Safety and efficacy in the cataract surgery process

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To Johan, Jacob and Siri
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Abstract

Background
Cataract and age-related macular degeneration (AMD) are two major causes for visual impairment in the elderly. Cataract surgery is one of the most common surgical interventions performed in the western world. As a consequence of the increasing number of operations performed, postoperative visits are a large workload for surgical units. It is important that all parts of the cataract surgery procedure are appropriate and cost-effective. During the last 20 years the trend is towards fewer visits both pre- as well as postoperatively. The number and timing of postoperative visits are also a subject of an ongoing debate. Few studies have previously evaluated safety perspectives concerning the number and timing of post-operative visits.

The last decade, new treatments for wet AMD have evolved and the number of patients receiving treatment has increased. It has been debated if blue-blocking intraocular lenses (IOL) have a protective effect on the development of wet AMD and decreasing the need for AMD-treatment after cataract surgery.

Aims
To analyse parts of the modern cataract surgery process including peri- and postoperative routines from a safety and efficacy perspective.

To analyse pre- and perioperative risk factors as well as protective factors associated with the need for wet AMD-treatment after cataract surgery.
Methods
I, II. These prospective, observational cohort studies included all cataract surgery cases (n=1249) during a 1-year period, at one institution. The cohort was analysed regarding the use of a standardized anaesthetic regimen and the safety perspectives, when the standard routine is no planned postoperative visit in uncomplicated cases without ocular comorbidity.

III. The above mentioned cohort (study group), was compared with a cohort from another clinic (control group) with a different follow-up routine, i.e. each case with first eye cataract surgery had a planned postoperative visit. In the control group all patients (n= 1162 cases) had surgery during the same 1-year period. The number of planned and unplanned visits was recorded, and the surgical outcome from the two institutions was compared.

IV. A register-based cohort study included all patients registered in the Swedish National Cataract Register and the Swedish Macula Register in 2010 - 2017, to find all eyes with past cataract surgery that were subsequently treated for wet AMD. Complete registry data was used for comparisons and analyses of pre- and peri-operative risk- and protective factors for wet AMD treatment after cataract surgery.

Results
I. A standardized anaesthetic method with topical and intracameral anaesthetics without sedation was used in most cases (90%). Median pain score after surgery was 0.7 (VAS 0-10) and most patients (97%) would choose the same anaesthetic method again.
II, III. Evaluation of all medical records 2 years after the cataract surgery procedure, found no report of missed adverse events. Significantly less patients in the study group (9% vs 16%; p=0.000036) initiated a postoperative unplanned contact compared with the control group. Patients with 70 km or longer to the hospital were less inclined to seek unplanned care (p=0.016).

IV. Female gender and high age are associated with an increased risk of needing treatment for wet AMD ≥1 year after cataract surgery. Eyes with a diagnosis of AMD preoperatively, and subsequently treated for wet AMD, had a significantly (p=0.023) lower degree of blue-blocking IOLs implanted at their previous cataract surgery.

**Conclusion**

I. A standardized anaesthetic method with topical and intracameral anaesthetics without sedation seems well tolerated by the patients, and is effective at cataract surgery, also in cases when complications/adverse events occur.

II, III. Without compromising patient safety, it is possible to refrain from standard postoperative visits after cataract surgery in patients with uncomplicated surgery and no ocular comorbidity. A significant reduction in postoperative visits is only obtained if the standard routine applies to both first and second eye surgery.

IV. Patients without preoperative AMD have no benefit from the use of blue-blocking IOLs. In patients with preoperatively diagnosed AMD, blue-blocking IOLs may offer some protection from the subsequent development of AMD.
Abbreviations

AMD: age-related macular degeneration

Anti-VEGF: Anti-vascular-endothelial-growth-factor

BSCVA: best spectacle corrected visual acuity

CME: cystoid macular oedema

ECCE: extracapsular cataract extraction

IOL: intraocular lens

IOP: intraocular pressure

IV: intravenous

LogMAR: Logarithm of the Minimum Angle of Resolution

NCR: National Cataract Register

PCO: posterior capsular opacification

PE: phacoemulsification

PXF: pseudoexfoliation

RD: retinal detachment

RVO: retinal vein occlusion
SMR: Swedish Macula Register

VA: visual acuity

VAS: visual analogue scale (0–10)
Enkel sammanfattning på svenska

Bakgrund

Det ökade antalet gråstarroperationer innebär också ett stort antal återbesök efter operation för ögonklinikerna i Sverige. Diskussion har förts kring hur många återbesök som är nödvändiga och när dessa skall ske. Det är dock få undersökningar som analyserat hur säkert det är för patienten om man minskar mängden återbesök.

Åldersförändringar i ögats gula fläck (makuladegeneration) är den näst vanligaste orsaken till synnedsättning hos äldre. En ny behandlingsmetod som kom 2007 har förbättrat möjligheten för drabbade patienter att behålla synen. Behandlingen består av injektioner av läkemedel i ögat. Det har diskuterats vilken
påverkan en gråstaroperation kan ha för utveckling av åldersförändringar i gula fläcken.

**Syfte**

Att analysera vårdrutiner både under och efter modern gråstaroperation ur ett patientsäkerhets- och effektivitetsperspektiv.

Genom en registerbaserad studie analysera patienter som efter gråstaroperation utvecklar behandlingskrävande åldersförändringar i gula fläcken. Syftet är att se vilka riskfaktorer före och under gråstaroperationen som kan påverka risken att utveckla åldersförändringar i gula fläcken och om typ av inopererad plastlins kan innebära en skyddande effekt.

**Metod**

Alla patienter med grå starr (1249 stycken) som under ett års tid opererades vid Ögonkliniken, Sunderby sjukhus, i Norrbotten ingår i undersökningen. Analys av all operationer görs utifrån bedövningsmetodens effektivitet och hur nöjda patienterna är med bedövningsrutinen.

Dessutom görs analys av patientsäkerheten när rutinen är inget återbesök efter gråstaroperation, för patienter där ögat inte har någon annan sjukdom än grå starr, och det inte varit några problem under operationen. Undersökningen kompletterades med en jämförelse med annan klinik, (Ögonkliniken, Umeå Universitetssjukhus) för alla patienter (1162 stycken) opererade under samma tidsperiod. Ögonkliniken i Umeå hade då rutinen att patienter som opererats för grå starr för första gången har ett planerat återbesök men inte efter operation av
andra ögat. Analys av antalet besök och hur ofta patienterna hör av sig akut, samt operationsresultat jämfördes mellan klinikerna.

En undersökning baserad på insamlade registerdata görs också där alla patienter registrerade i Svenska Nationella Katarakt Registret under 2010–2017 och Svenska Makula Registret ingår. Data från före och under gråstarroperationen mellan patienter som senare inte behövt, respektive de som behövt behandling för åldersförändringar i gula fläcken jämförs.

