EXTENDED REPORT

Agreement between optometrists and ophthalmologists on clinical management decisions for patients with glaucoma

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Background/aims: Although optometrists have become an accepted part of the team in many hospital glaucoma clinics, their decision making ability has not been assessed formally. This study aims to document the accuracy and safety of clinical work undertaken by optometrists in the hospital setting by investigating their management decisions on follow up of patients with glaucoma.

Methods: Four optometrists and three medical clinicians examined 50 patients each. Clinical findings were recorded as usual in the hospital records but management decisions were documented separately on a specially designed data collection form. Subsequently, the patient records and clinical findings were reviewed retrospectively and independently by two consultant ophthalmologists, who were masked to the management decisions of the optometrists and medical clinicians. The consultants' management decisions were then compared with those made by the optometrists and medical clinicians. Percentage agreements were computed together with kappa (κ), or weighted kappa, statistics where appropriate.

Results: Agreement between consultants and optometrists was 55% ($\kappa=0.33$) for evaluation of visual field status, 79% ($\kappa=0.67$) for medical management, 72–98% for other aspects of patient management, and 78% (weighted $\kappa=0.35$) for scheduling of next clinic appointment. Very similar levels of agreement were found between consultants and medical clinicians.

Conclusion: Agreement between optometrists and consultants, in glaucoma clinical decision making, was at least as good as that between medical clinicians and consultants. Within an appropriate environment, optometrists can safely work as part of the hospital glaucoma team in outpatient clinics.

The number of potential glaucoma sufferers is estimated to increase by about a third over the next 20 years.¹ This has raised concerns about the personnel and financial resources required to provide a good standard of clinical care. One means of alleviating the burden on the hospital eye service is to involve non-medical eye care professionals, such as optometrists. Community optometrists already play a key part in the detection of glaucoma in the United Kingdom. They are responsible for more than 95% of glaucoma referrals to the hospital eye service and have the basic skills to detect glaucoma.² Furthermore, optometrists are becoming increasingly involved in co-managed/shared care schemes and studies have been designed to assess their involvement.^{3–7} Studies to date have examined the agreement between ophthalmologists and optometrists regarding individual aspects of the clinical examination—for example, optic disc and intraocular pressure assessment,^{8–11} but, to our knowledge, not that regarding decision making for the management of glaucoma patients.

This study was designed to evaluate this agreement between optometrists and two glaucoma subspecialist consultant ophthalmologists. As a benchmark, the same evaluation of agreement was undertaken for medical clinicians (associate specialists) and the consultant ophthalmologists.

PATIENTS AND METHODS

The study was conducted in the glaucoma outpatient clinics of Moorfields Eye Hospital. Approval was granted by the hospital's ethics committee but patient informed consent was not required because the model of care already existed in these clinics.

Four optometrists and three associate specialists participated by examining patients, collecting clinical data, and making management decisions. The two consultants participated by retrospectively reviewing the clinical data and

making independent management decisions on the same patients.

The optometrists had worked in glaucoma clinics for 3–10 years in 1–2 half day sessions per week and had gained experience of patient assessment and management. Their training consisted of undertaking patient assessments in a supportive environment with ready access to the consultant ophthalmologist. Optometrists' performance was informally monitored by senior members of the glaucoma team. The three associate specialists had worked part-time in hospital glaucoma clinics for at least 10 years.

Preliminary evaluation of clinicians' abilities to assess optic disc

As the consultants did not assess the patients themselves, and therefore did not view their optic discs, the optometrists' and associate specialists' ability to evaluate these structures was investigated independently of the main study. They assessed 134 stereo pairs of disc photographs and were required to determine if each disc was glaucomatous or normal. Their judgment was compared with previously published results for this photographic set.¹²

The accuracy of intraocular pressure measurements by Goldmann tonometry was not evaluated in this study.

Allocation of patients

New and immediate postoperative patients were identified and excluded from the study patient pool. A total of 350 patients with a diagnosis of glaucoma (including primary open angle, angle closure, secondary and normal tension) or ocular hypertension were included in the study. These patients were allocated by the clinic clerk, on a sequential basis, to participating associate specialists or optometrists, who assessed 50 patients each.

