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The Changing Pattern of Cataract Surgery Indications

A 5-Year Study of 2 Cataract Surgery Databases

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Purpose: The aim of this study was to describe changes over time in the indications and outcomes of cataract surgery and to discuss optimal timing for the surgery.

Design: Database study.

Participants: Patients who had undergone cataract extraction in the Netherlands, Sweden, or Malaysia from 2008 through 2012.

Methods: We analyzed preoperative, surgical, and postoperative data from 2 databases: the European Registry of Quality Outcomes for Cataract and Refractive Surgery (EUREQUO) and the Malaysian National Cataract Registry. The EUREQUO contains complete data from the national cataract registries in the Netherlands and Sweden.

Main Outcome Measures: Preoperative and postoperative corrected distance visual acuity, preoperative ocular comorbidity in the surgery eye, and capsule complications during surgery.

Results: There were substantial differences in indication for surgery between the 3 national data sets. The percentage of eyes with a preoperative best-corrected visual acuity of 20/200 or worse varied from 7.1% to 72%. In all 3 data sets, the visual thresholds for cataract surgery decreased over time by 6% to 28% of the baseline values. The frequency of capsule complications varied between the 3 data sets, from 1.1% to 3.7% in 2008 and from 0.6% to 2.7% in 2012. An increasing postoperative visual acuity was also seen for all 3 data sets. A high frequency of capsule complication was related significantly to poor preoperative visual acuity, and a high frequency of decreased visual acuity after surgery was related significantly to excellent preoperative visual acuity.

Conclusions: The 5-year trend in all 3 national data sets showed decreasing visual thresholds for surgery, decreasing surgical complication rates, and increasing visual outcomes regardless of the initial preoperative visual level. Cataract surgery on eyes with poor preoperative visual acuity was related to surgical complications, and cataract surgery on eyes with excellent preoperative visual acuity was related to adverse visual results. *Ophthalmology 2014;■:1–8 © 2014 by the American Academy of Ophthalmology.*

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Age-related cataract is a chronic, slowly progressive disease that ultimately results in symptomatic disturbance of vision. The indication for cataract extraction usually is expressed as poor visual acuity, perceived visual problems in daily life, or both because of a cataract. As the opacities grow and the influence on vision increases over time, the indication for extraction rises. The timing of surgery is a matter of weighing benefits against risks, and particular attention must be paid to the informed patient's wish.

If the decision to operate is based solely on the preoperative visual acuity in the eye to be operated, the number of potential cataract extractions will increase substantially for each visual acuity level included as an indication for surgery.[1] If any lens opacity alone were considered an indication for surgery regardless of visual influence, almost every person older than 60 years would be eligible for a cataract extraction.

Cataract surgery is performed with increasing frequency in some countries,[2,3] and the cataract surgical rate (CSR) varies significantly worldwide.[4] Demographic changes, particularly in the developed world, have resulted in a dramatic increase in spending on cataract surgery, whether from the government, private insurers, or self-payers. The following questions need to be considered: Is there an optimal rate of cataract surgery? Is it possible to draw conclusions from large data sets of cataract surgery outcomes? The aim of this study was to describe changing indications and outcomes of cataract surgery over time and to discuss optimal timing for the surgery using 2 cataract surgery databases with a 5-year perspective.

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Methods

Two databases were used, each with 5-year data on cataract surgery: the European Registry of Quality Outcomes for Cataract and Refractive Surgery (EUREQUO)[5] and the Malaysian National Cataract Registry.[6] The EUREQUO includes complete data from the Dutch National Cataract Register and the Swedish National Cataract Register (SNCR).[3] Data from 2008 through 2012 were included in the study.

Use of the Malaysian National Cataract Registry was approved by the Malaysian Medical Research and Ethics Committee, whereas use of the SNCR was approved by the Swedish Data Inspection Board and a local ethics committee. The Dutch National Cataract Register fulfills Dutch rules for collection of sensitive personal information. The study was performed according to the tenets of the Declaration of Helsinki.

The SNCR covers approximately 97% of all procedures performed in Sweden,[3] and the Dutch National Cataract Register covers approximately 50% of all cataract surgeries performed in the Netherlands. All registry data from these 2 countries are transferred to the EUREQUO database. Cataract surgery clinics in Sweden are a mixture of publically run and privately run clinics, although most cataract surgery in the Netherlands is performed in publically run clinics. The Malaysian Cataract Registry includes data from all public cataract clinics in Malaysia. It covers approximately 97% of all surgeries performed in these public hospitals and more than half of all cataract extractions performed in Malaysia. In this study, the national data sets are identified by country.

