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CLINICAL STUDY

The Cataract National Dataset electronic multi-centre audit of 55 567 operations: updating benchmark standards of care in the United Kingdom and internationally

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Abstract

Aims **To pilot the use of the Cataract National Dataset (CND) using multi-centre data from Electronic Patient Record (EPR) systems and to demonstrate the ability of the CND to deliver certain of its intended benefits, including detailed preoperative profiling of cataract surgery patients and updating of benchmark standards of care in the NHS and beyond.**

Methods **NHS departments using EPR systems to collect a minimum preoperative, anaesthetic, operative and postoperative data set, the CND, were invited to submit data, which were remotely extracted, anonymised, assessed for conformity and completeness, and analysed.**

Results **Four-hundred and six surgeons from 12 NHS Trusts submitted data on 55 567 cataract operations between November 2001 and July 2006 (86% from January 2004). Mean age (SD) was 75.4 (10.4) years, 62.0% female. Surgery was for first eyes in 58.5%, under local anaesthesia in 95.5% and by phacoemulsification in 99.7%. Trainees performed 33.9% of operations. Preoperative visual acuity (VA) was 6/12 or better in 42.9% eyes overall, in 35.3% first eyes and in 55.3% second eyes. Complication rates included the following: posterior capsule rupture and/or vitreous loss of 1.92%, simple zonule dialysis of 0.46% and retained lens fragments of 0.18%. Postoperative VA of 6/12 or better (and 6/6 or better) was achieved for 91.0% (45.9%) of all eyes, 94.7% (51.0%) of eyes with no co-pathologies and 79.9% (30.2%) of eyes with one or more co-pathologies respectively.**

Conclusions **The CND is fit for purpose, is able to deliver useful benefits and can be collected as part of routine clinical care via EPR systems. This survey confirms shifts in practice since the 1997–1998 UK National Survey with full conversion to phacoemulsification, better preoperative acuity, a halving of the surgical 'index' benchmark complication of posterior capsule rupture and/or vitreous loss, and improved VA outcomes.**

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Introduction

Cataract surgery is the most commonly performed operation in the NHS. Over the past decade and a half the number of cataract operations performed annually has trebled, with an estimated 105 000 in the United Kingdom in 1990,[1] and for England alone 153 000 in 1997–1998,[2] 306 000 in 2004–2005 with a slight drop in 2005–2006 to 287 000[3] (Figure 1).

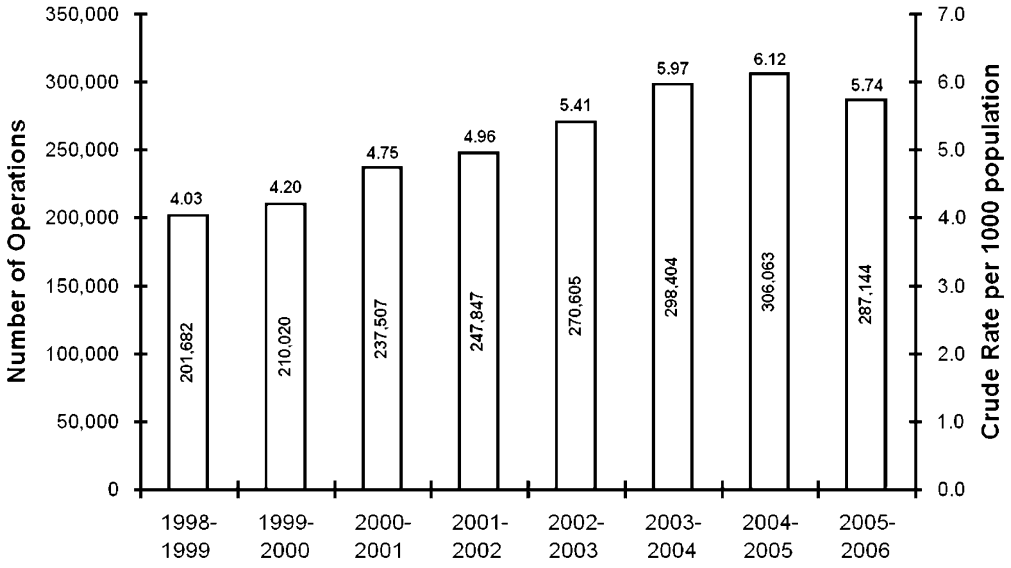

Figure 1 Cataract Surgery Frequency (finished consultant episodes) in England from 1998 to 2006. Number of cataract operations on left axis and crude surgical rate on right axis (assuming population of 50 millions for England).

Looking further back, a 10-fold increase occurred in England between 1968 and 2003[4] with notable regional variations. Despite this prodigious throughput, few ophthalmic departments can provide robust evidence of visual impairment or co-pathology preoperatively, operative complications, or postoperative clinical outcomes for their patients. The Royal College of Ophthalmologists has previously organised and hosted two Department of Health funded National Cataract Surgery Surveys in 1990 and 1997–1998, to examine variations in the organisation of cataract surgery services and clinical outcomes.[1,5–8] Both national surveys were, in part, designed to encourage all United Kingdom consultants to perform regular audit of their cataract surgery and to provide benchmark standards by which surgeons and departments could judge their performance. Our previous paper described the substantial improvements in productivity of NHS cataract services brought about by major organisational changes promoted by the 'Action on Cataracts' programme and the almost universal switch to day case, local anaesthetic, phacoemulsification cataract surgery.[2,9] Over several years, the Royal College of Ophthalmologists have facilitated the defining of a Cataract National Dataset (CND)[10] and their 2004 Cataract Surgery Guidelines[11] have been amended to encourage the adoption of this data set for electronic data collection as an integral part of normal clinical care by inclusion of the statement: 'for purposes of audit a robust method of prospective data collection of the CND, preferably electronically, should be the ideal aimed for in all units'.