Table 1 Structured examination for patient assessment

Clinical history	Topical medications	Clinical assessment
Previous diagnosis	Time last taken	External eye and anterior segment examination, including blebs, conjunctiva, iris, cornea
New symptoms or problems	Compliance	Measurement of intraocular pressure
General health	Side effects	Gonioscopy, when indicated
Systemic medications		Internal eye and posterior segment (with dilatation of pupil when necessary)—including anterior chamber, lens, vitreous, retina
Risk factors		Assessment of optic disc including vertical size, vertical cup disc ratio, neural retinal rim Nerve fibre layer Assessment of visual fields Supplementary tests required (eg, HRT imaging, disc photographs, blood tests)

HRT, Heidelberg retina tomograph.

Clinical assessment

Patients who had previously been scheduled for a visual field test had this examination completed by a technician before clinical assessment. The clinician then examined the patients using the clinic structured routine (see table 1).

Following collation of these clinical data, the optometrists and associate specialists were required to make management decisions on five specific aspects of patient care: visual field status (including the date of the last test), medical management (referred to as “clinical management 1”; see table 2), other clinical management (“clinical management 2”; see table 2), planned future tests, and time to next clinic appointment. Table 2 lists the issues requiring a management decision and shows possible outcomes from which the clinician had to select his/her choice.

Category “clinical management 2” grouped together management issues not readily included in the other four aspects of patient care—for example, when cataract or glaucoma surgery was considered, when medication com-

pliance was reinforced, and when there was a need to discuss management with the consultant.

Data management, analysis, and sample size

All clinical data were documented in the patients’ hospital records by the clinician. His/her management decisions arising based on this information at the time of patient assessment were recorded in the hospital records and, again, on a separate specially designed data collection form.

These management decisions were masked and not available to the consultants when they each reviewed the 350 hospital records. They made independent judgments on patient management and completed the specially designed data collection form for each patient.

The number of patients seen by each clinician was determined by Altman’s recommendation that a sample size of at least 50 should be used for a method comparison study.¹³ In order to generalise results, it was decided to include as many optometrists and associate specialists as possible. Four optometrists and three associate specialists were available.

To assess the agreement between optometrists and consultants for management decisions, results from the four optometrists were pooled and compared with those of the consultants. Similarly, management decision agreement between associate specialists and consultants was assessed by comparing pooled results of the associate specialists with those of the consultants. Agreement between the two consultants was also assessed. Percentage agreements were tabulated for each clinical decision. Kappa statistics were

Table 2 Management decisions

Aspect of management	Possible outcomes
Visual field status	Stable Progression Unreliable/insufficient data Non-glaucoma Other
Clinical management 1	No treatment Continue treatment Start/increase treatment Reduce treatment
Clinical management 2	Consider glaucoma surgery Consider cataract surgery Other*
Planned tests	Reinforce compliance Discuss with consultant Disc photographs HRT imaging Visual fields
Time to next clinic appointment	Phasing of intraocular pressure 1–2 months 3 months 6 months 9 months 12 months Discharge

*Including a change of treatment (because of intolerance or a new drug becoming available).

HRT, Heidelberg retina tomograph.

Table 3 Comparing agreement between clinician decisions on sensitivity and specificity in optic disc assessment

	Sensitivity (%)	Specificity (%)
Clinicians		
1	77.8	83.5
2	80.0	89.0
3	88.2	81.9
4	79.1	76.0
Associate specialists		
1	72.5	77.7
2	64.7	93.0
3	74.2	82.3

computed where tables were not heavily imbalanced; 0.00–0.20, poor; 0.21–0.40, fair; 0.41–0.60, moderate; 0.61–0.80, good; 0.81–1, very good. Weighted kappa statistics were computed for time to next clinical appointment; 1.0 for agreement, 0.75 for one step away disagreement, 0.5 for two steps away disagreement, 0.25 for three steps away disagreement, 0 for four or more steps away disagreement and any disagreement for discharge and missing data.