The variables studied for changing trends are listed below.

Preoperative Data

Preoperative data included age, corrected distance visual acuity in the eye to be operated on, visual acuity in logarithm of the minimum angle of resolution (logMAR) values calculated from the original decimal or Snellen notation in the registries (percentage at logMAR 1.0 [20/200] or worse, percentage at logMAR 0.3 [20/40] or worse, percentage at logMAR 0.0 [20/20] or better), and percentage of ocular comorbidity in the operated eye (age-related macular degeneration, glaucoma, or diabetic retinopathy). The condition for reporting a comorbidity to the registries is that the diagnosis is included in the list of diagnoses for the patient either before surgery or at discharge after surgery.

Surgical Procedure

Capsule complication during surgery is reported in all 3 registries. This is defined as a communication between the vitreous and the anterior segment caused by surgery and not present before surgery. Included is a capsular break or zonular dehiscence with or without vitreous loss.

Postoperative Data

Postoperative data included corrected distance visual acuity at follow-up. Follow-up time varies slightly between and within the registries. Follow-up data were calculated only for cases in which a phacoemulsification procedure was undertaken (and hence had the same recovery time).

Statistical Methods

Statistical significance in changing trends over 5 years was tested with logistic or linear regression using the analyzed parameter as the dependent variable and the calendar year as the independent variable (SPSS Statistics version 22; IBM Ltd, Chicago, IL). The significance of changes from one year to the next was tested with a *t* test for age and logMAR improvement and a chi-square test for visual acuity levels and capsule complications. A P value of 0.05 or less was considered significant.

Results

Number of Cases

This study included 404 714 cataract extractions from the Netherlands, 412 542 from Sweden, and 137 524 from Malaysia.

Age

Mean age at the time of cataract surgery was highest in Sweden (74.6 years; standard deviation [SD], 9.7 years) and lowest in Malaysia (64.6 years; SD, 11.6 years). The 5-year trend showed a slowly decreasing mean age in Sweden, stable mean age in the Netherlands, and slowly increasing mean age in Malaysia (Fig 1). The changes from one year to the next were significant for Sweden except between 2010 and 2011. For the Netherlands and Malaysia, only 1 annual step was significant for each: from 2010 to 2011 and from 2011 to 2012, respectively.

Preoperative Visual Acuity

Preoperative visual acuity in the eye to be operated on differed among the 3 countries. The percentage of eyes with visual acuity of 1.0 logMAR (20/200) or worse in 2008 was 7.1% in the Netherlands, 20.6% in Sweden, and 72% in Malaysia (Fig 2). The 5-year trend in all 3 countries was for better preoperative visual acuity, with the largest reduction occurring in Sweden (28% of baseline value) followed by the Netherlands (22.5%) and then Malaysia (6.3%). The 5-year changes in preoperative visual acuity were statistically significant for all 3 countries (the Netherlands, $P < 0.001$; Sweden, $P < 0.001$; Malaysia, $P < 0.001$). The changes from one year to the next were significant for all annual steps except for the Netherlands between 2009 and 2010 and for Malaysia between 2008 and 2009. The same pattern was seen when considering visual acuity worse than 0.3 logMAR (20/40); in 2008; this occurred in 44.7% of eyes in the Netherlands, 64.9% in Sweden, and 96.9% in Malaysia, whereas over the 5-year period, this percentage decreased by 16.1% of the baseline value in the Netherlands, 14.5% in Sweden, and 1.3% in Malaysia (Fig 3). The 5-year changes in preoperative visual acuity were statistically significant for all 3 countries (the Netherlands, $P < 0.001$; Sweden, $P < 0.001$; Malaysia, $P < 0.001$). The changes from one year to the next were significant for all annual steps for Sweden and the Netherlands. For Malaysia, the annual changes between 2009 and 2010 and between 2011 and 2012 were significant. Conversely, the percentage of cases with preoperative visual acuity of 0.0 logMAR (20/20) or better increased over time (Fig 4), and again the 5-year change was statistically significant for all 3 countries (the Netherlands, $P < 0.001$; Sweden, $P < 0.001$; Malaysia, $P = 0.025$). The change from one year to the next was not significant for any annual step for Malaysia. Two annual steps were significant for Sweden and 3 for the Netherlands.

