GLAUCOMA CARE

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SIGNED DECLARATION:

I Anurag Sharma, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed:

[redacted]

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ABSTRACT

What is the problem?

The number of people coming to the hospital eye departments is likely to increase in the future, as a result of an ageing population, increased optometric case finding and raised public awareness. This fact coupled with the increased economic pressures in health-care financing, and the relative shortage of ophthalmologists in the United Kingdom is going to put significant strain on ophthalmology provision.

As a result of these issues, there has been a drive by the government to move eye care into the community and to have more primary care involvement.

A variety of alternative models have been proposed for patient care in the

community. An important part of assessing these models is to investigate their relative cost effectiveness as well as safety, capacity and patient acceptance.

What are the current models?

There have been many shared care models that have been proposed. These have included the Community and Hospital Allied Network Glaucoma Evaluation Scheme (CHANGES), the Peterborough Scheme, East Devon Scheme, Waltham Forest Scheme and the Nottingham Scheme.

One of the main schemes was the Bristol Shared Care Scheme. This scheme was shown not to be cost effective. It did show that community optometrist's measurements were of comparable accuracy to those made in the hospital. The annual cost per patient follow-up by a community optometrist was £68.98-£108.98 compared to £14.50-£59.95 in the hospital. The main reason for the cost difference was due to a variation in the patient recall interval between the community and hospital. The second reason was due to the re-referral of patients back from the community clinics to the hospital clinics.

What was our contribution?

We developed an Integrated Glaucoma Care Model. This involved training and accrediting community optometrists to run Moorfields glaucoma clinics in their Optometric practices whilst alternating attending glaucoma clinics in the hospital.

Our results showed that it was more costly to run the community based glaucoma clinics compared to hospital based clinics. These were the same findings as in the Bristol shared care model. The main reasons for the higher costs in the community were due to the large overhead costs of running the glaucoma scheme in the community optometric practices as well as fewer patients being seen in the community compared to the hospital.

The community optometrists involved in our scheme were in general found to be competent, efficient and safe. The patient perspectives of our model were overall positive with a large majority of patients happy to be seen in the community again.

What were our recommendations?

Our main recommendation was to evolve our model to run the shared care scheme within the hospital setting to avoid the high rental costs of the optometric practices. This model is being successfully run at Bristol Eye Hospital where there is a complete shared care department involving optometrists. This type of model could utilise hospital optometrists but could also have accredited community optometrists attending the hospital and participating in such schemes.

A second possibility could be to run these shared care schemes in hospital satellite settings or mobile units. An example of this is the Newmedica model. There is a clear requirement for cost effectiveness evaluation of such schemes along with an assessment of safety, capacity and patient acceptance before any conclusions can be reached.

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1.0 Aim

The aim of this thesis was to first of all conduct a literature review of the optometric community glaucoma shared care schemes currently active. There was a process of data collection for hospital baseline data in terms of time to consultation, capacity, clinical record completeness and recall times. I then developed my own community glaucoma shared care model which involved recruiting optometrists. A training programme was then developed to accredit the optometrists. These optometrists then ran Moorfields glaucoma clinics in their practices. Data were then collected on time to consultation, clinical record completeness, capacity and recall times. A historical comparison was performed with the hospital data. These outcomes were then reviewed against the current literature. Patient perspective data was also obtained and reviewed.

2.0 Introduction

2.1 Optometry and Community Optometrists

2.1.1 Definition of an Optometrist

Optometrists are primary health care specialists trained to examine the eyes to detect defects in vision, signs of injury, ocular diseases or abnormality and problems with general health.[1]

2.1.2 University Optometric Qualification

There are currently 11 universities and colleges that offer Optometry as a BSc (Hons) degree course. The universities and colleges are listed below in Table 2.1.

Institution
City University
Glasgow Caledonian University
University of Bradford
Cardiff University
Aston University
Anglia Ruskin University
University of Ulster
University of Manchester
University of Plymouth
University of Bradford
University of Hertfordshire

Table 2.1: Universities and Colleges offering BSc (Hons) Optometry degree course.

The BSc Optometry degree is a three-year full time taught course comprising lectures, clinical sessions, written, viva and practical examinations. Once the degree is completed a further period of Pre-registration training has to be undertaken. At the end of the pre-registration period, trainee optometrists have to pass the professional qualifying examinations before fully qualified status can be achieved. Qualified optometrists can then use the title Member of the College of Optometrists (MCOptom) after their name.

2.1.3 Community Optometric Practices

2.1.3.1 Optometric Market Share

The optical market consists of large multiple optical chains, independent practices and supermarket chains.[2] Large multiples control approximately 80% of the market share with the remaining 20% divided between independent and supermarkets.

