## Risk Models for Posterior Capsule Rupture and Visual Acuity Loss

**Updating Risk Models**

Risk Models for Posterior Capsule Rupture and Visual Acuity Loss

(Updating of models published on earlier data)

A quantitative analysis for Work Package 2 of a NIHR funded Cataract Research Programme.

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Posterior Capsule Rupture (PCR)

Definition of PCR

Posterior capsular rupture (PCR) is defined for the purposes of the National Audit as “posterior capsule rupture with or without vitreous prolapse or zonule rupture with vitreous prolapse” and abbreviated simply as PCR. It should be noted that the definition excludes zonule dehiscence where no vitreous prolapse has occurred (<https://www.nodaudit.org.uk/>; accessed 20 March 2021).

Data coding

1. **Surgeon Grade**

This was coded into 4 categories; Consultant, Non-Consultant Career Grade, Senior Trainee, Junior Trainee. The categories were made up of the following grades:

Consultant – Consultant.

Non-Consultant Career Grade – Associate Specialist, Staff Grade, Trust Doctor.

Senior Trainee – Fellow, Registrar, Specialty trainee (Year 4, 5 & 6), Specialist Registrar, Specialty Registrar.

Junior Trainee – Senior House Office, Specialty trainee (Year 1, 2, 3)

1. **Co-Pathology**

Variables identifying presence (either prior to surgery or at surgery) or absence of the following co-pathologies or operations were created:

Glaucoma

‘Previous Trabeculetomy’ and ‘previous surgery for glaucoma’ included.

Age related macular degeneration.

Amblyopia

Brunescent / white cataract

Diabetic retinopathy

Those who had previous surgery for diabetes were included here.

Corneal Pathology

High myopia

Those who had ever had an axial length of >=28 prior to surgery were also included in this definition.

No fundal view / vitreous opacities

Previous vitrectomy.

Defined from the following 5 co-pathology codes;

‘Previous vitrectomy for FTMH/ ERM’ ,

‘Previous vitrectomy for FTMH / ERM / other reason’ and

‘Previous retinal detachment surgery’.

‘Retinal detachment’

‘Vitrectomy’

Also included were those who had previous surgery ppv (ppv = 1 on the previous surgery file) and the inclusion of these increased considerably the number with ‘previous vitrectomy.’

Pseudoexfoliation / phacodonesis

Uveitis / synaechiae.

Inherited Eye Disease

Optic nerve / CNS disease

Other

Other macular pathology

Those with the co-pathologies macular hole and epiretinal membrane were also included here.

Other retinal vascular pathology

The co-pathologies were defined using the definitions discussed using information from previous surgery and indication for current surgery, in addition to the information in the co-pathology dataset.

1. **Biometry**

For the biometry data, namely axial length and anterior chamber depth, some eyes had multiple assessments made. For this analysis, the assessment, closest to the time of the cataract operation has been used.

Sample Used in the Analysis

The sample has been defined according the criteria outlined in the documentation.

The sample consisted of 180,114 eyes from 127,685 patients. In this analysis missing data are noted in the tables but patterns of ‘missingness’ not investigated.

**Characteristics of sample to be used in the analysis.**

3514/180114 (1.95%) of eyes had PCR

Mean age of eyes 75.6 (standard deviation 10.35) (range 18.1 – 109.7)

Anterior Chamber length was only available for 31,105 eyes.