The influence of second-eye surgery could be studied only in a subset of data from the SNCR. Preoperative visual acuity for first-eye and second-eye procedures is shown in Figure 5 (available at www.aaojournal.org). The change in preoperative visual acuity during the entire study period was statistically significant for both first-eye surgery ($P < 0.001$) and second-eye surgery ($P < 0.001$). The changes from one year to the next during the study period were statistically significant for both first- and second-eye surgery. The percentage of cases with a preoperative visual acuity of 0 logMAR

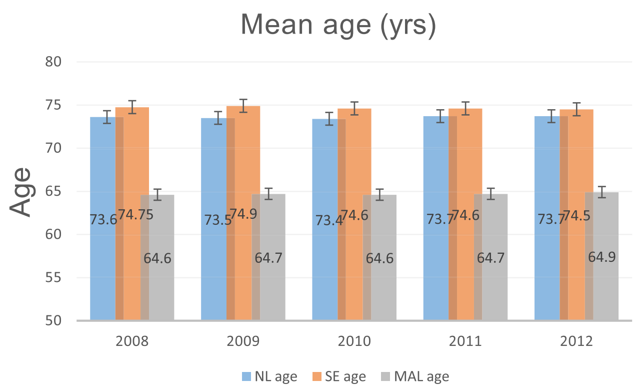

Figure 1. Bar graph showing the mean age per calendar year. Note that the y-axis starts at 50. Error bars indicate 95% confidence intervals. Blue bar = the Netherlands (NL); orange bar = Sweden (SE); grey bar = Malaysia (MAL).

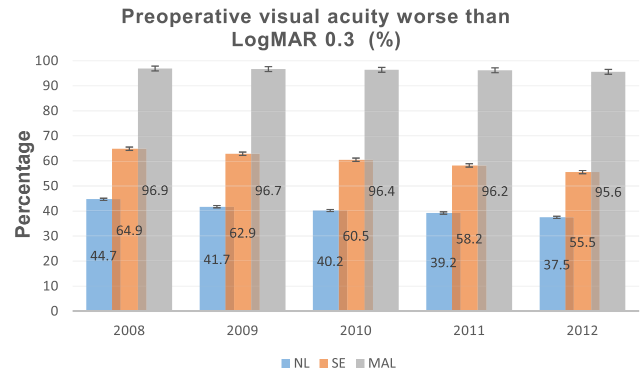

Figure 3. Bar graph showing the percentage of patients with preoperative visual acuity poorer than 0.3 logarithm of the minimum angle of resolution (logMAR; 20/40) in the eye to be operated on for each calendar year, 2008 through 2012. Error bars indicate 95% confidence intervals. Blue bar = the Netherlands (NL); orange bar = Sweden (SE); grey bar = Malaysia (MAL).

(20/20) or better changed during the 5-year period from 0.3 to 0.8 for first-eye procedures and from 1.2 to 2.9 for second-eye procedures.

Ocular Comorbidity

Age-Related Macular Degeneration. This comorbidity was most frequent in the Swedish national data, where it decreased from 16.2% to 15.8% during the 5-year study period, as shown in Figure 6 (available at www.aaojournal.org). In the Dutch national data, it remained stable at 8%, whereas in the Malaysian data, it increased from 1.2% to 1.6% ($P = 0.002$). The increase from one year to the next was significant only for the first annual step (2008–2009). The 5-year decrease in age-related macular degeneration (AMD) frequency was statistically significant for Sweden ($P = 0.001$) but not for the Netherlands ($P = 0.466$). Between single years, the decrease for Sweden was significant only from 2010 to 2011.

Glaucoma. There were only small changes in glaucoma frequency during the 5-year study period, as demonstrated in Figure 7 (available at www.aaojournal.org). In Sweden the frequency increased from 8.8% to 9.5% ($P < 0.001$), in the Netherlands, it decreased from 5% to 4.6% ($P < 0.001$), and in Malaysia, it remained stable at 6.5% ($P = 0.289$). The annual change in Sweden was most pronounced and significant between 2011 and 2012 and the annual decrease in the Netherlands was significant from 2010 onward.

Diabetic Retinopathy. The frequency of diabetic retinopathy (both proliferative and nonproliferative) was highest in Malaysia, as seen in Figure 8 (available at www.aaojournal.org), ranging from 8% to 10% over the 5-year study period ($P = 0.541$). This frequency decreased in the Netherlands ($P < 0.001$) and increased in Sweden ($P < 0.001$). The change from one year to the next was significant for the Netherlands from 2009 until 2011 (decrease) and for Sweden between 2009 and 2010 (increase).

