Application of predictive analytics in real-world studies: identifying risk factors associated with posterior capsule opacification (PCO) after cataract surgery

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Background

- Retrospective studies using routine clinical practice data are increasingly providing large support to healthcare stakeholders in their decision making.
- Valid risk predictions based on these real-world studies can help clinicians provide the best possible care
- In this study, a predictive model was developed to identify risk factors associated with the development of Posterior Capsule Opacification (PCO) following cataract surgery.
- Posterior Capsule Opacification is the most common complication patients experience after cataract surgery[1,2] which might lead to reduced visual acuity, impaired contrast and glare disability[3].
- Identifying risk factors associated with the development of PCO might help the clinicians take informed decisions to prevent its occurrence.

Objective

- The objective of this analysis was to identify factors associated with the development of posterior capsule opacification following cataract surgery in eyes implanted with monofocal acrylic intraocular lenses (IOLs).

Methods

Study Design

- This analysis was conducted as part of a large retrospective cohort study using NHS electronic medical records captured using Medisoft Electronic Medical Records (EMR) platform
- The population included patients undergoing cataract surgery in 7 UK ophthalmology clinics
- This analysis included data for eyes that underwent cataract surgery between 1st Jan 2010 and 31st Dec 2013, and followed up for at least 3 years until the end of 2016

Statistical Analysis

- In order to explore the risk factors associated with PCO, logistic regression models were estimated, each using a different set or combination of covariates.
- The covariates considered in these models included:
  - Demographics → age, gender
  - IOL characteristics → Sharp edge property (360º vs. non-360º); Optic material (hydrophobic vs. hydrophilic); IOL haptic design (single vs. multi-piece), IOL power
  - Surgery related factors → incision site, year of cataract surgery, microincision, surgeon's seniority, use of trypan blue on date of surgery
  - Clinical characteristics → visual acuity at index, pupil size, presence of co-pathologies, complications
- To obtain a model with good predictive ability and generalisability, the sample was split into training (~60%, 5 of the 7 NHS sites) and validation (~40%, remaining 2 NHS sites)
- The model was built on the training dataset and validated on the validation dataset.
- The best fitting model was determined based on Akaike Information Criteria (AIC) in both the training (Figure 1) and validation data, and validity shrinkage (reduction in predictive ability of a model when moving from training to validation data). Receiving Operating Characteristics (ROC) curve was also produced (Figure 2).