2.1.3.2 Large Multiple Chains

There are now currently four main large multiple chains in the Optical sector. They are Specsavers Opticians, Boots Opticians, Vision Express and Optical Express. Until recently there was another large multiple Dollond and Aitchison but this company was taken over by Boots.[3] Two supermarkets have also entered the optical market, Asda Opticians and Tesco Opticians.

Specsavers is the largest multiple chain with over 1390 stores across the Channel Islands, UK, Ireland, Netherlands, Scandinavia, Spain, Australia and New Zealand and employs around 26,000 staff worldwide.[4] All Specsavers stores are franchises which are run by opticians and optical retailers.

Boots Opticians which has acquired Dollond and Aitchison has become the second largest optical chain in the UK with around 690 stores, including 210 franchises and employs more than 5,000 people.[5]

Vision Express has over 330 stores across the UK and Ireland and recently acquired G C Bateman Group, a 100 year old family owned business.[6] Vision Express comprises company owned stores and joint venture stores.

2.1.3.2.1 Advantages of Large Multiple Chains

There are many advantages to large multiple chains. The size of the company allows them to purchase large quantities of frames at a more cost effective price. Multiples can then transfer some of this saving to their customers in terms of saving. The other main advantage that large multiples have over their independent competitors is in advertising their business. A perfect example of this is Specsavers which has invested a large amount of money in the advertising of its brand. Specsavers has led many popular TV, radio and poster campaigns, which have promoted its brand to make it the largest privately owned opticians in the U.K. Boots and Vision Express have also advertised on TV but their marketing campaigns have been smaller.

The marketing budgets of small independent practices are comparatively smaller therefore they are not able to gain the promotional power of TV and radio and instead rely largely on word of mouth from their customers.

The other main advantage of large multiples is the offers they can give to their patients in relation to spectacles and contact lenses. These large companies are able to purchase frames and contact lenses in bulk from all over the world at advantageous prices and they are able to pass these savings on to their patients in terms of price and offers such as “buy one get one free”.

The purchasing power of small independents is far less and therefore, they cannot always compete with the multiples in terms of price. The supermarket opticians are the only companies that can compete with the large optical chains. The financial position of the supermarkets allows them to reduce their optical appliance prices and give their patients unique benefits such as club card points as with Tesco Opticians.[7]

2.1.3.3 Independent Practices

There are a large number of independent opticians throughout the United Kingdom. These businesses can be a single practice or alternatively consist of small groups of practices which are privately owned. These types of practices rely strongly on patient word of mouth to build their patient base.

2.1.3.3.1 Advantages of Independent Practices

The advantages of independent practices are that they have greater flexibility when it comes to they way in which their business operates and they can implement changes in the practice more quickly and easily due to their relative small size compared to large multiples. They can also model their practice according to the demographics of their patient base.

It is relatively easier for a director of an independent practice to make changes to frame, lens and contact lens prices than that of a multiple.

This is mainly due to the fact that independents don't have to adhere to franchise and company policies.

2.1.3.4 Standard Roles of Community Optometrists

The standard roles for optometrists are to perform eye examinations on patients. The eye examination consists of a full ocular health screening and referral to a specialist or GP only if clinically required. It also involves performing a full refraction to obtain a spectacle prescription for the patient. In addition community optometrists are responsible for soft and RGP contact lens fitting and aftercare assessments.[8] The health screening, and refraction are obligatory.

The community optometrist has a duty to undertake a clinical examination of the external and internal structures of the eyes. They are obliged to refer any abnormality that warrants further ophthalmological investigation. The urgency of the referral is at the discretion of the optometrist and based on the type of ocular pathology.

The optometrist also has a duty to obtain the best visual acuity for each eye through the undertaking of a retinoscopy examination and a subjective refraction for each eye.

2.1.3.5 Expanded Roles of Community Optometrists

Over the years the roles of community optometrists have expanded into other areas outside their conventional duties of ocular health screening, refraction and contact lens fitting.

2.1.3.5.1 Diabetic Shared Care

There have been and are currently numerous diabetic screening services throughout the UK. These services screen diabetic patients for diabetic retinopathy assessment. If further secondary care is warranted, the patient is then referred on to the medical retina service in the hospital setting.

In the past there have been a multitude of schemes that have been operated throughout the UK involving General practitioners and Optometrists working in varied community settings. These various schemes have been superseded by the NHS Diabetic Eye Screening Programme (NDESP).

The aim of the Diabetic Eye Screening Programme has been to reduce the risk of sight loss among people with diabetes by the early detection and treatment, if required, of sight-threatening retinopathy. There are in excess of 80 such schemes that deliver screening throughout England.[9]

The National Programme Team account for local programmes who are required to submit an annual report containing general service information and information to support an assessment of the Service Objectives and Quality Assurance Standards of the NDESP.