Surgical Complication: Capsule Rupture

There was a trend of decreasing frequency of reported capsule complications in all 3 national data sets (Fig 9). The 5-year decrease was significant in all cases (the Netherlands, $P < 0.001$; Sweden, $P = 0.04$; Malaysia, $P < 0.001$). The decrease from one year to the next was significant for Malaysia between 2009 and 2010 and between 2011 and 2012. For Sweden, the decrease was significant between each annual step except for the first (2008–2009). The same significant changes were seen in the

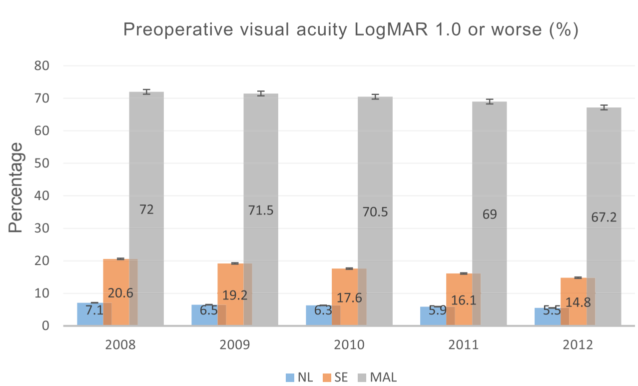

Figure 2. Bar graph showing the percentage of patients with preoperative visual acuity of 1.0 logarithm of the minimum angle of resolution (logMAR; 20/200) or poorer in the eye to be operated on for each calendar year, 2008 through 2012. Error bars indicate 95% confidence intervals. Blue bar = the Netherlands (NL); orange bar = Sweden (SE); grey bar = Malaysia (MAL).

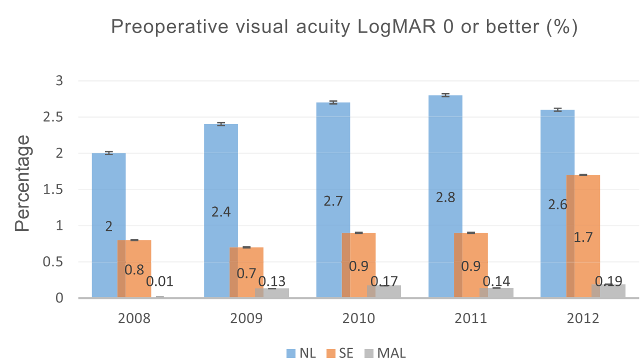

Figure 4. Bar graph showing the percentage of patients with preoperative visual acuity of 0 logarithm of the minimum angle of resolution (logMAR; 20/20) or better in the eye to be operated on for each calendar year, 2008 through 2012. Error bars indicate 95% confidence intervals. Blue bar = the Netherlands (NL); orange bar = Sweden (SE); grey bar = Malaysia (MAL).

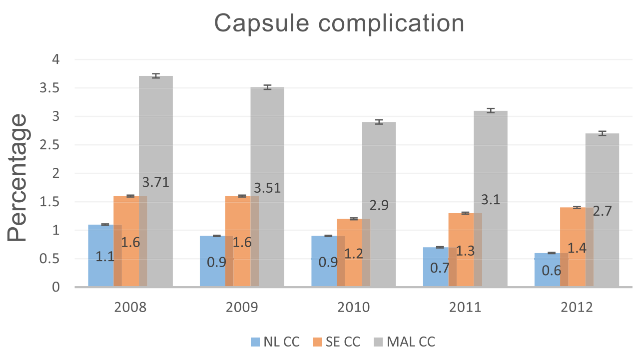

Figure 9. Bar graph showing the frequency (percentage) of reported capsule complications per year, 2008 through 2012. Error bars indicate 95% confidence intervals. Blue bar = the Netherlands (NL); orange bar = Sweden (SE); grey bar = Malaysia (MAL).

Netherlands except for 2009 through 2010. In a logistic regression analysis with capsule complication as the dependent variable and age, sex, ocular comorbidity, and preoperative visual acuity (logMAR) in the eye to be operated on as independent variables, preoperative visual acuity was most strongly related to a capsule complication ($P < 0.001$) in all 3 registries.