Possible benefits of CND use include: detailed local and national audit of cataract surgery, robust data collection for individual surgeons for annual appraisal and possibly revalidation, national monitoring of the delivery and clinical outcomes of cataract surgery in the United Kingdom, research, and facilitation of rational decision making for the commissioning of cataract surgery in the NHS. The CND has been further refined by the Cataract Do Once and Share (DOAS) programme,[12] which is a clinical engagement arm of Connecting for Health (previously the National Programme for Information technology or NPfIT) which includes within its remit the development of electronic clinical systems for the NHS. Within the DOAS context, and supported by the Royal College of Ophthalmologists, submissions have been made to the NHS Information Standards Board with a view to the establishment of the CND as an NHS approved data set.

The primary aims of the current survey were to pilot the use of the CND collected by means of Electronic Patient Record (EPR) systems in a multi-centre environment and to demonstrate the ability of the CND to deliver certain of its intended benefits, including detailed preoperative profiling of cataract surgery patients and updating of benchmark standards of care in the NHS and beyond.

Methods

Following on from an earlier pilot National Electronic Cataract Surgery Survey,[9] this study comprised a cross-sectional survey of NHS Ophthalmology departments

that currently use EPR clinical systems purporting to collect the CND prospectively throughout the cataract care pathway. Through the DOAS programme all current ophthalmology EPR software suppliers and customers in the United Kingdom were contacted and permission requested to extract locally collected CND data from cataract surgery EPR systems. Three companies agreed to extract data from their systems without payment. Data collected with three separate EPR systems were received and assessed (by JMS) for conformity and completeness with the CND. Data from one supplier (Medisoft) was found to be almost identical to the CND with few missing items for key variables. Data derived from the other two systems were either significantly incomplete or not sufficiently similar in structure to the CND to permit its use without substantial re-structuring. No funding was available to pay software companies for extraction or data re-structuring and it was also not possible to undertake such work within the resources of the current project. The final data extraction was from sites using a single EPR system, all participating sites having given consent for anonymised data to be remotely extracted from their local databases. Patient identifiers were completely stripped out and site and clinician were pseudo-anonymised. These processes had to be achieved within the tight timescales of the DOAS project. A Local Ethics Committee confirmed that ethics approval was not required, as this study was an audit and no patients, hospitals or health-care workers were identifiable.

Analysis was restricted to patients undergoing surgery for cataract alone or combined with surgery to reduce astigmatism; those patients undergoing other combined surgical procedures were excluded. The mode of data entry into the EPR varied slightly between sites. At all sites collection of demographic data (age, sex, and ethnicity) was dependent on automatic download from the hospital's patient administration system to the EPR and therefore the completeness of these variables was not under the control of the EPR. When used optimally, preoperative and operative data were entered 'live' directly into the EPR as an integral part of the care record. Postoperative data were either entered 'live' into the system at the clinic consultation or retrospectively from paper-based care records and returns from community optometrists. The data set for analysis closely resembled the CND.[10] In terms of operative complications a combined figure for posterior capsule rupture (PCR) or vitreous loss (VL) or both plus zonule rupture with vitreous loss has been presented to capture all occasions of either 'PCR or VL or both' in a single 'index' figure. A separate figure for 'simple' zonule dialysis (without VL) has been presented to differentiate this as a 'lesser' surgical complication since many of these are small and surgically relatively trivial. In this report preoperatively, the 'best-measured VA' was the best visual acuity (VA) of the VA with habitual correction and the uncorrected VA (UCVA); and where no result was available for either of these measures pinhole VA was used as a proxy. Visual impairment was defined as the best-measured VA of either the surgical or fellow eyes. Postoperatively, the best-measured VA was the best VA of the best-corrected VA (BCVA) that is with optimal postoperative refraction, UCVA and pinhole VA. In some centres, postoperative data were collected prior to postoperative refraction, which necessitated the inclusion of pinhole VA on such occasions.

Statistical methods

χ^2 tests were used to investigate potential differences in the proportion of eyes in different VA groups preoperatively and postoperatively. Fisher's exact testing was used when an expected frequency of a cell in a table was less than 5. As a consequence of anonymising patient data it was not possible to know which operations had been performed on two eyes of a single patient. This precluded any ability to statistically adjust for inter-eye correlations. To compensate we have used a stricter probability level for statistical significance, that is, $P<0.01$ rather than the more usual $P<0.05$. Statistical analysis was performed in Excel (Microsoft) and Stata.

Results

Data were extracted on 55 567 cataract operations performed at 12 NHS trusts by 406 surgeons between November 2001 and July 2006. The number and percentage of operations and time period over which data were collected for each Trust site are provided in Table 1. Overall 86.0% of operations were performed between January 2004 and July 2006. Patient's age at the time of each operation was recorded in 100% of cases. The mean age (SD) for all patients was 75.4 (10.4) years, for women 76.1 (10.2) years and for men 74.1 (10.7) years. Gender was recorded in 99.9% ($n=55\,496$) of cases, 62.0% ($n=34\,406$) were female. Data on ethnic origin were collected in 31 984 operations (57.6% of all cases) and are shown with range by site in Table 2. Whether cataract surgery was being performed on the patient's first or second eye was recorded in 49 507 operations (89.1%); of these 58.5% ($n=28\,942$) were performed on first eyes and 41.5% ($n=20\,565$) on second eyes.