**Resultat**

En standardiserad bedövningsmetod i form av ögondroppar kombinerat med bedövningsmedel insprutat i ögat under operationen fungerar väl för de flesta patienter. Det är få som har behov av lugnade medel eller extra bedövning under operationen. Smärtupplevelsen är låg 0.7 (smärtskala från 0–10 med 0 som ingen smärta och 10 som maximal smärta). De flesta patienter (97%) skulle välja samma bedövning igen.

Genomgång av samtliga journaler 2 år efter gråstarroperationen visar att man inte missat att upptäcka några komplikationer med den nya rutinen, inga återbesök för okomplicerade operationer. Det är färre patienter i gruppen inga planerade återbesök som hör av sig akut till ögonkliniken efter gråstarroperation jämfört med kontrollgruppen där alla patienter som opererade första ögat rutinmässigt alltid hade ett återbesök. Patienter med lång resväg till ögonklinik var mindre benägna att söka akut vård efter operationen.
Riskfaktorer som innebär ökad risk för behandling av åldersförändringar i gula fläcken mer än ett år efter kataraktoperation är kvinnligt kön och hög ålder. Patienter med åldersförändringar i gula fläcken som fanns före gråstarroperationen, har mindre risk att behöva behandling av gula fläcken om man under gråstarroperationen använder en plastlins som hindrar osynligt blått kortvågigt ljus.

**Sammanfattning**

En standardiserad bedövningsmetod i form av ögondroppar tillsammans med bedövning insprutat i ögat utan att något lugnande medel ges, tolereras väl av de flesta patienter. Metoden är effektiv vid gråstarroperation, även när komplikationer tillstöter.

Det är möjligt att på ett säkert sätt avstå från återbesök efter okomplicerad gråstarroperation för patienter som inte har någon annan samtidig ögonsjukdom.

Valet av plastlinstyp vid gråstarroperationen påverkar inte risken att behöva senare behandling för åldersförändringar i gula fläcken, för friska patienter. Patienter som har åldersförändringar i gula fläcken vid gråstarroperationen kan ha visst skydd av en plastlins som blockerar blått ljus, dvs man får mindre risk att senare behöva behandling för gula fläcken.
**Original papers**

This thesis is based on the following original papers, which will be referred to in the text by their Roman numerals.


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General aim of this thesis

To evaluate selected standardized parts of the cataract surgery process. The standardized routines should be safe and effective in most patients and result in a cost-effective care utilizing resources in an optimal way.

Specific aims

Paper I

- To evaluate if the standard anaesthetic regimen, topical combined with intracameral anaesthesia without sedation, is adequate, optimal and good practice, or if improvements are necessary.

Paper II

- To evaluate the safety perspectives, when the standard routine after cataract surgery is no planned postoperative visit in uncomplicated cases without comorbidity.

Paper III

- To evaluate the number of postoperative visits, between two standard routine follow-ups after cataract surgery, no planned postoperative visit vs planned postoperative visit for first eye surgery.

Paper IV

- To characterize pre- and perioperative risk- and protective factors for wet AMD treatment after cataract surgery in order to analyse the value of blue-blocking IOLs.
Introduction

This thesis is based on a prospective population-based cohort consisting of patients having cataract surgery at the Sunderby Hospital, Norrbotten County, Sweden, during a one-year period. The purpose of an improvement project at this clinic was to standardize and ensure that the increasing number of cataract operations was performed in a safe and effective way, with as few exceptions as possible from the standard routine. Before the study started, improvement and standardization of material used during surgery such as draping, viscoelastic, surgical instruments, etc was completed. All surgeons at the clinic used the same standardized equipment. The need for an intravenous line was evaluated resulting in intravenous lines no longer being mandatory, and consequently almost never used.

As the admitting area is large with long distances for the patients to travel, there is no specific preoperative visit to the surgeon. The preoperative visit, with information and plan for the operation is performed by the admitting ophthalmologist, also regarding the need for and timing of the postoperative follow-up. Both oral and written information about the operation is given by the ophthalmologist and the nurse who performs the preoperative exams.

As a result of the increasing number of cataract operations a more effective postoperative care was considered necessary. A decision was made to standardize the number of postoperative visits after cataract surgery. The new routine was no planned postoperative visit in cases with uncomplicated surgery, in patients without other significant ocular comorbidity. A comparative study with another
clinic using a different standard routine, no postoperative visit only for second eye surgery was made. The difference in number of postoperative visits both planned, and patient initiated between the two routines was evaluated.

In order to increase efficiency on the surgical day, a standard anaesthetic regime was implemented at the clinic. This routine was analysed regarding patient satisfaction and efficiency, in terms of need for additional anaesthetics or other supplements during surgery. All additions and changes from the standard routine are time consuming and it is important that the standard routine chosen functions well in most patients.

The increasing number of treatments for wet age-related macular degeneration (AMD) has made it necessary to analyse if the use of a blue-blocking intraocular lens (IOL) at cataract surgery lowers the risk of needing AMD-treatment after cataract surgery. A register-based study was performed to evaluate the association between preoperative patient-characteristics and data from the cataract surgical event, and subsequent treatment for wet AMD. If possible, it is important to reduce the number of patients developing and needing treatment for wet AMD. If this may be accomplished by use of blue-blocking IOLs instead of non-blue-blocking IOLs at cataract surgery the long-time visual outcome after cataract surgery will be benefit.
Background

Cataract is opacification of the lens and sometimes also the lens capsule and is a common and important cause of visual impairment worldwide. Surgery is the only treatment and cataract surgery with an intraocular lens implant (IOL) is one of the most frequently performed surgical procedures on elderly individuals in Europe and the United States.\textsuperscript{1,2} In Sweden, more than 94,000 operations were performed in 2011, of which 42\% were second eye surgery. In 2017 the number of operations had increased to more than 130,000.\textsuperscript{3,4}

Figure 1. Number of cataract operations in Sweden 1980-2017 (reproduced with permission of the National Cataract Register, Sweden)

The considerable increase in the number of cataract surgery procedures performed in the last decades, is likely due to the continuous improvement in
surgical technique and outcome.\textsuperscript{5,6} The number of operations performed with refractive error as the main indication, i.e. not only decreased vision due to cataract opacities, has also increased.\textsuperscript{7}