Visual Acuity Outcome

The visual acuity outcome for all patients recorded in the registries is shown in Table 1. This outcome improved over time in all 3 national data sets (Fig 10), and the improvement was statistically significant for both 0 logMAR (20/20) or better (the Netherlands, $P < 0.001$; Sweden, $P < 0.001$; Malaysia, $P < 0.001$) and 0.3 logMAR (20/40) or better (the Netherlands, $P < 0.001$; Sweden, $P < 0.001$; Malaysia, $P < 0.001$). The improvement from one year to the next for 0 logMAR (20/20) or better was significant for the Netherlands in all annual steps. For Sweden, it was significant between each annual step from 2008 to 2010, but for Malaysia, it was significant only between 2009 and 2010. The annual change of 0.3 logMAR (20/40) or better was significant between 2008 and 2009 for Sweden and between 2010 and 2012 for the Netherlands. No annual change was significant in the Malaysian data set.

Surgery produced a mean improvement in visual acuity of −0.32 logMAR (SD, 0.30 logMAR) in the Netherlands, −0.35 logMAR (SD 0.28 logMAR) in Sweden, and −1.11 logMAR (SD, 0.64 logMAR) in Malaysia. This visual improvement decreased slightly over the 5-year study period in all 3 countries (linear regression: the Netherlands, $P < 0.001$; Sweden, $P < 0.001$;

Table 1. Postoperative Corrected Distance Visual Acuity in Terms of Percentages Achieving 0.3 Logarithm of the Minimum Angle of Resolution (20/40) or Better and 0 Logarithm of the Minimum Angle of Resolution (20/20) or Better, Respectively

	Country Data		
Postoperative CDVA (%)	*The Netherlands*	*Sweden*	*Malaysia*
0.3 logMAR or better	95.1	90.9	87.8
0.0 logMAR or better	65.2	45.8	41.3

CDVA = corrected distance visual acuity; logMAR = logarithm of the minimum angle of resolution.
Type of surgery was phacoemulsification

Malaysia, $P < 0.001$; Table 2). The significance of change from one year to the next is shown in Table 2.

Ocular comorbidity had a moderate influence on the outcome (Table 3, available at www.aaojournal.org). Over time, in all 3 countries there was a slow decrease in visual improvement for both eyes without a comorbidity and in eyes with a comorbidity (data not shown).

Average percentages of cases with a worse visual acuity outcome compared with before surgery are listed in Table 4 (available at www.aaojournal.org). The percentages were reduced when only patients without comorbidity were analyzed, but the trends over time remained the same. The Dutch data showed an improvement over time, the Swedish data showed a deterioration, and the Malaysian data remained stable.

Worse postoperative visual acuity was related significantly to good preoperative visual acuity in all 3 registries ($P < 0.001$, Pearson correlation). When only cases with preoperative visual acuity of 0 logMAR (20/20) or better were analyzed, the percentage of cases with worse postoperative visual acuity was considerable (the Netherlands, 8.9%; Sweden, 19.1%; Malaysia, 34.7%). Table 5 shows data for a limited set of cataract extractions with the following inclusion criteria: age 70−74 years, preoperative visual acuity of 0.3 logMAR (20/40), no reported ocular comorbidity, and only phacoemulsification as type of surgery.

Discussion

In this study, we used large cataract databases to describe the 5-year trend of changing cataract surgery indications in 3 different countries. These countries represent 3 different levels of indications for cataract surgery, which should be considered in the light of each country's historical CSR. The inverse relationship between preoperative visual acuity and CSR has been described previously.[7] We do not have exact CSR numbers for Malaysia, but for Sweden, this information is available through the SNCR.[3] The CSR in Sweden was more than 7000 per 1 million in 2000, and during the study period, this figure increased from 8000 per 1 million in 2008 to more than 10 000 per 1 million in 2012.[8] The CSR for the Netherlands varied from 10 600 to 11 000 per 1 million over the study period, with both increases and decreases (Henry Y, personal communication, 2014), whereas the estimated CSR in Malaysia varied from 2000 to 3000 per 1 million (Goh PP, personal communication, 2014).