Results

Figure 1: Scree plot comparing the AIC of trained models

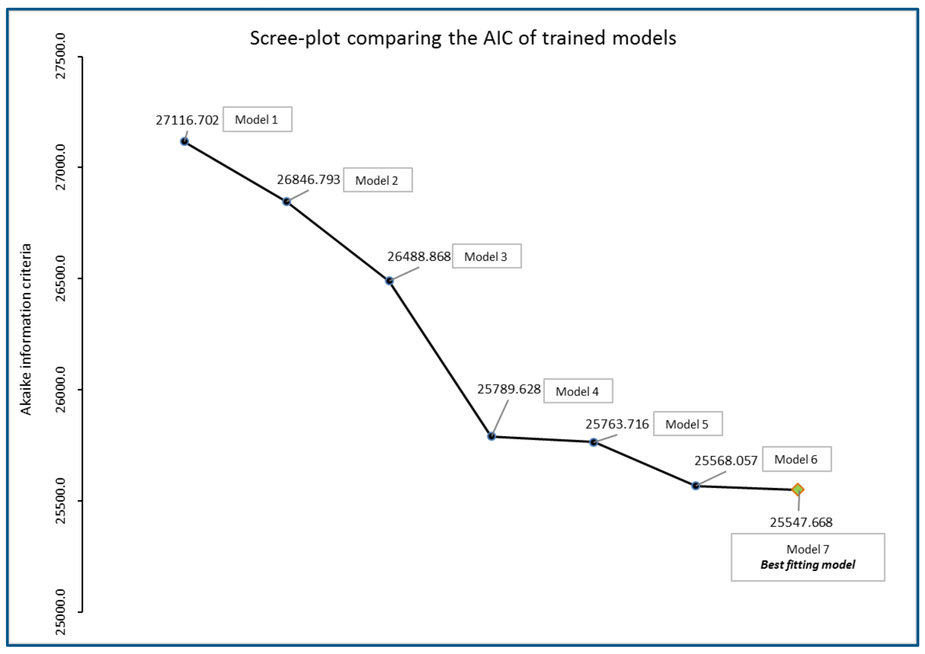
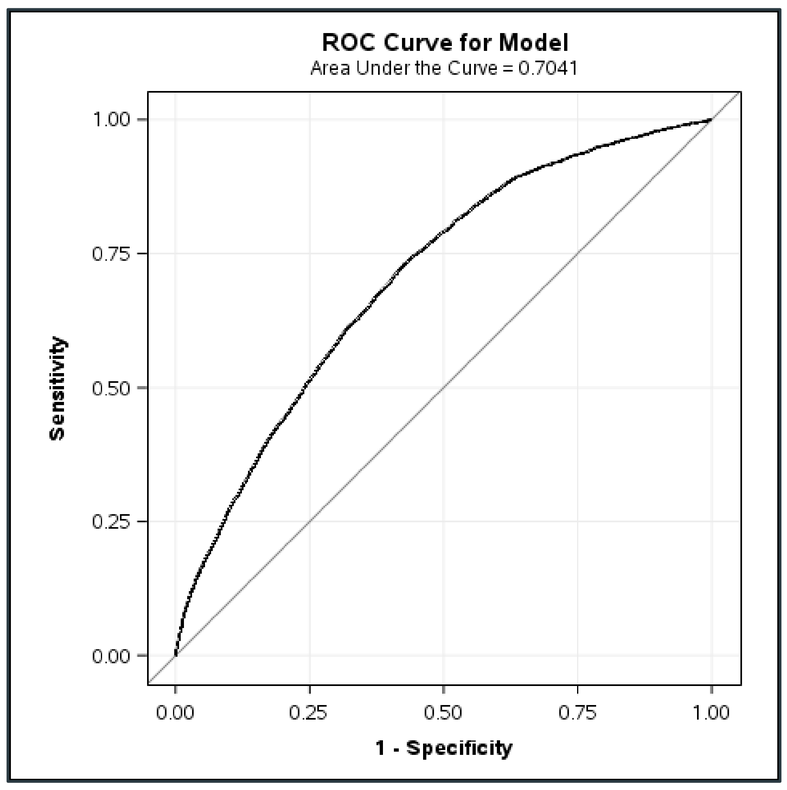


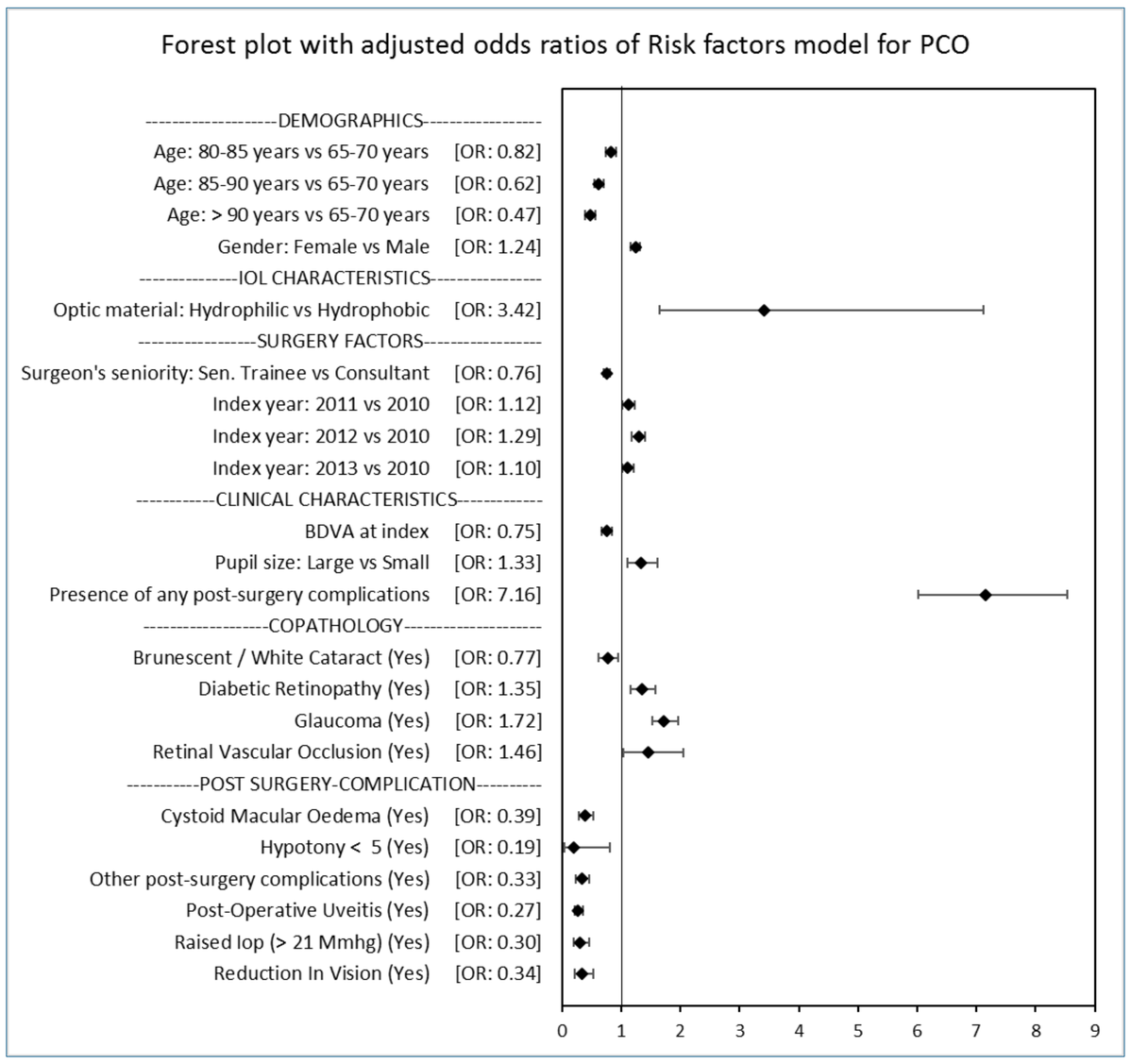
Figure 2: ROC curve explaining the Area Under the Curve (AUC) of the best fitting model