During the last 50 years the surgical technique has improved. In the 60s and 70s the intra-capsular lens extraction technique, removing the entire lens and lens capsule, was the method of choice. With the lens removed, the patient was fitted with high dioptre aphakic glasses.\textsuperscript{8} In the early 1980s the technique of extracapsular cataract extraction (ECCE) was introduced.\textsuperscript{9} By a relatively large scleral incision (7-9 mm) the lens contents were removed leaving the lens capsule intact in the eye. Using this technique, a posterior chamber IOL can be inserted in the capsular bag, which resulted in a huge improvement in postoperative visual function compared with the need of aphakic glasses. In 1990-95 the new method of cataract surgery, phacoemulsification (PE), was introduced in Sweden. As early as 1967 the technique of PE was described by Kelman.\textsuperscript{10} The lens is emulsified by an ultrasonic hand piece and aspirated from the eye. The advantage of a smaller incision (2.2-3.2 mm) with PE-surgery made it to a soon replacement of the ECCE technique. In the year of 2000, 98% of all cataract surgeries performed in Sweden were PE-surgery,\textsuperscript{11} and results from Europe in 2009-2012, show PE-surgery to be the method of choice in 99.5% of all operations.\textsuperscript{12}

Another advantage of the PE-technique is the decreasing rate of severe postoperative complications such as endophthalmitis, suprachoroidal haemorrhage and retinal detachment. These complications have been shown to decline from the 0.6% in the mid-1990s to 0.4% in the mid-2000s.\textsuperscript{13} Improvement of surgical instruments and better phacoemulsification machines
available to the surgeon made it easier to better manage complex cases. For instance, pupil stretchers, capsular tension rings and dyes to stain the capsule might also contribute to less surgical complications.\textsuperscript{13} Results, effectiveness, complications of different surgical techniques and the importance of measuring surgical outcomes have been discussed in several publications.\textsuperscript{14-17}

Figure 2. Phacoemulsification surgery (Courtesy of Alcon Research Ltd)

Technological advances in the cataract surgery process also comprise the IOLs. There is an abundance of different IOLs to use. Blue-light blocking IOLs were introduced in 1991 as an opportunity to protect the macula from exposure to short wave blue-light, thereby reducing the “blue-light hazard”, which has been
demonstrated having a negative effect on photoreceptors and retinal pigment epithelium and might be related to development of AMD \(^{18-20}\). The blue-blocking IOLs were designed to achieve a light transmission like the natural crystalline lens without affecting the visual function and previous research has shown that even if blue-blocking IOLs absorb a great deal of short-wave light which might impair night-time contrast-sensitivity visual acuity (VA), contrast sensitivity and glare are similar for patients with blue-blocking and conventional IOLs.\(^{21}\) Blue-blocking IOLs are routinely used for cataract surgery, in around 25% of implanted IOLs world-wide.\(^{18}\) In Sweden since 2008, blue-blocking IOLs are implanted in more than 50% of all cataract surgery cases.\(^4\) The macular protective effect of blue-blocking IOLs still remains to be proven.\(^{22}\)

Figure 3. Alcon AcrySof\(^\text{®}\) blue-blocking IOL (Courtesy of Alcon Research Ltd)

**Anaesthetic methods**

Cataract surgery has been performed using a variety of anaesthetic methods. Different techniques include general anaesthesia and local anaesthesia, such as retrobulbar, peribulbar, sub-Tenon injection, topical and intracameral
There are several studies analysing the various anaesthetic methods and sub-Tenonal injection, topical and intracameral have been proven to be safe and effective alternatives to retrobulbar and peribulbar injections with a sharp needle.\textsuperscript{24-27} Injections using sharp needles may be associated with complications such as strabismus, globe perforation and retrobulbar haemorrhage, which are not seen with blunt cannulas (sub-Tenonal) or non-needle techniques, topical and intracameral anaesthesia.\textsuperscript{28,29} General anaesthesia may be required in select cases due to medical, psychosocial or surgical conditions. Less than 2\% of cataract surgery cases are performed under general anaesthesia today (personal communication I Westborg).

Intravenous (IV) analgesia/sedation might require monitoring of the patient during surgery, and additional staff to uphold patient safety. The benefit of additional IV or intramuscular sedation or analgesia to improve pain relief has weak evidence in the literature.\textsuperscript{2,30} Local anaesthetic methods such as topical and intracameral anaesthesia are the most frequently used techniques in cataract surgery today.\textsuperscript{31-32} They are non-invasive, have low risk for general complications, and do not require monitoring of the patient during surgery. Several randomised trials have found topical anaesthesia alone or combined with intracameral lidocaine, to be safe and efficient with high patient satisfaction.\textsuperscript{33-36}
Postoperative visits

Guidelines for the number and timing of postoperative visits after cataract surgery have been published. Recommendations for the United States are a postoperative visit within 48 hours in routine cases, and in cases with complications within 24 hours \(^2\). After the introduction of PE-surgery, 1-2 postoperative visits have been the most common in Sweden. \(^37\)

Since cataract surgery became a more common surgical event the number and timing of post-operative visits have been debated. Several studies on timing of postoperative visits have found the time-span for postoperative visits to be from the surgical day to 10-14 days postoperatively.\(^38-40\) To find early postoperative complications such as raised intraocular pressure, wound leakage and prolapse of the iris, a postoperative visit the day after surgery has been considered appropriate.\(^41\) In small incision PE-surgery postoperative complications have shifted and the 3 most common complications are corneal oedema, raised IOP and intraocular inflammation.\(^42\) Same-day review after cataract surgery has also been shown to be safe and give possibility to omit the first-day postoperative visit.\(^43\)

There are also studies of shared care including ophthalmic nurses and opticians to reduce the demand on physician time for postoperative follow-up.\(^44-47\) Telephone-review as an alternative to first day visit has been studied, and found to be safe, effective and an acceptable and reasonable alternative to other first day review methods.\(^48\)
**Postoperative complications**

**Raised intraocular pressure**

The most frequent postoperative complication after cataract surgery that needs treatment is intraocular pressure (IOP) spikes. They are thought to be self-limited, peaking at approximately 6 hours after surgery and are more common in glaucoma patients.\(^{45-49}\) In healthy eyes, postoperatively raised IOP declines spontaneously and can be left untreated if not associated with corneal oedema or patient discomfort. In glaucoma patients, especially those with compromised optic discs, high IOP-spikes postoperatively can be devastating. This group of patients benefits from early postoperative check-ups. A prophylactic acetazolamide regime might reduce but does not completely eliminate the risk of pressure-spikes postoperatively.\(^{50-52}\) There is a recommendation that patients with glaucoma/ocular hypertension have their IOP measured day 1 after surgery.\(^{53}\)

**Cystoid macular oedema**

Cystoid macular oedema (CME) is an accumulation of intraretinal fluid in the outer plexiform and inner nuclear layer of the retina, forming cystic spaces. It causes a reduction in postoperative VA. Risk factors for CME are diabetic retinopathy, uveitis, previous retinal vein occlusion (RVO), epiretinal membrane, use of topical prostaglandin analogues and previous CME first eye surgery.\(^{54}\)

**Retinal detachment**

The risk for retinal detachment (RD) increases after cataract surgery. A
cumulative risk of about 0.9 % four years after surgery has been reported, with the risk increasing each postoperative year.\textsuperscript{55} Another study reported a persistent risk for at least six years and the overall cumulative incidence was increased nine-fold in operated eyes over eight years.\textsuperscript{56} In some patient groups such as high myopes, the increased risk may not reach a plateau until more than 10 years after cataract surgery.\textsuperscript{57} High-risk patients must be informed of RD symptoms and are advised to seek immediate care if symptoms occur. However, there are no evidence supporting annual examinations after cataract surgery to support early detection of RD.