It has been estimated that a CSR of more than 3000 per 1 million is required to avoid blindness (worse than 1.0 logMAR; 20/200),[9] but this number is uncertain and probably varies in different parts of the world. To reduce and subsequently avoid a backlog of cases suitable for cataract surgery, the CSR must equal or exceed the incidence of cataract suitable for surgery. Suitable for surgery here means fulfilling modern indications for cataract surgery (e.g., the presence of a cataract that affects vision, visual functioning, or both combined with the informed patient's wish). However, the CSR for keeping surgery equal to the incidence of cataract that needs surgery is unknown. Another uncertainty is the CSR term itself calculated on the entire population. It is not known whether cataract is more prevalent in some countries compared with others or whether it starts at a younger age

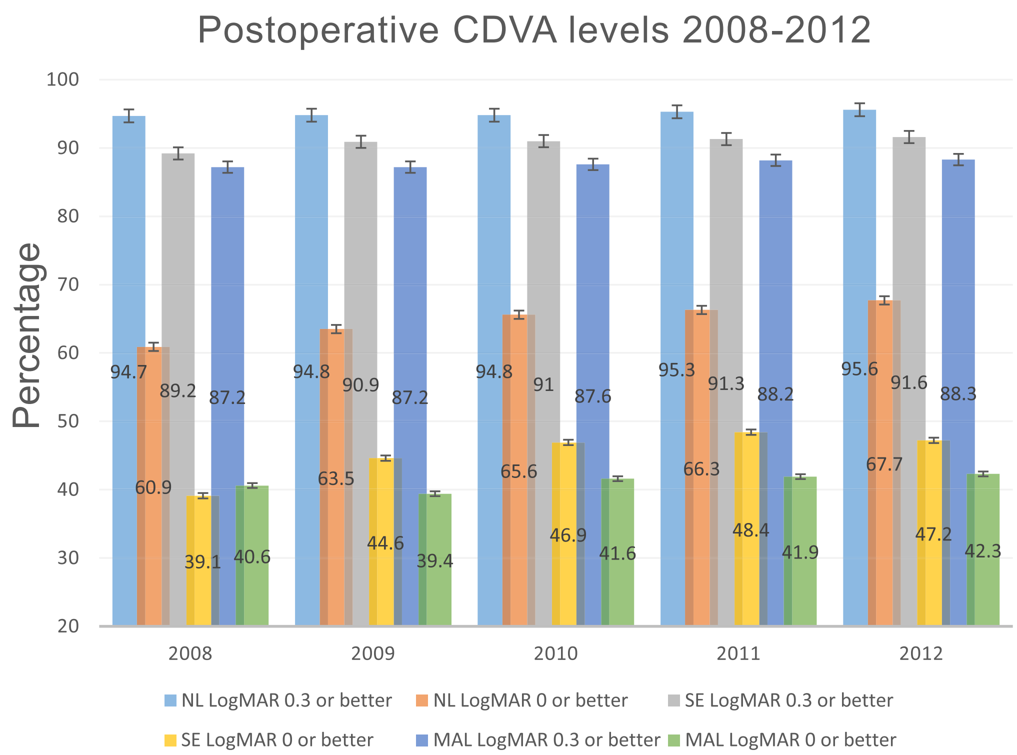

Figure 10. Bar graph showing 2 levels of visual outcome (corrected distance visual acuity [CDVA]), 0.3 logarithm of the minimum angle of resolution (logMAR; 20/40) or better and 0 logMAR (20/20) or better, as a percentage and per year, 2008 through 2012. Error bars indicate 95% confidence intervals. The type of surgery was phacoemulsification. Note that the y-axis starts at 20%. Light blue and orange bars = the Netherlands (NL); grey and yellow bars = Sweden (SE); dark blue and green bars = Malaysia (MAL).

in different countries, but it is well known that the age distribution varies between countries. Consequently, the optimal CSR that equals or exceeds the incidence of symptomatic cataract, thus avoiding a backlog of cases, also may vary between countries. In addition, the CSR may be influenced by administrative or reimbursement rules.

Our study showed a distinct difference in mean age among the 3 countries. If the CSR in a country has been low for many years, cataract surgery is performed on a backlog of more or less severe cases. Elderly patients may accept poor vision as a part of aging or for cultural reasons, whereas younger patients who are still active or still working may seek help. This could be one reason for our finding of a much lower mean age in Malaysia. Another reason could be the high prevalence of diabetes in Malaysia; a large proportion of patients having cataract surgery in the Malaysian registry also had diabetes. A large variation in mean age between units in different countries, ranging from 55.9 to 79.3 years, has been reported previously.[10] In that study, the mean age varied within European countries and was related to the number of cases operated in each country. In a World Health Organization study using data from 2008,[7] the mean age was highest in the European region and lowest in the Eastern Mediterranean region. It is not fully known whether this variation is caused by a difference in the mean age of the population,

Table 2. Mean Visual Improvement (Logarithm of the Minimum Angle of Resolution Change) during Each Study Year (2008–2012)

Country Data Set	2008	2009	2010	2011	2012
The Netherlands	−0.34	−0.33*	−0.32*	−0.32*	−0.31*
Sweden	−0.36	−0.36	−0.36	−0.33*	−0.33
Malaysia	−1.03	−1.03	−1.03	−1.01*	−1.00*

Changes from one year to the next were tested for significance using a *t* test.
*Significant changes ($P < 0.05$).