Results (continue)

- Complete case analysis was performed and the study population used in the analysis included 49,861 cataract procedures (eyes).
- Seven pre-specified models with different combinations of covariates were tested and the model with the smallest AIC (Figure 1) was determined to be the best fitting model
- This model showed the highest AUC of 0.704 (Figure 2) and the lowest validity shrinkage of 9.3% demonstrating its generalizability to external data. Odds ratios (ORs) from this model are shown in Figure 3.

Figure 3. Significant Risk Factors for PCO



Note: only ORs which were statistically significant were included in the plot

The model identified the following factors (Figure 3) to have an effect on increased risk of post-cataract PCO (ordered by decreasing effect magnitude):

- Presence of any post-operative complications (OR 7.16, 95% CI 6.01-8.54)
- Hydrophilic IOL (OR 3.42, 95% CI 1.64-7.12)
- Presence of the following co-pathologies:
  - Diabetic Retinopathy (OR 1.35, 95% CI 1.15-1.58),
  - Glaucoma (OR 1.72, 95% CI 1.52-1.96),
  - Retinal Vascular Occlusion (OR 1.46, 95% CI 1.03-2.05)
- Larger pupil size (OR 1.33, 95% CI 1.10-1.61)
- Female gender (OR 1.24, 95% CI 1.16-1.32)
- Index year category (OR 1.12 '2011 vs. 2010', 95% CI 1.02-1.23; OR 1.29 '2012 vs. 2010', 95% CI 1.18-1.41; OR 1.10 '2013 vs. 2010', 95% CI 1.01-1.21)
- Better visual acuity (i.e. lower logMAR value) (OR 0.75, 95% CI 0.67-0.85)
- Younger age (OR 0.82 '80-85 years' vs. '65-70 years', 95% CI 0.74-0.91; OR 0.62 '85-90 years' vs. '65-70 years', 95% CI 0.55-0.70; OR 0.47 '>90 years' vs. '65-70 years', 95% CI 0.39-0.56)

Conclusions

- This study used a large population to identify risk factors associated with PCO after cataract surgery
- The use of Medisoft® EMR, a validated source of data which allows for longitudinal track of patients and eye information in time, was a strength of this study
- Our findings confirmed that PCO is a complication affected by several factors; the use of robust modelling techniques allowed to identify a valid set of predictors for PCO
- The risk factor analysis confirmed previous findings that hydrophilic acrylic IOLs are associated with significantly greater risk of PCO compared to hydrophobic acrylic IOLs
- These findings might assists clinicians in taking informed decisions on the choice of IOLs to implant at the time of cataract surgery, and in planning post-surgery follow-up visits
- The lack of primary care data could represent a limitation due to potentially missing information on additional co-pathologies and other relevant risk factors for PCO
- Difficulties in estimating follow-up time accurately was another limitation of the study, as most of the patients only visited the clinic for their post-operative follow-up visit, or in case of any complication

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