**Miscellaneous complications**

Other postoperative complications which might require treatment, such as anterior uveitis and corneal abrasions are mostly associated with distinct ocular symptoms (pain and/or reduced vision). Corneal decompensation with oedema and corneal thickening is more common in patients with pre-existing endothelial cell dystrophies such as Fuchs’ endothelial dystrophy. Shorter axial length and longer phacoemulsification time are additional risk factors for corneal decompensation. Preoperative evaluation is important to find risk factors and plan for necessary precautions during surgery. Posterior capsular opacification (PCO) is the most common long-time post-operative complication in cataract surgery. Improved surgical techniques, hydrophobic IOLs designed with sharp posterior edge have decreased the prevalence of PCO. A Swedish study estimated the prevalence of PCO to be 12 % five years after cataract surgery.\textsuperscript{58}
**Age-related macular degeneration**

AMD is another major cause of visual impairment in the elderly population.\textsuperscript{59,60} The approval of the anti-VEGF agents (vascular-endothelial-growth-factor) Ranibizumab in 2007 and Aflibercept in 2012, has changed the previously bad visual outcome for patients affected with wet AMD.\textsuperscript{61,62}

Figure 4 Age-related macular degeneration (© Author)

The number of patients registered at visual rehabilitations clinics have decreased since the introduction of anti-VEGF treatment.\textsuperscript{63,64} In international and Swedish
studies, these treatments not only have proven to be efficient to maintain VA, but also to improve the visual outcome in all subtypes of choroidal neovascularization.\textsuperscript{65-68}

AMD is a major factor limiting visual outcome after cataract surgery.\textsuperscript{69-73} Nevertheless, it has been shown that patients with AMD, both wet as well as dry, benefit from cataract surgery in terms of improved visual function.\textsuperscript{69, 74-78} There is an ongoing discussion if cataract surgery in itself, increases the risk of AMD progression. There are reports showing an increased risk to develop neovascular AMD after cataract surgery,\textsuperscript{79-83} as well as there are studies showing no such association.\textsuperscript{84-86} Therefore, an optimal cataract surgery process includes, information on pre- and perioperative factors that might be associated with subsequent treatment for wet AMD. It is also important; to give the patient adequate preoperative information and realistic expectations on the surgical outcome especially in cases with known AMD as comorbidity.

\textbf{National quality registers in Sweden}

The Swedish National Cataract Register (NCR) started in 1992, primarily to monitor the effects of a new government-initiated national healthcare guarantee. This was a guarantee that the patient should receive necessary medical care within a time frame of 3 months. There were mostly surgical interventions included. In addition to cataract surgery also operations such as hip replacement, inguinal hernia and uterine prolapse were included in the guarantee. The following variables are registered in the NCR-core register for all cataract procedures performed in Sweden: surgical unit, running number of
the procedure, patient’s year of birth, county, sex, visual acuity in each eye, the date when the patient was put on the waiting list, date of surgery, previous cataract surgery in the fellow eye (yes or no), ocular comorbidity in the eye planned for surgery (for instance macular degeneration, glaucoma, diabetic retinopathy, etc), surgical technique, position and material of the intraocular lens implanted (such as hydrophilic, hydrophobic, etc), type of intraoperative antibiotic prophylaxis if any, and occurrence of zonular/capsular rupture during surgery. The type of IOL such as aspheric, yellow (blue-blocking), or multifocal and finally occurrence of any intraoperative difficulty warranting altered surgical technique, such as the use of capsular tension ring, mechanical dilation of the pupil etc, have been registered since 2008. The coverage of the NCR in Sweden is high, more than 96% of all cataract surgery cases in Sweden, and the collected data is therefore highly representative for Swedish cataract surgery.

In 2008, after the introduction of anti-VEGF treatment, the Swedish Macula Register (SMR) started as a web-based register containing patients treated for wet AMD. The SMR includes demographic data, time from referral/contact and diagnostic visit, duration of symptoms, data on type of macular lesion, near as well as distance VA, previous treatment for wet AMD and presence of wet AMD in the fellow eye. The choice of which anti-VEGF medication for treatment, the frequency of injections and clinical visits, as well as adverse events if present are also registered. Outcome measurements are improvement in near and distance VA. The coverage during 2010-2017 was 80% of all treatments for wet AMD in Sweden.
Materials and Methods

Study population.

*PAPER I and PAPER II*

All patients who had cataract surgery at Sunderby hospital, Luleå, Sweden, during a 1-year period, June 1st 2010 to May 31st 2011, were prospectively registered. The admitting area represents 1.8% of the Swedish population and is sparsely populated with long distances to travel for many patients. There are no private operating clinics in the area. Only a few patients living in the admitting area had surgery at another eye clinic during the period studied (1%;18/1267). More than 99% of the patients were Caucasians. The preoperative assessment of each patient included a routine examination of the eyes including VA, evaluation of any comorbidity and surgical risk factors, as well as questioning the patient to assess the patient’s expectations regarding the surgical outcome.

*Inclusion and exclusion criteria*

Patients who underwent cataract surgery combined with other surgical procedures were excluded. The study included a total of 1249 senile and presenile cataract surgery cases in 1114 patients. One-hundred and thirty-five patients (11%;135/1249) had cataract surgery on both their eyes during this 1-year period, of which 13 patients (10%) had same-day surgery on both eyes. Patient data was collected from the records, which for cataract surgery are standardized at the clinic. The study group was all patients following the standard procedure of the clinic (n= 1115), which is no planned postoperative visit in eyes without
ocular comorbidity.

As a control group all patients who had surgery during 1 month of the 1-year period (March) was chosen (n=134). All these patients had a planned postoperative visit, also if there was no ocular comorbidity or any surgical complication. The postoperative routine for patients with surgical complications is a planned postoperative visit for each patient.