Preoperative features

Preoperative VA in the operated eye

Preoperative best-measured VA for the operated eye was available for 55 528 (99.9%) eyes. Both preoperatively

Table 1 Operations performed at each site (available for 100% operations)

Site	*Time period*	*Number of operations*	*Percentage of total operations*
1	2001–2006	8696	15.7
2	2002–2006	4209	7.57
3	2002–2006	10 904	19.6
4	2002–2006	10 947	19.7
5	2003–2006	5745	10.3
6	2004–2006	324	0.58
7	2004–2006	1160	2.09
8	2004–2006	1396	2.51
9	2004–2006	2568	4.62
10	2004–2006	7353	13.2
11	2005–2006	960	1.73
12	2005–2006	1305	2.35
All	2001–2006	55 567	100

Table 2 Ethnic origin (available for $n = 31\,984$ or 57.6% operations)

Ethnic origin	*Number*	*Percentage*	*Range by site (%)*
White	31 146	97.4	85.8–99.4
Indian subcontinent	464	1.45	0.09–9.73
Black African/Caribbean	245	0.77	0.10–1.71
Mixed/other	129	0.40	0.11–3.10

best-measured VA and whether it was the patient's first- or second-cataract operation were available for 28 916 first eyes and 20 554 second eyes. Table 3 shows the preoperative best-measured VA for all operated eyes (including range by site), for first and second eyes, for the six VA groups: 6/6 or better, 6/9 or better, 6/12 or better, less than 6/12 to 6/18, less than 6/18 to 6/60, and less than 6/60 to NPL. It should be noted that for best-measured VA the 6/6 or better, 6/9 or better and 6/12 or better categories are cumulative. There was a statistically significant difference ($P < 0.001$) in the proportion of eyes with each level of visual impairment between the first and second eyes, with second eyes having lower levels of visual impairment (better VA) before cataract surgery.

Preoperative VA impairment

Assessing VA impairment (the VA in the better eye) before cataract surgery requires a measure of VA for both eyes and this was available for 52 125 operations (93.8%). Both preoperative visual impairment and whether it was the patient's first- or second-cataract operation were available for 46 441 (83.6%) operations, 27 010 for first eyes and 19 431 for second. Table 4 shows the preoperative VA impairment (including range by site), for all operations, for first-eye cases and for second eyes, for the six VA groups: 6/6 or better, 6/9 or better, 6/12 or better, less than 6/12 to 6/18, less than 6/18 to 6/60, and less than 6/60 to NPL. It should again be noted that for best-measured VA the 6/6 or better, 6/9 or better and 6/12 or better categories are cumulative. χ^2 testing was used to investigate differences in the proportion in the six VA groups by first or second eye. There was a statistically significant difference ($P < 0.001$) in the proportion of eyes with each level of visual impairment between the first and second eyes, with patients undergoing second eye surgery having lower levels of VA impairment.

Ocular co-pathology (identified as a reason for a guarded visual prognosis in the operated eye)

The presence or absence of ocular co-pathology considered to be a reason for a guarded visual prognosis in the operated eye was recorded in all cases. No reason for a guarded visual prognosis was identified preoperatively in 39 739 (71.5%) of eyes. The spectrum and percentage of eyes with each co-pathology are shown in Table 5.

Characteristics of surgical procedure

Type of admission

The type of admission was recorded for all operations (100%), with 54 723 (98.5%) performed as a day case and 844 (1.52%) performed as an in-patient.

Anaesthetic technique

Details of the anaesthetic technique were recorded in all but one operation. Overall, 95.5% ($n = 53\,043$) of operations were performed using local and topical anaesthetic techniques alone, and 4.54% ($n = 2523$) used general anaesthesia with or without a 'supplemental' block.

Surgical technique

The surgical technique was recorded for all 55 567 operations (100%). Phacoemulsification was used in 55 389 cases (99.7%), phacoemulsification was converted to extracapsular surgery in 75 cases (0.13%), planned extracapsular surgery was performed in 97 cases (0.17%) and intracapsular surgery was performed in 6 cases (0.01%).

Grade of surgeon

Data on the grade of 405 of the 406 surgeons who contributed to the study were available for 55 515 cases (99.9%). Table 6 shows details of the number of surgeons in each grade and the median, minimum, maximum number of operations performed by surgeons within each grade.

Table 3 Preoperative visual acuity (best measured) in the operated eye (available for 99.9% of operations)

Best-measured preoperative Snellen VA of surgical eye	*All eyes* n = *55 528*			*First-eye surgery*[a] n = *28 916*		*Second-eye surgery*[a] n = *20 554*	
	n	%	*Range by site %*	n	%	n	%
6/6 or better	2225	4.01	1.07–8.50	590	2.04	1443	7.02
6/9 or better	13 002	23.4	13.3–37.6	4849	16.8	6937	33.8
6/12 or better	23 800	42.9	32.0–58.6	10 193	35.3	11 368	55.3
<6/12 to 6/18	11 004	19.8	17.8–25.4	6105	21.1	3742	18.2
<6/18 to 6/60	15 284	27.5	17.8–34.9	9256	32.0	4181	20.3
<6/60	5440	9.80	5.91–13.2	3362	11.6	1263	6.14

See text for definition best-measured preoperative VA.
[a]Statistically significant differences (χ^2, $P<0.001$) existed between the proportions in all six VA groups by first and second eyes.
Grey-shaded rows contain cumulative categories.

Table 4 Preoperative visual acuity impairment (best-measured, vision in the better eye, available for 93.8% of operations)

Best-measured preoperative Snellen VA of better eye	*All eyes* n = *52 125*			*First-eye surgery*[a] n = *27 010*		*Second-eye surgery*[a] n = *19 431*	
	n	%	*Range by site %*	n	%	n	%
6/6 or better	13 038	25.0	12.3–33.3	4574	16.9	6701	34.5
6/9 or better	31 442	60.3	45.2–72.6	13 783	51.0	14 044	72.3
6/12 or better	40 305	77.3	66.8–86.5	19 161	70.9	16 678	85.8
<6/12 to 6/18	6161	11.8	7.88–19.3	4064	15.0	1530	7.87
<6/18 to 6/60	4795	9.20	4.51–14.2	3233	12.0	1025	5.28
<6/60	864	1.66	1.13–2.27	552	2.04	198	1.02

See text for definition best-measured preoperative VA.
[a]Statistically significant differences (χ^2, $P<0.001$) existed between the proportions of in all six visual impairment groups by first- and second-eye patients.
Grey-shaded rows contain cumulative categories.