**Table 1. Characteristics of sample for PCR**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | N | % |
| Age | <60 | 14,232 | 7.90 |
|  | 60-69 | 30,088 | 16.70 |
|  | 70-79 | 67,399 | 37.42 |
|  | 80-89 | 61,395 | 34.09 |
|  | 90+ | 7,000 | 3.89 |
|  |  |  |  |
| Gender | Male | 71,950 | 39.95 |
|  | Female | 107,662 | | 59.77 |
|  | Not specified | 502 | 0.28 |
|  |  |  |  |
|  |  |  |  |
| Any alpha blocker (alfuzosin, doxazosin | No | 176,440 | 97.96 |
| Indoramin, parazosin, tamsulosin, terazosin) | Yes | 3,674 | 2.04 |
|  |  |  |  |
| Able to lie flat | No | 2,136 | 1.19 |
|  | Yes | 63,437 | 35.22 |
|  | Missing | 114,541 | 63.59 |
|  |  |  |  |
| Inability to co-operate | No | 37,099 | 20.60 |
|  | Yes | 1,572 | 0.87 |
|  | Missing | 141,443 | 78.53 |
|  |  |  |  |
| Axial length | <26 | 171,855 | 95.41 |
| (will look at this in quintiles also) | >= 26 | 8,130 | 4.51 |
|  | Missing | 129 | 0.07 |
|  |  |  |  |
| Axial length in quintiles | <= 22.43 | 36,163 | 20.08 |
|  | 22.44 – 23.01 | 36,256 | 20.13 |
|  | 23.02 – 23.53 | 35,771 | 19.86 |
|  | 23.54 – 24.24 | 35,918 | 19.94 |
|  | >= 24.25 | 35,877 | 19.92 |
|  | Missing | 129 | 0.07 |
|  |  |  |  |
| Axial length | >21.5 | 172,259 | 95.64 |
|  | ≤ 21.5 | 7,726 | 4.29 |
|  | Missing | 129 | 0.07 |
|  |  |  |  |
| Glaucoma | No | 165,704 | 92.00 |
|  | Yes | 14,410 | 8.00 |
|  |  |  |  |
| Age related macular degeneration | No | 162,088 | 89.99 |
|  | Yes | 18,026 | 10.01 |
|  |  |  |  |
| Amblyopia | No | 177,434 | 98.51 |
|  | Yes | 2,680 | 1.49 |
|  |  |  |  |
| Brunescent White Cataract | No | 174,928 | 97.12 |
|  | Yes | 5,186 | 2.88 |
|  |  |  |  |
| Diabetic retinopathy | No | 171,649 | 95.30 |
|  | Yes | 8,465 | 4.70 |
|  |  |  |  |
| Corneal Pathology | No | 175,868 | 97.64 |
|  | Yes | 4,246 | 2.36 |
|  |  |  |  |
| High myopia | No | 173,557 | 96.36 |
|  | Yes | 6,557 | 3.64 |
|  |  |  |  |
| No fundal view/ vitreous opacities | No | 178,753 | 99.24 |
|  | Yes | 1,361 | 0.76 |
|  |  |  |  |
| Previous vitrectomy | No | 177,196 | 98.38 |
|  | Yes | 2,918 | 1.62 |
|  |  |  |  |
| Pseudoexfoliation / phacodonesis | No | 177,887 | 98.76 |
|  | Yes | 2,227 | 1.24 |
|  |  |  |  |
| Uveitis / synaechiae. | No | 178,344 | 99.02 |
|  | Yes | 1,770 | 0.98 |
|  |  |  |  |
| Inherited Eye Disease | No | 179,888 | 99.87 |
|  | Yes | 226 | 0.13 |
|  |  |  |  |
| Optic nerve / CNS disease | No | 179,409 | 99.61 |
|  | Yes | 705 | 0.39 |
|  |  |  |  |
| Other | No | 173,074 | 96.09 |
|  | Yes | 7,040 | 3.91 |
|  |  |  |  |
| Other macular pathology | No | 178,567 | 99.14 |
|  | Yes | 1,547 | 0.86 |
|  |  |  |  |
| Other retinal vascular pathology | No | 178,594 | 99.16 |
|  | Yes | 1,520 | 0.84 |
|  |  |  |  |
| Surgeon Grade | Consultant | 105,116 | 58.36 |
|  | Non-consultant career grade | 22,479 | 12.48 |
|  | Senior Trainee | 43,724 | 24.28 |
|  | Junior Trainee | 8,795 | 4.88 |
|  |  |  |  |
| Pupil size | Large | 155,302 | 86.22 |
|  | Medium | 19,189 | 10.65 |
|  | Small | 5,459 | 3.03 |
|  | Missing | 164 | 0.09 |

Logistic regression model for outcome PCR

The following variables: age, gender, pupil size, surgeon grade, any alpha blocker, axial length and the following co-pathologies; glaucoma, age related macular degeneration, amblyopia, brunescent white cataract, diabetic retinopathy, corneal pathology, high myopia, no fundal view/ vitreous opacities, previous vitrectomy, pseudoexfoliation / phacodonesis, uveitis synaechaie, other, other macular pathology, other retinal vascular pathology were offered to the logistic regression model.

Note the other co-pathologies and individual alpha blockers were not offered to this preliminary logistic regression model, as the numbers were relatively small.

The variables able to lie flat, inability to co-operative and anterior chamber length were not offered to the preliminary logistic regression model due to the large amount of missing data.