Table 5. Visual Outcome and Capsule Complications during Surgery for a Selection of Patients in the Dutch, Swedish, and Malaysian National Data set 70 to 74 Years of Age with Preoperative Visual Acuity of 0.3 Logarithm of the Minimum Angle of Resolution (20/40) and No Ocular Comorbidity

	The Netherlands	Sweden	Malaysia
Postoperative CDVA 0.3 logMAR or better (%)	98.1	96.1	96.6
Capsule complication during surgery (%)	0.9	1.4	1.6

CDVA = corrected distance visual acuity; logMAR = logarithm of the minimum angle of resolution.

the age-related cataract prevalence, or the CSR. The change in mean age over time in our study does not permit conclusions about trends to be drawn because the 5-year difference in mean age varied only between 0.1 and 0.3 years. Another study using the SNCR reported that with increasing CSR, the patients' mean age increased until the estimated backlog of cataract patients was cleared, and then, when operating more in line with incidence, the mean age started to decline.[3]

We found a large variation of preoperative visual acuity in the 3 countries' data. The European Cataract Outcome Study, which used data from 13 European countries in 2001, reported that the percentage of cases with a preoperative visual acuity of 0.1 (20/200; 1.0 logMAR) or less varied from 5.8% to 73.3%.[10] That study reflected a snapshot of the situation in countries with a wide variation in CSR at that time. This study revealed a steady trend toward better preoperative visual acuity, reflecting higher levels of CSR than before, in 3 different countries. It is worth asking whether this reduction of visual acuity thresholds for cataract surgery can be explained by an increasing number of second-eye procedures.[11] In our study, the trend of reduction was the same for first-eye as for second-eye operations, but the visual acuity threshold was lower for second-eye surgeries (Fig 5). This means that a higher percentage had poor visual acuity and a lower percentage of excellent visual acuity before surgery in first-eye surgery compared with second-eye surgery (Fig 5). Preoperative visual acuity became significantly better over time regardless of the previous CSR. This was not solely an effect of increasing second-eye surgery because preoperative visual acuity became better over time for both first-eye and second-eye procedures. We found no evidence that either a change in mean age or changing trends in ocular comorbidity could explain the improvement in preoperative visual acuity. However, existing ocular comorbidity may increase the risk for complications (glaucoma) or diminish the benefit of surgery (AMD). Our explanation is that the trend of better preoperative visual acuity is caused by changing thresholds of visual impairment as an indication for surgery. One reason behind this trend may be better technology and thus a lower estimated risk when weighing the benefits versus risks of performing a cataract extraction.

Ocular comorbidity is important when evaluating indications for surgery and also has the potential to influence visual outcome and self-reported visual function.[12] Both AMD and diabetic retinopathy are related to a poorer visual outcome.[13] Glaucoma is related to more difficult surgery and surgical complications in cases with small pupils,[14] and this also may influence the visual outcome; AMD is related to more advanced age.[15] The average trend in our study was increasing age in Malaysia, decreasing age in Sweden, and stable age for the Netherlands. Everything else being equal, this could mean an increasing frequency of AMD in Malaysia, a stable frequency in the Netherlands, and a decreasing frequency in Sweden; this indeed was our finding. Glaucoma is also related to older age.[16] In our study, the frequency of glaucoma did not follow the mean age trend, but rather the opposite. This may have been the result of differences in how the diagnosis was defined or regional variations in prevalence of glaucoma. It is reported that Malaysia has a high prevalence of diabetes,[17] and this is probably the reason for the high frequency of diabetic retinopathy in Malaysia compared with the Netherlands and Sweden.