Table 5 Preoperative recorded co-pathology/reasons for a guarded visual prognosis (available for 100% of operations) and range by site

Reason for a guarded prognosis	*Number*[a]	*Percentage*	*Range by site (%)*
None	39 739	71.5	48.9–88.7
Age-related macular degeneration	4933	8.88	3.52–22.7
Glaucoma	3025	5.44	2.04–11.3
Diabetic retinopathy	1877	3.38	0–6.59
Brunescent cataract	1211	2.18	0.07–3.97
High myopia	1109	2.00	0.45–3.32
Corneal pathology	971	1.75	0.24–4.71
Amblyopia	816	1.47	0.94–2.65
Uveitis/synechiae	531	0.96	0.17–2.16
No fundal view/vitreous opacities	495	0.89	0.10–2.67
Pseudoexfoliation/phacodonesis	525	0.94	0.47–2.15
Other retinal vascular pathology	426	0.77	0–1.00
Previous retinal detachment	470	0.85	0.01–2.06
Other macular pathology	400	0.72	0.14–1.79
Previous vitrectomy	297	0.53	0–1.09
Optic nerve/CNS disease	231	0.42	0.05–1.23
Previous trabeculectomy	40	0.07	0–0.54
Inherited eye disease	57	0.10	0–0.52

[a]It should be noted that patients may have had more than one ocular co-pathology identified.

Table 6 Surgeons by grade and the median, minimum, maximum number of operations performed (available for $n = 55\,515$ or 99.9% of operations, missing data on grade for one surgeon)

	Number of surgeons n = *405*	*Number of operations*	*Number of operations by individuals of each grade*		
			Median	*Minimum*	*Maximum*
Consultant	109	29 256	165	1	1417
Associate specialist	13	5919	185	1	2568
Staff grade	15	1515	10	1	606
Fellow	37	3086	61	1	399
Specialist registrar	152	12 683	46.5	1	415
SHO[a]	79	3056	23	1	353

[a]SHO, Senior House Officer.

Surgical complications

Operative complications

A record of the presence or absence of operative complications was recorded in 100% of cases (Table 7). One or more operative complications occurred in 2577 cases (4.64%). PCR or vitreous loss or both (PCR or VL or both) occurred in 1068 cases (1.92%), simple zonule dialysis occurred in 256 cases (0.46%), retained lens fragments (dropped nuclei) occurred in 99 cases (0.18%) and supra-choroidal haemorrhage in 38 cases (0.07%). Note that some eyes may have more than one operative complication recorded.

Postoperative complications

The presence or absence of postoperative complications are given in Table 8. These were recorded in 16 731 (30.1%) cases with a median time to postoperative review of 31 days. Table 9 contrasts the demographic and clinical characteristics of eyes that did and did not have an EPR record of their postoperative follow-up consultation.

Table 7 Operative complications, $n = 55\,567$ (100% of operations)

Operative complication[a]	*Number of cases*	*Percentage of cases*
None	52 990	95.4
PCR or VL or both[b]	1068	1.92
Other	634	1.14
Iris trauma/iris prolapse	305	0.55
Simple zonule dialysis (No VL)	256	0.46
Phaco burn/wound problems	140	0.25
Endothelial damage/Descemet's tear	138	0.25
Retained lens fragment (dropped nuclei)	99	0.18
Corneal epithelial abrasion	96	0.17
Corneal oedema	76	0.14
Lens exchange required/other IOL problems	73	0.13
Supra-choroidal haemorrhage	38	0.07
Hyphaema	29	0.05
IOL into the vitreous	7	0.01

[a]More than one complication could be recorded for a single procedure.
[b]PCR or VL or both, posterior capsule rupture or vitreous loss or both which is a composite figure including PCR without VL, PCR with VL, and zonule rupture with VL.

VA outcomes

Representativeness

Postoperative 'best-measured' VA outcome data were available for 40 758 (73.3%) operations, median follow-up 35 days. These cases are contrasted with those for whom data were not available with regard to age, gender, preoperative VA, ocular co-morbidity and 'PCR or VL or both' in Table 9. Statistically significant differences were found for all these variables despite the magnitude of these differences appearing clinically unimportant, a consequence of the large sample size and substantial statistical power of these data. BCVA data were available for 24 404 eyes (43.9%) as indicated in Table 10 where outcomes for BCVA are presented by presence or absence of ocular co-pathology. Comparison with outcomes for best-measured VA (top three rows in Table 11) show that these two measures of acuity gave closely similar results overall and by presence or absence of co-pathology. Statistically significant differences could be detected due to the large power of the data set, although numerically and clinically the observed differences between BCVA and best-measured VA were trivial (robust analysis of similarities and differences will be presented elsewhere).

Together these analyses provided reassurance that those for whom best-measured VA was available could be considered representative and that best-measured VA could be used as a legitimate proxy of best-corrected postoperative VA to maximise the utility of the data set in further analysis.

Postoperative 'best-measured' VA

Details of postoperative best-measured VA for 40 758 eyes are presented in Table 11. Overall 91.0% ($n = 37\,096$) of eyes achieved 6/12 or better and 45.9% ($n = 18\,698$) achieved 6/6 or better. For 30 726 eyes with no ocular co-pathology as a reason for a guarded visual prognosis

94.7% ($n=29\,083$) of eyes achieved 6/12 or better and 51.0% ($n=15671$) 6/6 or better. For 10 032 eyes with ocular co-pathology, 79.9% ($n=8013$) achieved 6/12 or better and 30.2% ($n=3027$) achieved 6/6 or better. The presence of any of the specific co-pathologies listed in Table 11, were statistically and significantly associated ($P<0.001$) with a reduced postoperative best-measured VA, a result which was mirrored in Table 10 using BCVA.