Backwards and forwards logistic regression was carried out, taking account of the clustered nature of the data (the fact that left and right eyes from the same patient are unlikely to be independent).

The following variables entered/ remained in the logistic regression model: age, surgeon grade, pupil size, glaucoma, brunescent white cataract, no fundal view/ vitreous opacities, previous vitrectomy, pseudoexfoliation/ phacodonesis and other.

Note n = 179,950 due to some missing data for pupil size.

**Table 2. Logistic regression model for PCR (N = 179,950)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Odds Ratio** | **95% CI** | **P-value** |
| Surgeon Grade | Consultant | 1.00 |  | <0.001 |
|  | Non-consultant career grade | 1.07 | [0.95, 1.20] |  |
|  | Senior Trainee | 1.71 | [1.59, 1.85] |  |
|  | Junior Trainee | 2.85 | [2.53, 3.20] |  |
|  |  |  |  |  |
| Pupil Size | Large | 1.00 |  | <0.001 |
|  | Medium | 1.21 | [1.09, 1.34] |  |
|  | Small | 1.72 | [1.48, 1.99] |  |
|  |  |  |  |  |
| Age | <60 | 1.00 |  | <0.001 |
|  | 60-69 | 0.87 | [0.75, 1.02] |  |
|  | 70-79 | 0.98 | [0.86, 1.12] |  |
|  | 80-89 | 1.15 | [1.01, 1.32] |  |
|  | 90+ | 1.56 | [1.30, 1.88] |  |
|  |  |  |  |  |
| Gender | Female /Not specified | 1.00 |  | 0.007 |
|  | Male | 1.10 | [1.03, 1.18] |  |
|  |  |  |  |  |
| Glaucoma | No | 1.00 |  | <0.001 |
|  | Yes | 1.23 | [1.10, 1.38] |  |
|  |  |  |  |  |
| Brunescent white cataract | No | 1.00 |  | <0.001 |
|  | Yes | 3.36 | [2.95, 3.82] |  |
|  |  |  |  |  |
| No fundal view/ vitreous opacities | No | 1.00 |  | <0.001 |
|  | Yes | 1.72 | [1.33, 2.22] |  |
|  |  |  |  |  |
| Previous vitrectomy | No | 1.00 |  | 0.007 |
|  | Yes | 1.40 | [1.10, 1.79] |  |
|  |  |  |  |  |
| Pseudoexfoliation / phacodonesis | No | 1.00 |  | <0.001 |
|  | Yes | 2.51 | [2.07, 3.04] |  |
|  |  |  |  |  |
| Other | No | 1.00 |  | <0.001 |
|  | Yes | 1.83 | [1.60, 2.10] |  |

**Figure 1. AROC for PCR Model**

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The area under the ROC curve is 0.6415.

Monocular Visual Acuity (VA) Loss

Definitions for VA and VA Loss

Pre-op and post-op visual acuity has been derived using the definitions of the NOD (<https://www.nodaudit.org.uk/> accessed 20 March 2021). VA Loss is defined as a doubling or worse of the visual angle.

As so few pre-op visual acuity readings were by pin-hole only, it was decided not to use the pre-op pin-hole data.

Of the 180,114 eyes in the sample, 147,962 had pre-op visual acuity readings. For 104,437 (70.6%), they were corrected visual acuity readings and for 43,525 (29.4%), they were uncorrected readings. A further 1,591 eyes had preoperative pin hole readings only, but these were not used in this analysis.

Of the 180,114 eyes in the sample, 116,038 eyes had post-op visual acuity readings. For 74,887 (64.5%), they were corrected visual acuity readings, for 28,678 (24.7%), they were uncorrected visual acuity readings and for 12,473 (10.8%) they were pin-hole visual acuity readings, which were accepted postoperatively.

Of the 147,962 eyes with pre-op visual acuity readings, 95,561 (64.6%) had post-op visual acuity readings. For 60,578 (63.4%), they were corrected visual acuity readings, for 24,460 (25.6%), they were uncorrected visual acuity readings and for 10,523 (11.0%) they were pin-hole visual acuity readings.

For 1,455/95,561 (1.52%) eyes, the visual acuity got worse after cataract surgery.

This has been defined as [Pre-op visual acuity] – [Post-op visual acuity] ≤ -0.30 (With visual acuity rounded and analysed to two decimal places, so a change of -0.28 is NOT defined as getting worse).

Characteristics of sample to be used in the analysis (N= 95561).