Immediately after surgery, the patients in the control group also answered a questionnaire concerning the anaesthetic regimen. The questionnaire used included 4 questions regarding the patient’s perioperative experience and was administered and filled in immediately after cataract surgery and the same questionnaire was repeated 6 weeks later. (Appendix)

**PAPER III**

The same cohort (n=1249) from the Sunderby clinic used in paper I and II was included as the study group. The control group in this paper consisted of all cataract surgery cases during the same 1-year period at Umeå University Hospital (n=1162). Patients who underwent cataract surgery combined with other surgical procedures were excluded at both sites.

Regarding the control group, the admitting area represents 1.3% of the Swedish population and is also sparsely populated, though most patients live in the vicinity of Umeå city, i.e. the population is more concentrated to the coastal region around Umeå compared with the more even distribution around Sunderby hospital. The standard follow-up at the Umeå clinic was a planned postoperative
visit for all first eye surgery patients, also in patients without comorbidity or any surgical complications. Second eye surgery patients without comorbidity or surgical complications had no planned postoperative visit. In the control group more than 99% of the patients were Caucasians. Postoperative data was collected from the records, which at the two clinics are computerized and standardized.

In 2011 a survey was mailed to all clinics in Sweden performing cataract surgery, to elucidate their standard routine for postoperative visits after cataract surgery.

**PAPER IV**

Prospectively registered data was collected from the NCR and SMR registers from January 1st 2010 to September 1st 2017. In each first-eye cataract case registered in the NCR within the above mentioned time frame, a search was performed in the SMR for any treatment for wet AMD on the same eye within the same time-period. For all matching cases, the dates for cataract surgery and initiation of AMD treatment were registered.

Nine factors were investigated for association with postoperative AMD; treatment age, gender, use of a blue-blocking IOL, registration of preoperative AMD in the NCR (the NCR registry does not classify type of AMD), preoperative best spectacle corrected visual acuity (BSCVA, converted to logarithm of the minimum angle of resolution (logMAR) VA), any posterior capsule rupture during the cataract procedure and ocular comorbidities (glaucoma, diabetes and “other”). Eyes treated for AMD ≥1 year after cataract surgery were divided into two groups, eyes with no preoperatively registered AMD (Group 1) and eyes with preoperatively registered AMD (Group 2).
Group 1 (n=909) was compared with eyes without preoperatively registered AMD and no treatment for wet AMD ≥1 year after cataract surgery (control 1).

Group 2 (n=744) was compared with eyes with preoperative registered AMD and no treatment for wet AMD ≥ 1 year after cataract surgery (control 2).

The type of AMD is not registered in the NCR. Therefore eyes treated for AMD within the first year after cataract surgery were excluded, as treatment for wet AMD initiated soon after cataract surgery is more likely to be associated with preexisting wet AMD. Complete first-eye surgery data from the study period from both registers were used for inter-individual comparisons.
Statistical methods

**PAPER I**

Independent samples t-tests were used to compare mean age, pulse rate and oxygen saturation between groups. Yate’s corrected chi-square tests or Fischer’s exact tests were used to analyse the two-by-two tables, when appropriate. All tests were 2-sided, and P values less than 0.05 were considered statistically significant. Statistical analyses were performed using SPSS for MS Windows software (version 19.0, SPSS Inc.).

**PAPER II**

Independent samples t-test was used to compare mean age. Chi-square tests corrected for continuity were used to analyse the two-by-two tables. Mann-Whitney U-test was used to check for differences in VA (logMAR) between the study and control group. P-values < 0.05 were considered statistically significant. Statistical analyses were performed using SPSS for MS Windows software (version 20 SPSS Inc.)

**PAPER III**

Independent samples t-test was used to compare mean age. Chi-square tests corrected for continuity were used to analyse the two-by-two tables. Mann-Whitney U-tests were used to check for differences in VA (logMAR) between the study and control group. P-values < 0.05 were considered statistically significant. Statistical analyses were performed using SPSS for MS Windows software (version 24 SPSS Inc.)
Independent samples t-tests were used for univariate analysis of normally distributed data; the data were presented as means ± standard deviations. Chi-square tests were used for nominal data (use of blue-blocking IOL: s yes/no, pre-existing AMD yes/no, posterior capsule rupture yes/no, and any ocular comorbidity yes/no). Mann-Whitney U-tests were used to check for differences in VA (logMAR)). Finally, a step-wise multivariate logistic regression analysis was used for all 9 variables investigated to assess independent risk factors for AMD treatment after cataract surgery. All statistical calculations were performed using SPSS version 22 (IBM SPSS Inc., Chicago, IL, USA). P values <0.05 were considered statistically significant.
Results

**PAPER I**

*Sedation and anaesthesia*

Paper I evaluate a combined topical and intracameral anaesthesia without sedation for cataract surgery. Most cases (90%;1125/1249) had this anaesthetic method, and of these only a few (7%;78/1125) experienced insufficient anaesthesia. In the majority of cases with insufficient anaesthesia additional drops of amethocaine-hydrochloride (1%) were sufficient to ease the pain. Only 12 patients needed additional intracameral anaesthesia (1% lidocaine-hydrochloride). Women and younger patients had a significantly increased need for preoperative sedation compared with males and older patients (p<0.000, and p= 0.001).

*Surgical complications and other adverse events during surgery*

The frequency of complications with vitreous loss was low and similar to Sweden as a whole (1.5% vs 1.3%). There was no significant difference in percentage of complications/adverse events between patients who had sedation and those without (6.4%; 6/94 and 7.2%; 82/1146; p=0.94).

*Patient satisfaction questionnaire (appendix)*

Perceived pain during surgery, rated by the patient using a visual analogue scale (VAS) immediately after surgery (0-10), show that most patients experience a very low degree of pain, with a median VAS-score of 0.7 (Q1:0.3–Q3:1.9) (n=123; 1 non-responder to this question).
**PAPER II**

*Postoperative visits*

There was no statistically significant difference in postoperative VA and serious postoperative complications such as vitreous loss, between the patients in the study and the control group.

Preoperatively planned postoperative visits were mainly on patients with ocular comorbidity. Most patients (87%; 370/548) with ocular comorbidity had a planned postoperative visit or a scheduled visit within 12 months after surgery.

*Postoperative controls and patient-initiated additional postoperative contacts/visits*

There was no significant difference in postoperative patient-initiated contacts between the study group and the control group, Table. Only 117 patients (9%; 117/1249) initiated by themselves a post-operative contact (telephone or visit to the clinic). Of these patients (26%; 30/117) already had a planned visit. There were a slightly higher percentage of patient-initiated postoperative contacts in the study group compared with the control group, but this difference was not significant. Two-thirds (68%) of the patients initiating contact were first eye surgery and 32% was second eye surgery.