In all 3 databases, the frequency of capsule complications decreased significantly over time, as has been shown previously for Sweden.[18] However, there was an obvious difference between the registries in the incidence of capsule complication. In our study, the occurrence of a capsule complication was related significantly to the preoperative visual acuity in the operated eye. This relationship indicates that an increasing complication frequency is connected to poorer preoperative visual acuity, which, in turn, may be regarded as a proxy for dense cataract in a cataract population. The data in this study consisted of self-reported data from clinics and surgeons, so the reliability of the complication data may be questionable. In a recent validity study of the SNCR, we found that the reported number of capsule complications did not diverge significantly from the real number, although there was a certain level of underreporting.[18] We suspect that there was also some underreporting in this study, although this is unlikely to have varied in magnitude over the study period; hence we consider the trend to be a reliable one, as in the Swedish study.[18]

Our study showed that a lower CSR means operating on patients with poorer preoperative visual acuity, higher frequency of surgical difficulties and surgical complications, and poorer visual outcome. The poorer result from operating on advanced cataract cases was eliminated when we compared the outcome of surgery in patients with equal risk factors (Table 5). In all 3 national data sets, representing different levels of preoperative visual acuity, we found improved visual acuity after surgery. This improvement slowly decreased over time as the preoperative visual acuity became better but remained substantial over the 5-year period.

Is there any drawback in moving the indication for cataract surgery to almost no preoperative deterioration in visual acuity? In our study it was evident that excellent visual acuity before surgery (0 logMAR; 20/20 or better) was related to high frequency of worse visual acuity after surgery. A previous study of the EUREQUO database showed that the risk of worse postoperative visual acuity after cataract surgery increased with better preoperative visual acuity.[19] In that study, 11.9% of patients with preoperative visual acuity of 0 logMAR (20/20) or better ended up with worse visual acuity after surgery.[19] It has also been reported that good self-assessed visual function before surgery (no or slight visual disability) is related to a risk of more self-assessed problems after surgery.[20] This means that if the purpose of cataract surgery is to improve vision or visual function, the risk of an adverse outcome increases with very good preoperative vision or visual function.

The decision on timing of cataract surgery is a complex one, and the one-size-fits-all approach does not work. This decision must be shared between the individual surgeon and the individual and adequately informed patient, balancing the potential benefits to the patient's visual function against the estimated risks. However, from these large data sets, we learned that late surgery on an eye with poor vision means increased risk for complications, whereas early surgery with excellent preoperative visual acuity means increased risk for poorer visual acuity. The optimal timing for cataract surgery lies between these 2 stages of cataract growth.

A cataract extraction late in the cataract process means an increased risk of complications, which, in addition to causing quality-of-life problems for the patient, may cause poor vision for a long period. However, with an increasing number of cataract extractions performed on eyes with excellent preoperative visual acuity, there is an obvious risk for an adverse outcome. Ocular comorbidity complicates the decision to operate because it sometimes means no improvement in visual acuity. Based on our findings, a CSR as high as 10 000 per million inhabitants still seems to slowly decrease the visual acuity threshold for surgery. In a steady state, a slightly lower (but still population-appropriate) CSR may correspond to operating on incidence of cataract to avoid a backlog of cases, while also still ensuring a CSR that produces optimal benefit for the patients.

In this study, we confined lens extraction to cataract surgery and did not include refractive lens exchange. Is there a clear border between cataract surgery and refractive lens exchange in our 3 national cataract registries? The inclusion criterion for these registries is the presence of cataract as an indication for the surgery, and so all patients with preoperative visual acuity of 0 logMAR (20/20) should have a symptomatic cataract. However, if second-eye cataract surgery is performed in the absence of cataract symptoms because of anisometropia after first-eye surgery, there is no clear boundary between lens extraction for symptomatic cataract and lens extraction for purely refractive reasons.

A weakness in this study is the fact that all data in the 3 registries were self-reported data from the participating clinics. Registry data in EUREQUO from the Netherlands and Sweden were transferred from existing national registries, and the registry data from the Malaysian cataract registry were reported by participating clinics in Malaysia. The registry data in the SNCR have been validated twice, with very small errors found.[18,21] As discussed above, certain variables such as capsule complications or poor visual outcomes may be underreported and thus may represent a bias introduced by the self-reporting model. However, we believe that the reported 5-year trends are not affected by this bias. Another weakness may be the fact that clinics in different countries use different visual acuity charts, meaning that our study did not use standardized testing. A third weakness may be the fact that the 3 national data sets contain different mixtures of public and private clinics, which may skew the comparison of indications. One strength of this study was the enormous amount of data, which supports our trend findings and largely eliminates the problem of different test charts.

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Abbreviations and Acronyms:
AMD = age-related macular degeneration; **CSR** = cataract surgical rate; **EUREQUO** = European Registry of Quality Outcomes for Cataract and Refractive Surgery; **logMAR** = logarithm of the minimum angle of resolution; **SD** = standard deviation; **SNCR** = Swedish National Cataract Register.

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