RESULTS

Preliminary evaluation of clinicians' abilities to assess the optic disc

The level of sensitivity in determining whether discs were normal or glaucomatous was 77.8–88.2% for optometrists and 64.7–74.2% for associate specialists, with specificity of 76–89% for optometrists and 77.7–93% for associate specialists (table 3).

Decision making accuracy

Analysis was only undertaken on 349 patients because one hospital record could not be retrieved. Eye conditions ranged from mild ocular hypertension to advanced glaucoma. Some patients had multiple pathology and some cases were tertiary referrals.

The levels of agreement between the two consultants, between the consultants and the optometrists (grouped together), and between the consultants and the associate specialists (grouped together) are presented in tables 4–9. Where there was a high percentage of agreement between the two consultants, the results are presented for only one consultant (C1) compared with the optometrists and the associate specialists. However, in three sections (visual field status, next planned field test, and planned imaging), the agreement between the two consultants was less good, so tables 5 and 8 are broken down to show agreements with consultants 1 (C1) and 2 (C2) separately.

Visual field: status and time since last examination

Time since last field test was included to act as a gauge for the accuracy and completeness of data entry by those taking part in the study (table 4). Agreement was a minimum of good for everyone (as defined by kappa) and any discrepancies may have arisen because of the confusion about classifying a visual field of exactly 1 year old into the "more than 1 year old" or "less than 1 year old" category.

Evaluation of visual field status showed that agreement between consultants (62%) was slightly better than that between consultants and either optometrists (C1 55%; C2 54%) or associate specialists (C1 44%; C2 43%) (see table 5). In 11 and 14 cases, consultants 1 and 2, respectively, thought that the field was stable, whereas the optometrists thought that it was progressing. There were fewer cases where the consultants thought that visual field was progressing while the optometrists thought that it was stable. The reverse pattern was seen between consultants and associate specialists. There were two cases where each of the consultants

considered that visual field was stable, whereas the associate specialists thought that it was progressing, and seven and four cases respectively, where the associate specialists considered the field was stable but the consultants thought there was progression.

Clinical management 1

The results of clinical management 1 (table 6) showed a high percentage of agreement between the two consultants (agreement 84%; kappa 0.74) and between consultant 1 and optometrists (agreement 79%; kappa 0.67), and moderate agreement between consultants and associate specialists (agreement 71%; kappa 0.52). It should be noted that the associate specialists had 5.3% missing data compared with 2% for consultant 1, 3.4% for consultant 2, and 3% for the optometrists; these missing data influenced the agreement calculation.

The proportion of cases in which consultant 1 would have started or increased treatment when other clinicians would not have was 6.6% (consultant 2), 10.6% (optometrists), and 8.7% (associate specialists). The proportion of cases in which other clinicians would have started or increased treatment when consultant 1 would not have was 4.6% (consultant 2), 5.5% (optometrists), and 0.7% (associate specialists). If the missing data are removed from the analysis, the percentage agreement increases to 88% between the two consultants, 83% between consultant 1 and the optometrists, and 84% between consultant 1 and the associate specialists.

Clinical management 2

The proportion of cases in which consultant 1 would have considered cataract surgery when other clinicians would not have was 5.7% for (consultant 2), 5.5% (optometrists), and 8.7% (associate specialists) (see table 7).

The proportion of cases in which consultant 1 would have considered glaucoma surgery when other clinicians would not have was 2.3% (consultant 2), 2.5% (optometrists), and 0.7% (associate specialists). In addition, the optometrists considered that 2.5% of patients might need glaucoma surgery when consultant 1 did not. Overall, there was a high percentage of agreement between all groups in this category.

There was good agreement between all groups regarding reinforcing patient compliance (all agreements $\geq 97\%$).

The results on whether a case should have been discussed with the consultant showed that the agreement between the two consultants was 72%, which was the same as that between consultant 1 and the optometrists. There was a better agreement (81%) between consultant 1 and the associate specialists.