Most of these contacts (55%; 64/117) resulted in an appointment with an ophthalmologist. Visual disturbance was the most common symptom, most often caused by transient corneal oedema.
Table. Frequencies of postoperative visits preoperatively planned or planned on the day of surgery, frequencies of postoperative patient-initiated contacts, and postoperative visual acuity for the study group and the control group, respectively.

<table>
<thead>
<tr>
<th>Total number of patients</th>
<th>Study group (n=1115)</th>
<th>Control group (n=134)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned postoperative visits, no (%)</td>
<td>421 (38)</td>
<td>134 (100)</td>
<td></td>
</tr>
<tr>
<td>Postoperative patient-initiated contact, no (%)</td>
<td>105 (9.4)</td>
<td>12 (8.9)</td>
<td>0.87</td>
</tr>
<tr>
<td>Patients with documented postoperative visual acuity and refraction, no (%)</td>
<td>884 (79)</td>
<td>134 (100)</td>
<td></td>
</tr>
<tr>
<td>Median (min-max) Post-operatively (logMAR) (Snellen)</td>
<td>0.10(-0.10-2.0)</td>
<td>0.10(-0.08-1.4)</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>0.80(0.0-1.25)</td>
<td>0.80(0.0-1.20)</td>
<td></td>
</tr>
</tbody>
</table>

A majority of the study group patients (56%; 628/1115) had no planned postoperative or otherwise scheduled review after surgery. Evaluation of all medical records 2 years after the cataract surgery, found no report of missed adverse events.

**PAPER III**

There were no differences in age, sex, first eye surgery, or cases with vitreous loss between the study group and the control group. In the study as well as the control groups the most common reasons for planning a postoperative appointment after second eye surgery were glaucoma, wet AMD and/or diabetic retinopathy.

**Postoperative follow-up and patient-initiated additional postoperative contacts/visits**

The flow chart (figure 6) shows patient-initiated contacts for the study and
control groups, respectively. In the control group, 182 patients (16%;182/1162) initiated a postoperative contact (telephone call or visit to the clinic) vs 117 patients (9%;117/1249) in study group (p=0.000036). Two-thirds (68%;79/117) of the patients in the study group who initiated contact had first eye surgery and (32%;38/117) had second eye surgery. In the control group first eye surgery cases were (59%;108/182) and (41%; 74/182) second eye surgery (p=0.15).

Figure 6. Flow chart showing patient-initiated contact.

In the study group, 44% of the cases (548/1249) had any ocular comorbidity registered in the medical records, the majority of whom had a planned postoperative visit (64%:349/548). In the control group 40% of the patients (465/1162) had any ocular comorbidity and of these (88%;411/465) had a planned postoperative visit. All these postoperative visits were eventless without any complications detected.

All medical records for the patients in the study as well as the control group 2 years after cataract surgery were checked. There was no report of adverse events, as for instance high IOP, infection or sign of wound leakage, that could have been
detected with a postoperative visit.

**Distance to the hospital**

Patients in the study group with a distance to the clinic of 70 km or longer did seek significantly less postoperative advice or care compared with patients who had less than 70 km to the hospital (p=0.016). There was no significant difference if the patient had a pre-planned postoperative visit or not (p=0.76). In the control group there was no significant difference in needing unplanned ophthalmic care depending on distance to the hospital (p=0.41)

**Postoperative routines in Sweden**

In 2011 83% (50/60) of the cataract operating clinics in Sweden answered the survey enquiring their standard routine regarding postoperative visits after cataract surgery. The most common routine (68%; 34/50), was a planned postoperative visit for all patients after the first as well as the second eye surgery. Postoperative visits for the first eye surgery only was standard routine at (14%;7/50 clinics) and no planned visits after cataract surgery in (18%;9/50 clinics).
PAPER IV

Age and gender
Female gender (p=.001) and high age (p=.001) were associated with an increased risk of undergoing wet AMD treatment from 1 to 8 years after cataract surgery.

Posterior capsule rupture and ocular comorbidities
Posterior capsule rupture during cataract surgery did not increase the risk for wet AMD treatment after surgery. Similarly, glaucoma, diabetes and “other ocular comorbidity” were not identified as risk factors for undergoing AMD treatment after cataract surgery.

Blue-blocking intraocular lenses
The average time from cataract surgery to the initiation of AMD treatment for eyes treated 1 year or more after the cataract procedure was 1197±556 days for eyes with blue-blocking IOLs, and 1194±559 days for eyes with conventional IOLs (means±SD; p=0.46) (figure 7). The proportion of eyes treated at different postoperative time intervals was similar between blue-blocking and conventional IOLs.

In eyes with preoperatively diagnosed AMD the use of blue-blocking IOLs was significantly lower in eyes subsequently treated for wet AMD (p=0.023).
Figure 7. Number of cases treated for wet AMD year 1-8 after cataract surgery.
Discussion

PAPER I

**Standardized anaesthetic regime**

Several studies have analysed and compared different anaesthetic methods for cataract surgery. A transition from retro/peri-bulbar and sub-Tenon’s injections to topical and intracameral anaesthesia has developed over the years.\(^{31,87-88}\) Surprisingly, studies comparing no anaesthesia versus topical and intracameral anaesthesia for cataract surgery have also been published.\(^{89}\) With increasing cataract surgery volumes, a standardized anaesthetic method that is well tolerated and adequate for most patients facilitates safe and effective operations. There should only be a few cases needing additional anaesthetics or another anaesthetic regime in order to optimize efficiency.

The anaesthetic regime chosen at the clinic was topical plus intracameral anaesthesia without sedation. The present study shows it to be effective and safe in most cases including complicated surgery and patients with high myopia.\(^{27,36,90,91}\) More than ninety percent of the study patients had combined topical and intracameral anaesthesia without sedation, and only a few experienced insufficient anaesthesia. In this study only 1% of the operations were performed under general anaesthesia. The rating of perceived intra-surgical pain immediately after surgery, using a VAS scale (0-10), shows that most patients experienced a very low degree of pain with a median score of 0.7. Six weeks after surgery, the median pain score was 0.5, indicating that the memory of pain-perception during cataract surgery decreases with time.
Another indication that this anaesthetic regimen functions well is that most patients would choose the same anaesthetics if having surgery again. This is true also for the majority of patients with a pain score 2 or higher. The level of pain score recorded in this study corresponds well to findings in previous studies.33-35

Apart from showing a high patient satisfaction with the anaesthetic regime, this study also shows that the routine with preoperative evaluation and information by any ophthalmologist, not only cataract surgeons, works well. Information given to the patient was consistent regardless the profession of the staff member and repeated several times, for instance by nurses when the preoperative measurements were performed. Both written and oral information was given and was considered necessary as most patients are elderly.