The NDESP has set protocols on actions to be taken based on screening outcomes. The type of action is determined by the level of diabetic retinopathy detected.[9]

The grading within the service is done by qualified graders. All the graders within the NDESP have to undergo formal training and qualifications. Since September 2006, the national screening programme has used an accreditation package offered in conjunction with City and Guilds.

The award type is a level 3 Qualification in Diabetic Retinopathy Screening that consists of nine units. These nine units provide for a wide range of job roles. These have been used to create five qualifications (two Diplomas and three Certificates). Each qualification or job role has incorporated a mandatory minimum combination of units.[10]

Scanlon first described the English national screening programme for sight-threatening diabetic retinopathy in 2008. He discussed the two-field mydriatic digital photographic screening for all people with diabetes in England over the age of 12 years.

Scanlon et al had already shown in 2003 that two field mydriatic digital photography performed well against both reference standards which included an ophthalmologist's examination and seven field stereo photography.

The potential benefits stated were to reduce the prevalence of diabetic blindness in England from 4200 to 1000 people whilst also reducing the annual incidence of diabetic retinopathy blindness by one third (33%).[11]

There has not been a great deal of evidence based work on actual diabetic shared care schemes. There has been a paper published for the first twelve months operation of the Kettering shared care scheme. This was for the period from April 1995 to March 1996.[12] This scheme was an optometric practice based scheme for monitoring the eye care of diabetic patients in the Kettering health area of Northamptonshire.

This scheme involved diabetic patients attending participating optometric practices for an annual sight test and eye examination including a dilated fundus examination. This scheme was conducted with the full cooperation of the general practitioner and under case review of the hospital based specialist.

The Kettering scheme screened a large number of patients with a figure of 1781 quoted in the literature. The scheme also had a large number of optometrists participating, 44 optometrists from 26 practices. These optometrists screened 34% of the projected diabetic population of the Kettering health area, which represented a reasonable level of service provision within a geographical location.[12]

There were training issues that were highlighted, as 10.8 % of those screened were referred requiring ophthalmological assessment. However, only one third received treatment and/or a second review over the audit period.

In Preston in 2002, Hulme et al evaluated a district wide diabetic retinopathy screening service. This service involved optometrists using slit lamp and Volk lenses. The ophthalmologist performed an audit of the optometrist screening.[13]

This Preston audit was undertaken over a longer period of time compared to the Kettering audit, 4 years vs.1 year respectively. The Preston audit also highlighted optometrist sensitivity and specificity for any retinopathy. The sensitivity for any disease was 72% and the specificity was 77%.

Okoli et al in the same year as the Preston audit, in Barnet gave the results of a detailed evaluation of three models of diabetic retinopathy screening ahead of setting up a screening programme.[14]

The first was a GP-led model which involved using a single reflex lens camera and indirect ophthalmoscopy, the results were interpreted by an orthoptist. The second was an optometrist scheme which had a similar structure to the GP-led scheme but with the camera rotating between optometrists. The third was another optometrist model which involved indirect ophthalmoscopy conducted in their own practice with resulting interpretation.

There were a large number of patients screened between March 1998 and August 2000. The number quoted was 2230 diabetic patients. They compared coverage details of the models, with the GP led model achieving 63% coverage and the two optometrist models 24%.[14]

A year later in Stockport, Warburton et al researched the sensitivity and specificity for sight-threatening eye disease of the diabetic retinopathy screening scheme.[15]

In Dorset, a diabetic eye screening service using optometrists has been running for 20 years. The service has been utilising digital photography since the 1st January 2007 to comply with national standards.[16]

2.1.3.5.2 Cataract Shared Care

Cataract shared care schemes involving optometrists have included direct referral schemes as well as pre-op and post-op assessments. In 2009 Park et al compared the quality of referrals and listing rates of direct optometric referrals against GP referrals for cataract surgery.[17]

There were 124 patients referred, 62 were from the optometrist direct referral pathway and 62 from the traditional GP pathway. The outcomes were that optometric direct referral for cataract surgery provided better information with regards to measured vision along with better delivery of pre-operative counselling. In comparison the GP referrals however contained better medical history and drug information and information on personal circumstances. The authors linked these outcomes merely to the scope of clinical practice.[17]

In 2003 a new optometrist-led direct cataract assessment direct referral scheme was piloted in Stockport. This service was developed in conjunction with Stockport Primary Care Trust, Stockport NHS Trust and Stockport Local Optical Committee.[18] The waiting times were found to be short with an average of 10 days between their initial assessment and the cataract assessment. It was deemed that 86% of patients assessed during the pilot were suitable for direct referral. Of these patients, 98% were listed for surgery.[19]

In 2001, Gaskell et al reported on the feasibility of direct referral from optometrists to a one-stop cataract surgery pilot scheme in Ayrshire.[20]