Planned tests

Compared with some other aspects of the study, there was a lower percentage of agreement between the two consultants in the areas of planned field tests (62%) and imaging (76%). For planned visual fields, there was similar agreement between consultant 1 and the optometrists (59%), and

Table 4 Comparing agreement between clinician decisions on time since last visual field examination

C1	C2			Optometrist			Associate specialist		
	VF <1 year	VF >1 year	M	VF <1 year	VF >1 year	M	VF <1 year	VF >1 year	M
VF <1 year	241	5	3	131	5	2	99	9	3
VF >1 year	4	89	3	6	43	10	1	27	9
Missing	0	4	0	0	0	2	0	1	1
Agreement (%), kappa	95, 0.87			88, 0.74			85, 0.66		

C1, consultant 1; C2, consultant 2; VF, visual fields; y, year; M, missing data.

Table 5 Comparing agreement between clinician decisions on evaluation of visual field status

	C2					Optometrist					Associate specialist				
	S	P	U	N	M	S	P	U	N	M	S	P	U	N	M
C1															
Stable	136	6	27	1	3	73	11	6	5	1	45	2	0	0	30
Progression	8	11	13	0	1	8	9	1	0	1	7	2	0	1	4
Unreliable/insufficient	42	5	56	1	6	21	10	20	6	9	10	1	7	2	24
No glaucoma	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0
Missing	5	1	11	0	14	3	0	5	1	8	1	0	1	0	12
Agreement (%), kappa			62, 0.39					55, 0.33					44, 0.22		
C2															
Stable						78	14	15	6	1	44	2	1	3	28
Progression						5	7	1	0	1	4	0	0	0	5
Unreliable/insufficient						17	9	16	5	10	15	3	8	0	25
No glaucoma						1	0	0	0	1	0	0	0	0	0
Missing						5	0	0	1	6	0	0	0	0	12
Agreement (%), kappa								54, 0.27					43, 0.21		

C1, consultant 1; C2, consultant 2; S, stable; P, progression; U, unreliable or insufficient data; N, non-glaucoma; M, missing data or that the data were not recorded.

between consultant 2 and the optometrists (65%) (see table 8). There was also similar agreement between consultant 1 and the optometrists for imaging (74%), and between consultant 2 and the optometrists (72%). Percentage agreement figures between the consultants and the associate specialists in both areas were lower. For visual fields, agreement was 53% with consultant 1 and 54% with consultant 2; for imaging, agreement was 69% with consultant 1 and 53% with consultant 2.

For phasing of both patient intraocular pressures and disc photographs, there was almost total agreement between all groups, with very few tests being ordered. The only variance was between the consultants and optometrists regarding disc photographs; in 17 out of 199 cases where the optometrists arranged for disc photography the consultants did not consider it necessary.

Next clinic appointment

The results for the next clinic appointment (table 9) were weighted and showed a high percentage of agreement (80%) between the two consultants and between consultant 1 and the optometrists (79%), and almost as good agreement between consultant 1 and the associate specialists (73%).

DISCUSSION

There has been much interest in the roles that non-medical eye care professionals can have in the management of glaucoma patients. Various publications support the potential contribution from nurses,¹⁴ orthoptists,¹⁵ and optometrists.^{16–19} Participation from the optometry profession may occur in either the community setting or within the hospital eye service. To our knowledge, this is the first time that the decision making ability of optometrists working within the hospital glaucoma service has been assessed and compared with that of medical clinicians

and published in a peer reviewed journal. For each of the aspects investigated in this study, the optometrists demonstrated an acceptable level of competence which, overall, was at least as good as the non-consultant medical staff. Differences in opinion on patient management were seen between medical personnel, and even between consultants, in every part of the study. Such variation in management approach is not unusual.^{20–21}

Evaluation of performance is important for new members of the team, but it is particularly pertinent when non-medical personnel assist in an increasingly busy work environment. Documented appraisal of individuals' abilities aids in addressing the wider issues of safety, and also helps to reassure the clinic consultant who needs to delegate specific responsibilities for patient contact and management to various members of the clinical team.