Table 8 Most common postoperative complications where this information was available, $n=16\,731$ (30.1% of all operations)

Postoperative complication[a]	*Number of cases*	*Percentage of cases*
None	14 323	85.6
Postoperative uveitis	551	3.29
Corneal oedema/striae/ Descemet's folds	867	5.18
Raised IOP (>21 mm Hg)	430	2.57
Cystoid macular oedema	271	1.62
Posterior capsule opacification	204	1.22
Iris prolapse/iris to wound	26	0.16
Retained soft lens matter	75	0.45
Vitreous to section	65	0.39
Vitreous in anterior chamber	28	0.17
IOL decentred	36	0.22
Wound leak (Siedel +ve)	23	0.14
Choroidal effusion/haemorrhage	21	0.13
Hyphaema	11	0.07

[a]More than one complication could be recorded for a single procedure.

VA outcomes and age

Figure 2 shows the proportion of eyes achieving a postoperative best-measured VA of 6/6 or better, 6/9 or better and 6/12 or better at final follow-up at 5 year age intervals. The figure shows a rapid decline in the percentage of eyes achieving 6/6 or better from the age of 65 onwards, whereas a similar trend is not evident in the percentage of eyes achieving 6/9 or better or 6/12 or better until 80 years.

Change in VA before and after surgery

A cross-tabulation of preoperative *vs* postoperative best-measured VA is given in Table 12 for 40 724 (73.3%) eyes. This format allows easy access to VA outcomes for each level of preoperative VA. The row percentages

Table 9 Demographic and clinical data of patients who did and did not have an EPR record of their postoperative follow-up consultation

	All		*With follow-up data*[a]		*Without follow-up data*[a]	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Age (years)	75.4	10.4	75.6	9.88	74.7	11.8
N	55 567		40 758		14 809	
	Number	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*
Sex						
Female	34 406	62.0	25 583	62.8	8823	59.8
Male	21 090	38.0	15 154	37.2	5936	40.2
All	55 496		40 737		14 759	
Best measured preoperative VA						
6/12 or better	23 800	42.9	18 280	44.9	5520	37.3
Less than 6/12 to 6/60	26 288	47.3	18 982	46.6	7306	49.3
Less than 6/60 to NPL	5440	9.80	3462	8.50	1978	13.4
All	55 528		40 724		14 804	
Ocular co-morbidity						
Present	15 828	28.5	10 032	24.6	5796	39.1
Absent	39 739	71.5	30 726	75.4	9013	60.9
All	55 567		40 758		14 809	
PCR or VL or both[b]						
Present	1068	1.92	506	1.24	562	3.79
Absent	54 499	98.1	40 252	98.8	14 247	96.2
All	55 567		40 758		14 809	

[a]Statistically significant differences ($P<0.001$) existed between those with and without follow up data for all these variables. (A two sample *t*-test was used to compare the mean age of those with and without follow-up data and χ^2 for differences between proportions of those with and without follow-up data for the other variables).
See text for definition best-measured preoperative Snellen VA.
[b]PCR or VL or both, posterior capsule rupture or vitreous loss or both which is a composite figure including PCR without VL, PCR with VL, and zonule rupture with VL.

Table 10 Best corrected visual acuity (BCVA) by presence or absence of ocular co-pathology at final follow-up

	Postoperative Snellen BCVA							
	6/6 or better		*6/12 or better*		*<6/12 to 6/60*		*<6/60*	
	n	%	n	%	n	%	n	%
All eyes $n=24\,404$	11 510	47.2	22 300	91.4	1871	7.67	233	0.95
Eyes with no ocular co-pathology[a] $n=18\,219$	9526	52.3	17 231	94.6	917	5.03	71	0.39
Eyes with ocular co-pathology[a] $n=6185$	1984	32.1	5069	82.0	954	15.4	162	2.62

[a]Statistically significant ($P<0.001$) differences were found for the proportion in all acuity groupings between eyes with no ocular co-pathology and eyes with co-pathology (χ^2 tests).
Grey-shaded columns contain cumulative categories.
BCVA was available for 24 404 (43.9%) eyes.

Table 11 Best-measured postoperative VA for specific ocular co-pathologies at final follow-up (available for 40 758 or 73.3% of operations)

Ocular co-pathology	*Postoperative best-measured Snellen visual acuity*							
	6/6 or better		*6/12 or better*		*<6/12 to 6/60*		*<6/60*	
	n	%	n	%	n	%	n	%
All eyes	18 698	45.9	37 096	91.0	3167	7.78	495	1.21
Eyes with no ocular co-pathology[a]	15 671	51.0	29 083	94.7	1501	4.89	142	0.46
Eyes with any ocular co-pathology	3027	30.2	8013	79.9	1666	16.6	353	3.52
Age related macular degeneration	817	23.9	2556	74.8	671	19.6	189	5.53
Glaucoma	631	35.1	1530	85.1	219	12.2	49	2.73
Diabetic retinopathy	280	27.0	786	75.9	223	21.5	27	2.61
Brunescent/white cataract	237	32.5	579	79.3	113	15.5	38	5.21
High myopia	327	43.1	652	85.9	86	11.3	21	2.77
Corneal pathology	154	25.0	477	77.3	119	19.3	21	3.40
Amblyopia	114	20.8	369	67.2	159	29.0	21	3.83
Uveitis/synechiae	88	36.5	198	82.2	36	14.9	7	2.90
No fundal view/vitreous opacities	103	33.7	234	76.5	56	18.3	16	5.23
Pseudoexfoliation syndrome/phacodonesis	96	29.4	275	84.1	40	12.2	12	3.67

See text for definition best-measured postoperative VA.
[a]Statistically significant ($P<0.001$) differences were found for proportions in all acuity groupings between eyes with no ocular co-pathology and eyes with every group and sub-group of ocular co-pathology (χ^2 or Fisher's where appropriate). Eyes may have had more than one co-pathology present.
Grey-shaded columns contain cumulative categories.