**PAPER II**

This study was instigated to analyse the safety aspects of the new routine, no planned postoperative visit in uncomplicated cases with no ocular comorbidity. A randomized trial with two cohorts in which the patients was assigned to either a postoperative visit or not would have been the best option. The resources for the clinic both regarding staff and economy were limited and that path was not feasible. The number and timing of postoperative visits after cataract surgery has always been debated and an evaluation from a safety and efficacy aspect was found important. Thus, the study was started despite the above limitation. This prospective study aimed to include all cataract surgeries performed during the first year of the new postoperative regime. The study does not analyse if the patients would prefer a postoperative check-up by their surgeon. An unpublished
survey at the Sunderby clinic was made which examined if the patients preferred a postoperative visit to their surgeon at the operating clinic or visiting a satellite clinic nearby their home. Most patients preferred a visit with as short distance to travel as possible. This is in accordance with a previous study in which the patients preferred visiting a peripheral nurse-led clinic instead of visiting a doctor at the main hospital.  

**Patients with ocular comorbidity**

Ocular comorbidity is a common finding in eyes scheduled for cataract surgery. In a European study from 1998 ocular comorbidity was present in 38 % of the surgical cases, and data from 2009 -2011 show coexisting comorbidities in 30 % of the cases, of these 12% had AMD and 8 % had glaucoma. In the study cohort ocular comorbidity was present in 44%. AMD and glaucoma were the most frequent comorbidities with AMD 36% and glaucoma 42%. Ocular comorbidity can be a risk factor for postoperative complications and poor visual outcome. Preoperative evaluation and correct preoperative information and postoperative follow-up with consideration to the comorbidity is important. In this study most, patients (87%;370/548) with ocular comorbidity had a planned postoperative visit or a scheduled visit within 12 months, the timing depending on the type of comorbidity.

**Glaucoma**

Patients with glaucoma must always have a follow-up plan. Pseudo-exfoliations (PXF) are common in northern Sweden, with 39% of the cataract cases having PXF at surgery. Previous research has shown a high risk for significant IOP
elevation in the early postoperative period which can be devastating in patients with capsular glaucoma and/or optic disc damage. Therefore, in the present study the majority of patients with glaucoma/ocular hypertension were scheduled for day 1 postoperative visit and IOP measurement.

**Diabetic retinopathy**

Patients with diabetes develop cataract earlier than non-diabetics, and benefit from cataract surgery with improved VA in most cases. It is also important to remove the cataract in order to be able to screen, follow and treat diabetic retinopathy. Previous research has shown that diabetic retinopathy and macular oedema might worsen after cataract surgery. The risk is increased in patients with moderate to severe non-proliferative diabetic retinopathy and proliferative retinopathy compared to mild non-proliferative retinopathy. More recent studies have suggested that the risk is less with PE surgery compared with ECCE. At the preoperative visit, the recommendation is to assess if there is any diabetic retinopathy. If that is the case, the degree of the preoperative retinopathy determines the plan for post-operative controls or adjust the timing for the postoperative diabetic screening. In the present study 70% of patients with diabetes had a planned postoperative visit. The patients with diabetes and no additional postoperative visit had no or only low-grade retinopathy and remained in the routine screening program.

**Postoperative complications**

In the present study the frequency of postoperative retinal detachment was high in the early postoperative period, 0.4%, 5 cases within 2 months. The 3-year
incidence after cataract surgery in a published Swedish study was 0.3% in cases without complications during cataract surgery.\textsuperscript{103} Retinal detachment is a known late complication after cataract surgery and the high incidence found in the early postoperative period in the present study might be random.\textsuperscript{103-106} The preoperative evaluation of the patients who had postoperative RD revealed high myopia in 2 cases and 1 case had complicated surgery. All patients with RD initiated contact shortly after symptoms of visual disturbance.

\textbf{Postoperative visits}

In a national survey from United Kingdom there were no complications (peri- and/or postoperative) in more than 95 % of the cases.\textsuperscript{104} The findings in the present Sunderby cohort are in concordance with several studies on uneventful cataract surgery, in which more than 95% of review visits found nothing to be achieved beyond mutual reassurance.\textsuperscript{44} The first review after PE cataract surgery was found to be safely deferred until 2 weeks. Previous research has found intervention rate to be low on the first postoperative day after uncomplicated cataract surgery, but it was concluded to be impossible both regarding personal and economic resources, to design a routine for detection of serious postoperative complications, before they were symptomatic.\textsuperscript{107}

\textbf{Post-operative patient-initiated contacts}

Only (9%;117/1249) of the patients initiated a previously unplanned contact, and care by an ophthalmologist was needed in (55%;64/117) of these patients. Thus, these post-operative contacts initiated by the patient could in many cases be solved by advice over the telephone or by visiting an ophthalmic nurse. There
was a low threshold for offering ophthalmologist’s care. If a routine of no planned postoperative visits in uncomplicated cases without comorbidity is to be implemented, the clinic must have resources to answer questions from patients and be prepared for additional unplanned visits.

Improved perioperative patient education with an open channel for immediate self-referral when symptomatic problems develop is very important. The routine of both oral and written patient education is necessary and sufficient.

In the present study all operations were performed by experienced surgeons. Postoperative visits are important and necessary as a learning tool and a major part in acquiring surgical skill for residents or surgeons in training. A population-based study found that surgeons in their first year of independent practice are 9 times more likely to have high complications rates (≥2%) than surgeons in their tenth year.\textsuperscript{108} Another study shows no difference in complication rates (1.7% and 2.0%) between staff surgeons and resident trainees in uncomplicated cases.\textsuperscript{109} A routine of no planned postoperative visits is valid only after surgery by experienced surgeons.

**PAPER III**

The postoperative questionnaire to all clinics in Sweden performing cataract surgery in 2011, showed the most common routine (68%;34/50 clinics) to be a planned postoperative visit for all patients. Only in (18%;9/50) the routine was no planned visits. Paper III compares the number of visits and self-initiated unplanned contacts in the Sunderby cohort with another clinic with a different postoperative routine, i.e. no postoperative visit only for second eye surgery in
uncomplicated surgery in cases without ocular comorbidity. All first eye surgery patients had a planned visit postoperatively.

Ocular comorbidity was present in 44% of the study group and 32% of the control group. The higher frequency of comorbidity found in the study group might be caused by the new routine with no post-operative visit for patients without comorbidity. The ophthalmologist performing the pre-operative evaluation might in a higher degree notice signs of comorbidity as they were responsible for planning the post-operative care.

