor occupation.¹

It has been shown that exposure of the excised lens, or lens proteins, to sunlight leads to the formation of brown pigments from tryptophan; this effect occurs particularly with light of wavelength 295–310 nm. It has been proposed that ultraviolet radiation (above 295 nm) ionizes tryptophan residues, with generation of superoxides as free radicals, leading to cross-linking of lens proteins in the absence of adequate sulfhydryl groups in glutathione. It has also been shown that light damages the cation pump activity by the superoxide mechanism, and that such damage is attenuated by ascorbate at levels like those in the normal human aqueous humour. Cotlier and his associates have reported that serum tryptophan levels are significantly elevated in cataract patients and that tryptophan and its metabolite, kynurenine, bind to lens protein. Salicylates lower plasma levels of tryptophan and prevent binding to the lens, and there is some evidence that chronic salicylate ingestion significantly retards cataract formation in both diabetics and non-diabetics.

Other metabolic abnormalities

It has long been known that young children with the inborn error of metabolism, galactosaemia, develop cataract as part of this fatal disorder. Recent studies suggest that heterozygous carriers of this recessive gene have a partial manifestation of the disorder, and may develop cataract in the early and middle adult years. This metabolic defect is detectable by the absence of the enzymes galactokinase (EC 2.7.1.6) and galactose-1 phosphate uridyltransferase (EC 2.7.7.10) in red cells. It is postulated that the excess galactose is metabolized by aldose reductase to dulcitol, which accumulates in the lens and leads to cataract formation. Similarly, it has been shown that male subjects who lack glucose-6-phosphate dehydrogenase (EC 1.1.1.49) in their red blood cells have an increased rate of presenile cataract formation in adult life.

Ionizing radiation

X-rays were noted to induce cataracts in human subjects during the first two decades of this century. The dose–response curve of cataract formation with radiation of the head has been determined in patients treated therapeutically.^m For a single radiation treatment, all doses over 52 mC/kg (200R) led to cataract formation. In the lower range (52–168 mC/kg) the average interval before onset was 8 years 7 months, while at higher doses (168–300 mC/kg), the average interval was 4 years 4 months. Since only 25% of the eyes were examined by slitlamp in this early study, it is probable that some opacities were missed. Cataract formation was reported also after multiple doses of X-rays spread over many months.

Among survivors of the atomic bomb blast in Nagasaki, who received high doses of radi-

¹ ZIGMAN, S. ET AL. Sunlight and human cataracts. *Investigative ophthalmology and visual science*, 18: 462-467 (1979).

^m MERRIAM, G. R. & FOCHT, E. F. A clinical study of radiation cataracts and the relationship to dose. *American journal of roentgenology, radium therapy, and nuclear medicine*, 77: 759-785 (1957).

ation (more than 2 Gy (200 rads)), 10% had axial opacities visible by ophthalmoscope and slitlamp, and 83% had bilateral polychromatic posterior subcapsular (PSC) opacities (versus 30% of controls). Comparable figures for Hiroshima survivors were lower, with 6% having axial opacities and 34% having PSC opacities (versus 9% of controls). The radiation from the Nagasaki weapon was almost all gamma rays, but in Hiroshima, 20% of the radiation was in the form of fast neutrons. The effects of radiation dose on axial opacity and PSC formation at Hiroshima were most clearly apparent in persons in the 10–19-year age group at the time of exposure.

Microwave radiation

Zaret has strongly supported the hypothesis that exposure to low levels of microwave radiation, e.g., from radar sets or microwave ovens, produces cataracts. One study of workers in a Danish factory developing radar equipment found significantly more subcapsular opacities in workers exposed to radiation than in non-exposed workers. Surveys of exposed military personnel and others have not revealed any excess of cataract, however, and there is no consensus regarding microwave radiation as a risk factor for cataract formation.ⁿ Allowable levels of exposure to microwave radiation have varied 250-fold from 0.04 mW/cm² in the Soviet Union to 10 mW/cm² in the USA.

Drugs and other cataractogenic factors

The occurrence of posterior subcapsular cataract in patients on oral corticosteroid therapy was first reported in 1960 and lens opacity has also been observed after topical corticosteroid treatment. Cataract formation occurs more frequently with high doses (more than 15 mg of prednisone per day) and prolonged treatment.^o Other drugs and substances reported to produce cataract formation include topical phospholine iodide, psychotherapeutic drugs such as phenothiazines and trifluoperidol, total parenteral nutrition in newborns, and organic solvents in paints.

Starvation and malnutrition also play a major role in cataract formation; however, their significance, mechanism, and epidemiological importance are poorly understood.

DISCUSSION

Of the four diseases of greatest concern to the WHO programme for the prevention of blindness, namely trachoma, onchocerciasis, xerophthalmia, and cataract, only cataract is common to all countries regardless of their stage of economic development. With the general increase in life expectancy, cataract will become increasingly prevalent and will place greater demands on health care systems. However, since there are substantial differences in the prevalence and incidence of cataract in different areas, it cannot be regarded as a normal feature of ageing.

The problem presented by cataract in developing countries is different from that in the industrialized countries. In developing countries, there is a need for epidemiological surveys to determine the relative importance of the various causes of blindness so that appropriate measures can be taken to deal with the problem. Particularly in rural areas, there are often large numbers of persons who are blind from cataract and whose sight could be restored by relatively simple surgery. While it may be argued that many of these people

ⁿ SWANSON, J. R. ET AL. A review of international microwave exposure guides. *American industrial hygiene association journal*, 31: 623-629 (1970).

^o CREWS, S. J. Posterior subcapsular lens opacities in patients on long-term corticosteroid therapy. *British medical journal*, 2: 1644-1647 (1963).

are old and the investment of health care services in restoring their sight would not benefit the community, the problem cannot be ignored by programmes that purport to aim at the elimination of preventable and easily curable blindness. Indeed, most of these individuals can be restored to full participation in the economic and social life of their community. The "cataract camps" in India and Pakistan demonstrate how such surgery can be carried out at minimum cost, but different approaches may be needed in other countries. Such mass surgery must be safe, simple, and effective with a minimum of complications. Practical, operational research will be needed in almost all countries to develop the methods best suited to local conditions.

In developed countries with established health care systems, the trends in age-distribution and rates of cataract surgery should be assessed carefully to predict more accurately the future need for this service. Moreover, new methods of dealing with cataract and with the consequences of corrective surgery have been developed in recent years, such as phacoemulsification (fragmentation of the lens with ultrasound and removal by suction), the emplacement of intraocular lenses, and long-wear contact lenses. These new methods should be evaluated in terms of efficacy, safety, and cost, particularly because resources available for medical care are limited, even in the most affluent industrialized countries. In both developing and industrialized countries, research is needed to identify the factors leading to cataract formation so that preventive methods can be devised.

Finally, it must be recognized that new means, particularly drugs, are being proposed for the prevention or retardation of cataract formation. It may be possible to detect individuals at high risk of developing cataract; in addition to diabetes, other biochemical abnormalities occur with relatively high frequency in cataract surgery patients, e.g., elevated serum tryptophan levels, or lack of glucose-6-phosphate dehydrogenase and galactose metabolizing enzymes in red blood cells. Clinical trials are needed to test prophylactic measures and to identify the risk factors involved in cataract formation.

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