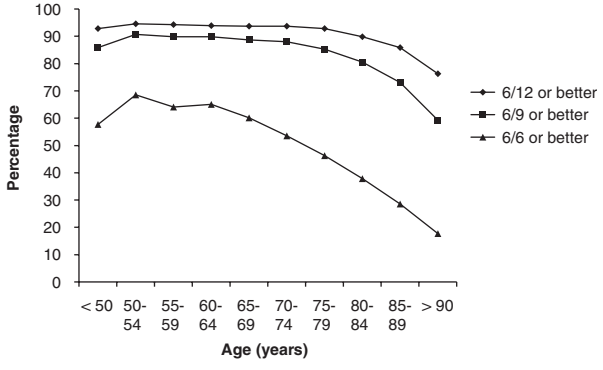

Figure 2 Best-measured VA by age for three postoperative acuity outcomes groups ($N=40\,758$). The observed age related changes were statistically significant (χ^2, $P<0.001$) for each outcome group.

indicate the proportion of eyes with a given preoperative VA, which achieved each postoperative VA outcome. Overall 95% of eyes were either the same or better postoperatively.

Discussion

Surgical techniques and cataract extraction rates per head of population have changed enormously over the past two decades. Understanding these changes in the context of patients' clinical presentation and surgical outcomes is essential for quality assurance. Technological advances have not been limited to the procedure itself, the current large scale survey has been made possible by the use of specialty specific EPR systems, which have allowed the authors to assemble a substantial set of detailed data

Table 12 Change in best-measured Snellen VA before and after surgery (available for both for $n = 40\,742$ or 73.3%)

	Postoperative																								
Preoperative	*6/3*	*6/4*	*6/5*	*6/6*	*6/7.5*	*6/9*	*6/12*	*6/15*	*6/18*	*6/24*	*6/30*	*6/36*	*6/48*	*6/60*	*5/60*	*4/60*	*3/60*	*2.5/60*	*2/60*	*1/60*	*HM*	*CF*	*PL*	*NPL*	*Row totals*
6/3			1			2																			3
			33%			67%																			100%
6/4		11	11	4		3																			29
		38%	38%	14%		10%																			100%
6/5	1	29	129	111	12	37	3		1																323
	0.3%	9.0%	40%	34%	3.7%	11%	0.9%		0.3%																100%
6/6		80	339	610	64	292	30		9	1	1	2										1			1429
		5.6%	24%	43%	4.5%	20%	2.1%		0.6%	0.1%	0.1%	0.1%										0.1%			100%
6/7.5	1	25	134	334	90	170	22	3	4												1				784
	0.1%	3.2%	17%	43%	11%	22%	2.8%	0.4%	0.5%												0.1%				100%
6/9	5	218	1,246	2910	568	2224	305	7	82	23	1	10		9							3		1		7612
	0.1%	2.9%	16%	38%	7.5%	29%	4.0%	0.1%	1.1%	0.3%	0.0%	0.1%		0.1%							0.0%		0.0%		100%
6/12	5	147	994	2655	666	2669	679	21	175	44	1	18	2	10		1	2		1	1	4	5			8100
	0.1%	1.8%	12%	33%	8.2%	33%	8.4%	0.3%	2.2%	0.5%	0.0%	0.2%	0.0%	0.1%		0.0%	0.0%		0.0%	0.0%	0.0%	0.1%			100%
6/15		11	62	173	59	203	52	5	13	3		2		1								1			585
		1.9%	11%	30%	10%	35%	8.9%	0.9%	2.2%	0.5%		0.3%		0.2%								0.2%			100%
6/18	2	131	787	2189	623	2515	744	50	338	93	7	26	1	19		1			2	1	9	3		2	7543
	0.0%	1.7%	10%	29%	8.3%	33%	9.9%	0.7%	4.5%	1.2%	0.1%	0.3%	0.0%	0.3%		0.0%			0.0%	0.0%	0.1%	0.0%		0.0%	100%
6/24	2	73	416	1182	326	1408	504	27	294	114	2	55	2	19			2	1			10	4			4441
	0.0%	1.6%	9.4%	27%	7.3%	32%	11%	0.6%	6.6%	2.6%	0.0%	1.2%	0.0%	0.4%			0.0%	0.0%			0.2%	0.1%			100%
6/30		3	19	45	13	54	18		10	7	3	2							1		1	1			177
		1.7%	11%	25%	7.3%	31%	10%	0.0%	5.6%	4.0%	1.7%	1.1%							0.6%		0.6%	0.6%			100%
6/36	2	77	393	1046	283	1002	369	36	250	128	10	106	5	38	1	1	6		1	2	13	3	1		3773
	0.1%	2.0%	10%	28%	7.5%	27%	9.8%	1.0%	6.6%	3.4%	0.3%	2.8%	0.1%	1.0%	0.0%	0.0%	0.2%		0.0%	0.1%	0.3%	0.1%	0.0%		100%
6/48		1	20	39	10	37	14	4	15			6	1	2						1		1			151
		0.7%	13%	26%	6.6%	25%	9.3%	2.6%	9.9%			4.0%	0.7%	1.3%						0.7%		0.7%			100%
6/60		38	232	589	145	605	221	12	124	92	10	114	4	79	1	2	9	1	6	6	17	5			2312
		1.6%	10%	25%	6.3%	26%	9.6%	0.5%	5.4%	4.0%	0.4%	4.9%	0.2%	3.4%	0.0%	0.1%	0.4%	0.0%	0.3%	0.3%	0.7%	0.2%			100%
5/60		3	11	29	8	25	9	1	7	4		2		3								1			103
		2.9%	11%	28%	7.8%	24%	8.7%	1.0%	6.8%	3.9%		1.9%		2.9%								1.0%			100%
4/60		1	4	16	10	30	8		4			7		4			2								86
		1.2%	4.7%	19%	12%	35%	9.3%		4.7%			8.1%		4.7%			2.3%								100%
3/60	1	7	40	88	31	96	31	2	18	9	1	10	1	17		1	6			1	4	1			365
	0.3%	1.9%	11%	24%	8.5%	26%	8.5%	0.5%	4.9%	2.5%	0.3%	2.7%	0.3%	4.7%		0.3%	1.6%			0.3%	1.1%	0.3%			100%
2.5/60			1	11		13	4		3																32
			3.1%	34%		41%	13%		9.4%																100%
2/60		6	34	64	16	53	27	1	11	2		6		9		1	4		1	2	2	1			240
		2.5%	14%	27%	6.7%	22%	11%	0.4%	4.6%	0.8%		2.5%		3.8%		0.4%	1.7%		0.4%	0.8%	0.8%	0.4%			100%
1/60		1	23	53	22	47	21		11	5	2	6		7			3		5	2	3	2			213
		0.5%	11%	25%	10%	22%	9.9%		5.2%	2.3%	0.9%	2.8%		3.3%			1.4%		2.3%	0.9%	1.4%	0.9%			100%