All follow up patients, with the exception of postoperative cases, were included in this study. As a tertiary referral centre, Moorfields Eye Hospital receives difficult cases from elsewhere. These were not removed from the study because they make up the usual case mix within the clinic, and optometrists working in this environment need to be able to deal with them. It is typical for the consultant to be involved if the optometrist is unsure of how to handle a case, or if surgery is indicated. The level of agreement between optometrists and consultants on when a case should be discussed with the consultant (72%) was the same as that found between consultants, and provides reassurance that, in the majority of situations, optometrists do seek guidance appropriately.

A significant advantage of hiring non-medical personnel is the reduced staffing cost. However, the savings may be offset if optometrists make inappropriate decisions—for instance, bringing patients back too frequently or ordering too many

Table 6 Comparing agreement between clinician decisions on "clinical management 1"

C1	C2 (n = 349)					Optometrist (n = 199)					Associate specialist (n = 150)				
	CND	CDU	S	R	M	CND	CDU	S	R	M	CND	CDU	S	R	M
CND	95	4	0	1	4	56	2	2	0	0	21	4	1	1	17
CDU	1	159	14	1	2	2	82	8	1	1	2	78	0	0	3
S	2	17	36	0	4	4	13	18	0	4	0	11	7	0	2
R	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0
M	2	1	2	0	2	1	2	1	0	1	0	1	0	0	1
Agreement (%), kappa			84, 0.74					79, 0.67					71, 0.52		

C1, consultant 1; C2, consultant 2; CND, continue no drops; CDU, continue drops unchanged; S, start or increase drops; R, reduce drops; M, missing data

Table 7 Comparing agreement between clinician decisions on "clinical management 2"

	C1	C2		Agreement (%)	Optometrist		Agreement (%)	Associate specialist		Agreement (%)
		Yes	No		Yes	No		Yes	No	
Consider cataract	Yes	5	20		1	11		0	13	
Surgery	No	3	321	93	1	186	94	0	137	91
Consider glaucoma	Yes	1	8		1	5		2	1	
Surgery	No	1	339	97	5	188	95	0	147	99
Reinforce	Yes	2	3		4	0		0	1	
Compliance	No	4	340	98	6	189	97	1	148	99
Discuss with	Yes	17	78		16	46		5	28	
Consultant	No	19	235	72	10	127	72	0	117	81

C1, consultant 1; C2, consultant 2.

tests. Because of its importance, the decision about the timing of the next clinic appointment was evaluated in this study. A high percentage of agreement (79%) was found between optometrists and consultants, and was very similar to that between the consultants (80%) and between consultants and associate specialists (73%).

For an optimal assessment of agreement, the consultant would have personally examined every patient and then made a management decision, rather than using previously recorded data. However, the clinic workload constraints made this impossible. Completeness and accuracy of data collection were ensured by using a structured data collection form, and by assessing the clinicians' ability to differentiate between normal and glaucomatous optic discs using disc stereophotograph pairs. Despite that, some information gained by talking directly to the patient is difficult to capture—for example, interactions with the patient about possible cataract surgery. The percentage agreement between consultant and optometrists on clinical management was very high (94% for cataract surgery consideration).

The result of the optometrists' disc assessments was good; optometrists had higher sensitivity (77–88.2% for optometrists; 64.7–74.2% for associate specialists), and the associate specialists had slightly higher specificity (76–89% for optometrists; 77.7–93% for associate specialists). These

results are better than those presented by Abrams *et al*⁸ and comparable with those of Wollstein *et al*.²¹ In the latter study, five expert clinicians evaluated the same optic disc photographic set as that used in this study to discriminate between healthy and glaucomatous optic discs. The best single observer achieved a specificity of 85.4% with a sensitivity of 64.7%. Evaluating stereo photographs differs from the clinical evaluation at the slit lamp, but is a fair surrogate and the only practical means we have to assess the reliability of disc assessments.