Mean age of eyes 75.8 (standard deviation 10.01) (range 18.1 – 104.1)

The 95,561 eyes are from 76,640 patients.

**Table 3. Characteristics of sample for VA Loss (N=95,561)**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | N | % |
| PCR | No | 94,219 | 98.60 |
|  | Yes | 1,342 | 1.40 |
|  |  |  |  |
| Age | <60 | 6,934 | 7.26 |
|  | 60-69 | 15,980 | 16.72 |
|  | 70-79 | 36,658 | 38.36 |
|  | 80-89 | 32,519 | 34.03 |
|  | 90+ | 3,470 | 3.63 |
|  |  |  |  |
| Gender | Male | 37,943 | 39.71 |
|  | Female | 57,338 | 60.00 |
|  | Not specified | 280 | 0.29 |
|  |  |  |  |
| Any alpha blocker (alfuzosin, doxazosin | No | 93,587 | 97.93 |
| Indoramin, parazosin, tamsulosin, terazosin) | Yes | 1,974 | 2.07 |
|  |  |  |  |
| Able to lie flat | No | 1,198 | 1.25 |
|  | Yes | 38,906 | 40.71 |
|  | Missing | 55,457 | 58.03 |
|  |  |  |  |
| Inability to co-operate | No | 23,809 | 24.91 |
|  | Yes | 930 | 0.97 |
|  | Missing | 70,822 | 74.11 |
|  |  |  |  |
| Axial length | <26 | 91,340 | 95.58 |
| (will look at this in quintiles also) | >= 26 | 4,153 | 4.35 |
|  | Missing | 68 | 0.07 |
|  |  |  |  |
| Axial length in quintiles | <= 22.43 | 18,877 | 19.75 |
|  | 22.44 – 23.01 | 19,273 | 20.17 |
|  | 23.02 – 23.53 | 19,067 | 19.95 |
|  | 23.54 – 24.24 | 19,371 | 20.27 |
|  | >= 24.25 | 18,905 | 19.78 |
|  | Missing | 68 | 0.07 |
|  |  |  |  |
| Axial length | >21.5 | 91,557 | 95.81 |
|  | ≤ 21.5 | 3,936 | 4.12 |
|  | Missing | 68 | 0.07 |
|  |  |  |  |
| Glaucoma | No | 89,358 | 93.51 |
|  | Yes | 6,203 | 6.49 |
|  |  |  |  |
| Age related macular degeneration | No | 85,700 | 89.68 |
|  | Yes | 9,861 | 10.32 |
|  |  |  |  |
| Amblyopia | No | 94,216 | 98.59 |
|  | Yes | 1,345 | 1.41 |
|  |  |  |  |
| Brunescent White Cataract | No | 93,171 | 97.50 |
|  | Yes | 2,390 | 2.50 |
|  |  |  |  |
| Diabetic retinopathy | No | 91,611 | 95.87 |
|  | Yes | 3,950 | 4.13 |
|  |  |  |  |
| Corneal Pathology | No | 93,605 | 97.95 |
|  | Yes | 1,956 | 2.05 |
|  |  |  |  |
| High myopia | No | 92,069 | 96.35 |
|  | Yes | 3,492 | 3.65 |
|  |  |  |  |
| No fundal view/ vitreous opacities | No | 94,904 | 99.31 |
|  | Yes | 657 | 0.69 |
|  |  |  |  |
| Previous vitrectomy | No | 94,349 | 98.73 |
|  | Yes | 1,212 | 1.27 |
|  |  |  |  |
| Pseudoexfoliation / phacodonesis | No | 94,485 | 98.87 |
|  | Yes | 1,076 | 1.13 |
|  |  |  |  |
| Uveitis / synaechiae. | No | 94,883 | 99.29 |
|  | Yes | 678 | 0.71 |
|  |  |  |  |
| Inherited Eye Disease | No | 95,455 | 99.89 |
|  | Yes | 106 | 0.11 |
|  |  |  |  |
| Optic nerve / CNS disease | No | 95,243 | 99.67 |
|  | Yes | 318 | 0.33 |
|  |  |  |  |
| Other | No | 91,905 | 96.17 |
|  | Yes | 3,656 | 3.83 |
|  |  |  |  |
| Other macular pathology | No | 94,782 | 99.18 |
|  | Yes | 779 | 0.82 |
|  |  |  |  |
| Other retinal vascular pathology | No | 94,830 | 99.24 |
|  | Yes | 731 | 0.76 |
|  |  |  |  |
| Surgeon Grade | Consultant | 56,750 | 59.39 |
|  | Non-consultant career grade | 11,419 | 11.95 |
|  | Senior Trainee | 22,520 | 23.57 |
|  | Junior Trainee | 4,872 | 5.10 |
|  |  |  |  |
| Pupil size | Large | 82,314 | 86.14 |
|  | Medium | 10,498 | 10.99 |
|  | Small | 2,653 | 2.78 |
|  | Missing | 96 | 0.10 |