Table 12 (Continued)

Preoperative	*Postoperative*																								*Row totals*
	6/3	*6/4*	*6/5*	*6/6*	*6/7.5*	*6/9*	*6/12*	*6/15*	*6/18*	*6/24*	*6/30*	*6/36*	*6/48*	*6/60*	*5/60*	*4/60*	*3/60*	*2.5/60*	*2/60*	*1/60*	*HM*	*CF*	*PL*	*NPL*	
CF		23	122	321	79	337	125	5	84	47	3	62		76	2	3	14	1	11	11	97	18	1		1442
		1.6%	8.5%	22%	5.5%	23%	8.7%	0.3%	5.8%	3.3%	0.2%	4.3%		5.3%	0.1%	0.2%	1.0%	0.1%	0.8%	0.8%	6.7%	1.2%	0.1%		100%
HM	1	12	77	153	31	189	66	6	41	34	1	26	2	35	1	1	9	2	8	8	48	45	5		801
	0.1%	1.5%	9.6%	19%	3.9%	24%	8.2%	0.7%	5.1%	4.2%	0.1%	3.2%	0.2%	4.4%	0.1%	0.1%	1.1%	0.2%	1.0%	1.0%	6.0%	5.6%	0.6%		100%
PL			15	34	6	40	18	2	8	8		5		7	1		2				8	11	8		173
			8.7%	20%	3.5%	23%	10%	1.2%	4.6%	4.6%		2.9%		4.0%	0.6%		1.2%				4.6%	6.4%	4.6%		100%
NPL			1			1		1	3														1		7
			14%			14%		14%	43%														14%		100%
Not		1	8	5	1	10	3			3		1		1					1						34
		2.9%	24%	15%	2.9%	29%	8.8%			8.8%		2.9%		2.9%					2.9%						100%
Column totals	20	898	5119	12 661	3063	12 062	3273	183	1505	617	42	466	18	336	6	11	59	5	37	35	220	103	17	2	40 758

Row % indicates the proportion of eyes with a given preoperative VA (left most column) which achieved the postoperative VA outcome for that column. See text for definitions of best-measured VA.
Diagonal grey shading indicates no change, eyes above and to the right achieved a worse postoperative outcome than existed preoperatively.

collected as part of routine clinical care. Alongside these developments and facilitated by the Royal College of Ophthalmologists, the DOAS cataract project has further refined a CND.[10,12]

Work included assessment of structure, completeness and conformity with the CND of data sets from a number of EPR software sources. It was found that EPR data collected as part of routine clinical care were available in a usable form with a structure sufficiently similar to the CND to permit rapid electronic merger for analysis. With cooperation of relevant stakeholders it has been possible to illustrate 'proof of concept' to the NHS Information Standards Board that the CND is essentially 'fit for purpose' with large scale data collection and merger feasible provided appropriate local software implementations are in place.

The size of the reported sample is sufficiently large to allow very precise point estimates (percentages and averages) and for detection of small differences between groups and subgroups. Estimates derived from this data set can therefore be expected to be precise provided the sample itself is representative. Available information suggests that overall this is the case, which is reassuring since the participating surgeons and units are at the forefront of cataract EPR implementation and as such may not have been a representative group. The majority of the data (86%) from the 12 participating trusts were collected between January 2004 and July 2006, with no individual surgeon having performed more than 4.6% of the operations and no unit having contributed more than 20% of all operations. In our sample, the mean age was 75.4 years with 62% being females. These basic demographics are essentially identical to national figures for England during this period, for instance during 2004–2005 the mean age for 306 000 reported NHS cataract operations was 75 years with 62% of procedures on female patients. In our sample 98.5% of operations were undertaken as day cases, slightly higher than the figure of 94% nationally.[3]

EPR programmes are able to force data collection for key variables, thus for preoperative and operative data where collection has been complete or near complete within this data set estimates are likely to be reliable, although for follow-up information the representativeness of the presented results remains less certain. Details of similarities and differences between those with and without follow-up data are provided in Table 9 and relevant results should be interpreted in the appropriate context. Follow-up data for postoperative complications were only available for 30% of eyes. This is due to partial uptake of EPR systems so that preoperative and operative data are fully collected in all centres but this does not always occur for postoperative clinical assessments. In a number of centres VA outcome data

were entered independently of postoperative clinical assessments. Best-corrected acuity data were mostly provided by optometrists and were available for 44% with best-measured VA outcome being available for 73% of eyes.