Surprisingly, the number of patient-initiated contacts was significantly fewer in the study group compared with the control group, who had more planned visits. This might be explained by the new standard routine with no post-operative visits, meant improved and consistent oral and written information to all patients. The information described which symptoms were common and harmless, and which symptoms should initiate immediate contact with the clinic. Both standard routines, the one in the study group and the one in the control group, were safe as there were no missed adverse events in either group. From an efficacy perspective, a reduction in number of postoperative visits is only achieved when the standard routine is no post-operative visits for both first and second eye surgery, i.e. the routine of the study group clinic. A recent published study from Finland also concluded that patient safety was not endangered by omitting postoperative visit to ophthalmologists. The Finnish study emphasized the importance of scheduling postoperative visits at a low threshold, as around 10% of the cataract patients had ocular comorbidity and/or intraoperative complications or postoperative symptoms that made a
postoperative visits necessary. An additional improvement to the standard routine might be introducing a letter the patient can bring to the optician approximately 4-6 weeks after surgery, to simplify the return of information regarding VA and refraction results to the clinic.

PAPER IV

Risk factors for needing wet AMD treatment after cataract surgery

There is a major clinical interest in evaluating the demographics as well as assessing the pre- and perioperative risk factors for needing and undergoing treatment for wet AMD after cataract surgery. Factors possibly affecting the risk for AMD treatment might include age, gender, preoperative VA, ocular comorbidities and surgical complications such as posterior capsule rupture. A factor possibly offering protection from postoperative development of wet AMD is the use of blue-blocking IOLs at cataract surgery. The Swedish Quality Registers enables large scale register-based studies on factors predisposing for AMD treatment after cataract surgery.

The Swedish National Cataract Register variable list includes data on age, gender, if a blue-blocking IOL has been implanted, any preoperative AMD, preoperative VA, any intraoperative complication and other ocular comorbidities. The Swedish Macula Register was cross-checked to find all patients with first eye PE surgery who subsequently were treated for wet AMD.

This study does not aim to answer the question if cataract surgery per se increases the risk for treatment of wet AMD. Instead, it provides information of patient characteristics and cataract surgery data and the association with subsequent
treatment for wet AMD. A limitation of the study is that NCR do not classify the type of AMD, and that the study might therefore contain cases with wet AMD already at the time for cataract surgery. Therefore, the eyes treated for wet AMD within one year after cataract surgery were excluded to reduce this risk. If there was a significant progression of the AMD, so that treatment was needed more than one year after cataract surgery, it is unlikely that the patient had wet AMD at the time for cataract surgery, and a possible protective effect of blue-blocking IOLs can be evaluated. In eyes without AMD preoperatively, there were no significant difference in the number of cases treated for wet AMD within the first eight years after cataract surgery, between eyes having blue-blocking IOLs implanted and conventional IOLs. Thus, in eyes with a healthy macula at the time of cataract surgery there was no support for an AMD protective effect by blue-blocking IOLs.

In eyes with AMD found preoperatively, dry AMD was presumed in most cases, blue-blocking IOLs were less common in eyes that later were treated for wet AMD (54% vs 57% in the control group; p=0.023). This indicates that blue-blocking IOLs might offer some degree of protection from progression to wet AMD and subsequently a need for AMD treatment. Female gender and high age were identified to be the only independent risk factors for undergoing treatment for wet AMD 1 year or more after cataract surgery which is in concordance with previous studies concerning risk factors for developing wet AMD.111,112

Despite the increased surgical trauma in eyes with a posterior capsule rupture, this complication does not seem to influence the postoperative treatment rate of wet AMD. Likewise, glaucoma, diabetes and “other ocular comorbidities” seems not to be of importance. The Swedish Quality Registers give opportunity to
forthcoming studies, with long-time results concerning the risk for wet AMD treatment after cataract surgery.
Conclusion

**Paper I.** A standardized anaesthetic method with topical and intracameral anaesthetics without sedation seems well tolerated by most patients and was effective at cataract surgery, also in cases when complications/adverse events occur. Patient satisfaction was high, and a majority of patients would choose the same anaesthetic method if having surgery again.

**Paper II.** Without compromising patient safety, it is possible to refrain from postoperative visits after cataract surgery in patients with uncomplicated surgery and no ocular comorbidity. However, meticulous patient education is necessary. The present study shows that in approximately 50% of cataract surgery cases it is possible to omit the postoperative visit. Information of postoperative refraction and visual acuity can be obtained from opticians or optometrists.

**Paper III.** A significant reduction in the number of postoperative visits is obtained only if the standard routine is no planned postoperative visit in uncomplicated cases without ocular comorbidity for both first and second eye cataract surgery.

**Paper IV.** Female gender and high age are associated with an increased risk of undergoing treatment for wet AMD one year or more after cataract surgery. Patients without AMD preoperatively have no benefit from having a blue-blocking IOL implanted compared with a conventional IOL. In patients with a diagnose of AMD preoperatively, blue-blocking IOLs might offer some protection.
from subsequent AMD treatment.
Future perspectives

The increasing possibilities in ophthalmology with new surgical techniques, improved materials and new treatments for many diagnoses cause an ever-growing demand for ophthalmic service. Despite a continuously higher workload on all professionals involved, it is important to uphold a safe and efficient patient care in all parts of the cataract surgery process. In order to improve the processes, we must continue recording and scrutinizing our results. To scientifically analyse any change in routines and medical treatment is important to ensure that patient safety is maintained, and that changes really means improvement. Results from this study have changed the routine for postoperative visits at the Umeå University hospital. The standard routine is now no postoperative visit in uncomplicated cases without comorbidity, the same as at the Sunderby Hospital.

Our quality registers are important tools to follow and analyse epidemiological data, difference in choice of treatments and their results in Sweden. The large number of patients registered gives opportunity to analyse results and provide information on the standard of care in a real-world setting. They can also provide information on complications and rare adverse events, which otherwise might take a long time to discover, if at all. Randomized register-based clinical trials can be done in quality registers. This is not a reality in the two ophthalmic registers presented in this thesis, but the opportunity is already provided in other Swedish Quality Registers. There are many options for ophthalmologists to analyse the results and evaluate the changes we implement.
Patient education is an important part of all ophthalmologist’s work and it is an important strive to inform and make the patient a part of the treatment decisions. Studies that give information of risk factors and results depending on different treatment options enables ophthalmologists to give well substantiated information. Well-informed patients with realistic expectations increase the chances of results that is satisfying for both patients and doctors.
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Appendix

The questions of the satisfaction with anaesthetics questionnaire
(translation from Swedish)

Please answer some questions regarding your experience of your cataract surgery.

1) Approximately how painful was your cataract surgery?

No pain at all

Unbearable pain

Please put a mark on the line according to the degree of experienced pain

2) I believe I got

[ ] Too little anesthetics

[ ] Just enough amount of

[ ] Too much anesthetics

3) If you didn’t get any preoperative sedation, would you have needed some, do you think?

[ ] Yes

[ ] No

4) If you are having cataract surgery again, will you choose the same anesthetic method?

[ ] Yes

[ ] No