Logistic regression model for outcome VA Loss

In addition to the variables offered to the logistic regression model for the PCR outcome, a variable for PCR was also offered to the logistic regression and the model adjusted for pre-op visual acuity.

The following variables entered/ remained in the logistic regression model, when the analysis was carried out **adjusting for pre-op visual acuity**: PCR, age, axial length, pupil size, gender and the co-pathologies; glaucoma, age-related macular degeneration, diabetic retinopathy, corneal pathology, brunescent white cataract, previous vitrectomy, other macular pathology, other retinal vascular pathology and other.

**Figure 2. AROC for VA Loss Model**



The area under the ROC curve for this model is 0.7053.

The adjusted odds ratios for this model, adjusting for all variables included in the model and pre-op visual acuity (N= 95400)

**Table 4. Logistic regression model for VA Loss**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Odds Ratio** | **95% CI** | **P-value** |
| Pupil Size | Large | 1.00 |  | 0.0062 |
|  | Medium | 1.27 | [1.10, 1.48] |  |
|  | Small | 1.12 | [0.85, 1.47] |  |
|  |  |  |  |  |
| Age | <60 | 1.00 |  | <0.001 |
|  | 60-69 | 1.51 | [1.12, 2.02] |  |
|  | 70-79 | 1.28 | [0.97, 1.69] |  |
|  | 80-89 | 1.63 | [1.23, 2.15] |  |
|  | 90+ | 2.80 | [2.00, 3.91] |  |
|  |  |  |  |  |
| PCR | No | 1.00 |  | <0.001 |
|  | Yes | 5.27 | [4.21, 6.61] |  |
|  |  |  |  |  |
| Axial length in quintiles | <= 21.50 | 1.91 | [1.52, 2.39] | <0.001 |
|  | 21.51- 22.43 | 1.27 | [1.07, 1.50] |  |
|  | 22.44 – 23.01 | 0.98 | [0.83, 1.16] |  |
|  | 23.02 – 23.53 | 1.00 |  |  |
|  | 23.54 – 24.24 | 0.83 | [0.70, 0.99] |  |
|  | 24.25 – 25.99 | 0.86 | [0.71, 1.04] |  |
|  | >= 26 | 0.90 | [0.65, 1.24] |  |
|  |  |  |  |  |
| Gender | Female /Not specified | 1.00 |  | 0.048 |
|  | Male | 1.12 | [1.00, 1.26] |  |
|  |  |  |  |  |
| Age related macular degeneration | No | 1.00 |  | <0.001 |
|  | Yes | 2.16 | [1.88, 2.48] |  |
|  |  |  |  |  |
| Other retinal vascular pathology | No | 1.00 |  | <0.001 |
|  | Yes | 4.83 | [3.50, 6.67] |  |
|  |  |  |  |  |
| Diabetic retinopathy | No | 1.00 |  | <0.001 |
|  | Yes | 2.21 | [1.79, 2.72] |  |
|  |  |  |  |  |
| Glaucoma | No | 1.00 |  | <0.001 |
|  | Yes | 1.97 | [1.67, 2.33] |  |
|  |  |  |  |  |
| Corneal Pathology | No | 1.00 |  | <0.001 |
|  | Yes | 2.37 | [1.84, 3.05] |  |
|  |  |  |  |  |
| Previous vitrectomy | No | 1.00 |  | <0.001 |
|  | Yes | 2.79 | [1.93, 4.05] |  |
|  |  |  |  |  |
| Brunescent white cataract | No | 1.00 |  | <0.001 |
|  | Yes | 1.96 | [1.43, 2.70] |  |
|  |  |  |  |  |
| Other macular pathology | No | 1.00 |  | <0.001 |
|  | Yes | 3.35 | [2.32, 4.84] |  |
|  |  |  |  |  |
| Other | No | 1.00 |  | 0.040 |
|  | Yes | 1.28 | [1.01, 1.62] |  |