Preoperative acuity in the operated eye was 6/12 or better in 43% of eyes (Table 3). Over the past couple of decades acuity thresholds for listing for surgery have become increasingly lenient, in 1990 under 9% of eyes for surgery had an acuity 6/12 or better,[5] by 1997 this had risen to 31%,[7] and a report in 2005 on cases carried out between 1998 and 2003 noted this rate to have reached 45% in an 8-centre-pilot electronic audit of over 16 500 cases.[9] Although some of these differences may have been due to varying methodology there is a clear trend towards better vision preoperatively over this time period. In this analysis, we chose a definition of best-measured preoperative acuity, which placed an emphasis on habitual correction and unaided vision. Using a different definition of preoperative vision that is the best of habitual, unaided or pinhole-corrected acuity we found 63% of eyes had a preoperative acuity of 6/12 or better. Also of interest in our sample was the observation that listings for first- and second-eye surgery were significantly different with more lenient thresholds being used for second eyes, that is 55% with best-measured 6/12 or better compared with 35% for first eyes (43% overall). In our sample, 23% of eyes had best-measured acuity of 6/9 or better at listing, 17% for first eyes and 34% for second eyes. In terms of VA impairment (best-measured vision in the better eye, Table 4) it is of note that overall 60% of patients had acuity of 6/9 in the better eye, this being 51% for first eyes and 72% for second eyes. With such lenient criteria being applied for listing it would seem advisable for future studies to comment on acuities better than 6/12 preoperatively and postoperatively (as we have done) to avoid a ceiling effect due to scale truncation. In addition there is a case for a robust patient centred quality of life outcome, which is sufficiently brief to be usable in an everyday service delivery environment.

As detailed in Table 7 surgery was uneventful in over 95% of cases, with under 2% of operations being complicated by posterior capsular rupture and/or vitreous loss. This figure included vitreous loss from other causes, including zonule rupture. A composite figure has been presented because the authors are of the view that capsule rupture and/or vitreous loss should trigger an anterior vitrectomy with chamber clearance of all vitreous in the vast majority of cases. This approach avoids temptation to trivialise 'simple' PCR without obvious vitreous loss as a lesser complication. Failure to deal adequately with posterior capsular rupture during primary surgery increases the frequency of postoperative problems such as secondary glaucoma, cystoid macular oedema and retinal detachment.[13–15]

The halving of this 'index' complication, posterior capsular rupture and/or vitreous loss from the 4.4% rate observed in the second national cataract surgery survey of 1997–1998 is noteworthy. In the current survey, 99.7% of operations were by phacoemulsification, which illustrates that UK surgeons have now fully adopted this technique, and the 2% index complication rate reflects what should be expected from a modern surgical service. Just over half of the operations were performed by consultants, approximately 13% by non-consultant career grade surgeons and just over a third by surgical trainees. The 2% index figure, therefore, includes experienced surgeons as well as the most junior surgeons in training. Furthermore, the case mix of this sample was unselected with 'higher surgical risk' cases, such as eyes with high myopia, eyes which had previously undergone vitrectomy, eyes with no fundal view and so on included in expected proportions (Table 5).

VA outcomes have been presented separately for BCVA and best-measured VA. Follow-up data for our sample are incomplete and we have presented BCVA on a reduced sample size ($n = 24\,404$, 44%) as a 'gold standard outcome' as well as best-measured VA ($n = 40\,758$, 73%) to optimise available information. Comparison of Tables 10 and 11 confirm that the acuity outcomes were similar for these two measures, both overall and by presence or absence of co-pathology. In view of the larger sample size available for best-measured VA, outcomes for individual co-pathologies have been presented separately in Table 11. Co-pathologies in this case series were recorded only if considered sufficiently severe to be a reason for a guarded prognosis (Table 5). Overall 72% of eyes were free of significant co-pathology, which is less than noted in the second national cataract surgery survey.[7,8] The authors consider the difference in reported rates to be due to different definitions for co-pathology used in the two surveys rather than case mix differences. In this sample, 95% of eyes with no co-pathology and 80% of eyes with co-pathology achieved a 'best-measured' VA of 6/12 or better compared with 92 and 77%, respectively, in the second national cataract surgery survey.[8] This improvement in outcome may reflect greater experience of phacoemulsification technique which was only used for 77% of operations in the earlier survey compared with close on 100% in this report. It should however also be noted that the preoperative VA was generally better in this sample compared with the earlier sample. The overall 91.4% of eyes which achieved a BCVA of 6/12 or better in this study is similar to the 93% reported recently on a sample of 1000 cases selected for 'choice' at a London teaching hospital, in which 16.5% of operations were performed by consultants.[16]

In Table 12 we have cross-tabulated preoperative acuity and best-measured postoperative acuity. The diagonal shading indicates the 'line of no change' with cells to the right and above indicating eyes with a worse postoperative acuity than existed preoperatively and such eyes appear to have been harmed by surgery. While it must be accepted that there will always be a proportion of eyes which are harmed by surgery, where preoperative acuity was good these findings raise questions as to whether the risk to benefit ratio for cataract surgery is being given appropriate consideration in every case.[17]

The age-related decline in outcome for the more sensitive acuity levels seen in Figure 2 is likely to be contributed to by increasing rates and severity of age-related maculopathy in older patients. Awareness of this decline in expected outcome should be useful to clinicians when counselling elderly patients preoperatively to maintain realistic expectations of their surgery.

Conclusion

This paper illustrates the ability and power of specialty-specific EPR systems to deliver the CND from data collected as part of routine clinical care and provides an opportunity to update modern cataract surgery benchmarks both nationally in the United Kingdom and internationally. Our report details the profile of patients coming forward for cataract surgery, and we describe practice standards for surgical complications and VA outcomes.

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