The results show a level of agreement between the "gold standard" and the optometrists at least as high as that between the consultants and the associate specialists. This agreement is reflected in all the important aspects of patient management. The lack of agreement in some instances was caused by the optometrists being overcautious. For example, there were more cases where visual field was judged to be progressing by the optometrists compared with cases where visual field was judged to be progressing by the consultants. Missing data from the associate specialists was an issue (for example, 16% in table 6) that affected the analysis, and any future study should try to minimise this problem. None the less, the findings demonstrate that optometrists who are given specialist training and work in a supportive environment are capable of making appropriate clinical judgments

Table 8 Comparing agreement between clinician decisions on planned tests

	C1	C2		Agreement (%)	Optometrist		Agreement (%)	Associate specialist		Agreement (%)
		Yes	No		Yes	No		Yes	No	
Visual field	C1									
	Yes	163	22	62	86	43	59	28	28	53
	No	112	52		39	31		43	51	
	C2									
Imaging	Yes				103	48	65	63	61	54
	No				22	26		8	18	
	C1									
	Yes	79	29	76	19	39	74	6	44	69
Phasing	No	55	186		12	129		3	97	
	C2									
	Yes				19	43	72	5	67	53
	No				12	25		4	74	
Disc photo	C1									
	Yes	0	5	98	1	4	97	0	0	100
	No	1	343		2	192		0	150	
	C2									
Disc photo	Yes				0	1	98	0	0	100
	No				3	195		0	150	
	C1									
	Yes	0	0	99	0	0	91	0	0	100
Disc photo	No	2	347		17	182		0	150	
	C2									
	Yes				0	1		0	1	
	No				17	181	91	0	149	99

C1, consultant 1; C2, consultant 2.

Table 9 Comparing agreement between clinician decisions on next clinic appointment

	C2										Specialist associate									
	Optometrist					C1					1-2 m					3 m				
	1-2 m	Disc	1 y	9 m	Mis	1-2 m	Disc	1 y	9 m	Mis	1-2 m	Disc	1 y	9 m	Mis	1-2 m	Disc	1 y	9 m	Mis
1-2 months	21	0	0	1	0	4	1	0	0	0	0	0	0	0	0	1	0	0	0	0
3 months	41	0	3	5	0	38	1	3	3	0	6	0	1	3	2	10	0	0	1	3
6 months	8	0	12	12	0	86	1	12	7	2	19	0	4	7	2	11	0	0	3	5
9 months	2	0	13	15	0	37	0	13	6	1	2	0	3	6	1	3	0	2	3	0
1 year	0	0	5	13	0	12	0	5	2	0	0	1	3	2	0	0	1	5	6	3
Discharge	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0
Missing	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Agreement (%)																				
Weighted kappa																				
	80					79					79					73				
	0.41					0.35					0.29									

m, month; y, year; Disc, discharge; Mis, missing.

and provide a satisfactory standard of care. Skill mix of this type on a wide scale could impact on the NHS healthcare delivery. With a growing aged population, there is a likely significant increase in patients attending glaucoma out-patient clinics. Services will need to expand to cope with the demand, and a portion of these patients will be suitable for co-management by optometrists.

Increasingly, optometrists are being drawn to hospital practice for the variety and increased scope of work. Rarely is there difficulty in recruiting optometrists for work in glaucoma clinics, many of whom work both in the hospital setting and in community practice. In the latter case, they make decisions about whether to refer a patient for medical care. Improvement in clinical decision making skills should reduce the burden of inappropriate referrals. The Department of Health has recently identified glaucoma in the National Eye Care Steering Group as one of the four pathways for greater involvement by optometrists in primary care co-management.²² In this study we did not investigate the issue of patient satisfaction but another study has indicated that patients respond positively to being seen by an optometrist instead of an ophthalmologist.⁴

There are plans by the Department of Health to introduce legislation to grant suitably trained optometrists the rights to prescribe a small range of medications independently and a larger range dependently.²³ This may cover medications for glaucoma treatment, widening the scope for appropriately trained and experienced optometrists working in a multi-disciplinary environment. Concerns will undoubtedly arise from this step and it is hoped that studies investigating the choice of therapeutic medication and, once again, comparing optometrists' decision making with consultants' opinions will be conducted.

Compared with the United Kingdom, anecdotally there are relatively larger numbers of ophthalmologists per head of the population in other EU countries and elsewhere in the western world. With fewer ophthalmologists in the United Kingdom, there is an ever growing need to staff the glaucoma clinics with other eye care professionals. This study indicates that optometrists are a resource that should be given serious consideration.

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