There were 40 community optometrists with 160 patients referred to the one-stop clinic. It was found that all patients achieved a good level of visual acuity post-op with 151 patients achieving 6/12 or better at an average of 31 days post op. It was deemed that 3.7% of patients were referred in-appropriately. It was noted that only 1.8% of referrals were supplemented with additional information from the GP. This suggested that the content of the optometrist direct referral was adequate in the majority of cases.[19]

Newsom et al in Huntingdon, Cambridgeshire conducted a small audit for a direct cataract referral scheme. A sample of 200 referrals was analysed.[21] 100 direct cataract referrals were compared with 100 non-direct referrals. The results showed that similar levels of post-op visual acuity and post operative refraction levels in both routes.[19]

The Cambridgeshire scheme was shown to be an exemplar scheme with an excellent relationship between community optometry and secondary care. The patient satisfaction survey showed a positive response in all areas. A key outcome was that the waiting times dropped from 15 months to 3 months for the entire cataract pathway.[22]

The direct cataract referral schemes have shown improved patient waiting times and patient flow pathway however they have not shown strong evidence regarding the cost-effectiveness of these models.

2.1.3.5.3 Age Related Macular Degeneration Shared Care

These schemes have used community optometrists to detect wet age related macular degeneration (AMD) patients and refer them directly to the hospital eye service for treatment. The aim of these schemes has been to achieve rapid access to treatment for patients with wet AMD.

In the Brighton AMD project four community optometrists with special interest (COSI) assessed patients in their optometric practices between January 2005 and August 2006. Any patients found to have wet AMD were referred on to the hospital eye service.[19]

All the assessments were reviewed by the Consultant Ophthalmologist. It was found that 51% (48/94) of the patients that were diagnosed by the community optometrist as having suspected or actual wet AMD were actually true positives. 3% (5/157) of the assessments were found to be false negatives. It was found that 34% (53/157) of cases were confirmed with a diagnosis of wet AMD. 20% (10/50) of these were treatable. The mean time from referral to a COSI to treatment was 12 days, for the 9 patients treated for wet AMD for whom the treatment was recorded.[19]

In the Waltham Forest AMD scheme local community optometrists were used to assess patients and refer any that needed treatment for wet AMD between the period March and September 2005.[19] There were 6 patients referred through the pathway during this period. The proforma used in the scheme was developed from the action on cataracts proforma. It was found that the number of referrals thorough the new pathway was lower than expected. There was no fee structure for the referring optometrists.[19]

The Brighton AMD scheme seemed to achieve the aim of rapid access of AMD patients. The Waltham Forest AMD scheme had lower referrals and therefore did not perform as well as the Brighton scheme.

2.1.4 Distribution of Community Optometrists

The majority of community optometrists work in large optical chains such as Specsavers, Boots, Vision Express and Optical Express. These large optical chains control approximately 80% of the optical market. The remaining optometric workforce work in independent practices and supermarkets.

Optometrists working for multiples, independents and supermarkets are either employed by the company or work as locum optometrists.

There is a small proportion of optometrists that work for companies providing domiciliary services to the community such as the Outside Clinic.[23]

2.2 Involvement of Optometrists in Hospital and Extended Roles

2.2.1 Standard Roles of Hospital Optometrists

2.2.1.1 Spectacle Refraction

Hospital optometrists perform all types of spectacle refractions in the hospital setting. The types of refractions performed are broadly categorised into adult and paediatric.

Adult refractions include general cases along with complex refractions such as high hypermetropic, astigmatic and myopic prescriptions. The complex cases can also include keratoconic and aphakic patients following cataract surgery. Other common cases include patients with corneal disease and low vision cases.

Paediatric refractions commonly include cycloplegic refractions as well as subjective refractions. These types of refractions are performed so that the outcomes can be used in combination with orthoptic and paediatric ophthalmology findings to arrive at an optimum management plan for the patient.

2.2.1.2 Contact lenses

The contact lens clinics in most hospital eye departments deal with complex contact lens fittings and aftercares. There are a range of patients that are seen in these clinics from keratoconic, anisometropic patients, high prescriptions and corneal cases.

Optometrists working in these clinics use more complex contact lens designs, specialist rigid gas permeable lenses, annual soft lenses and scleral contact lenses. The patients attending these clinics require more regular follow ups due to the complex nature of the fittings.

2.2.1.3 Low Vision

Low vision is defined by the World Health Organisation (WHO) in functional terms as “a person who has impairment of visual functioning even after treatment and/or standard refractive correction, and has a visual acuity of less than 6/18 to light perception, or a visual field less than 10 degrees from the point of fixation, but who uses, or is potentially able to use, vision for the planning and/or execution of a task.[24]

Low vision services are provided in a wide range of settings. There are some based in the hospital eye service or the university setting. There are also some clinics that run in local community optometric practices.

Local societies in the community for the visually impaired may also run such clinics. The Royal National Institute of Blind People (RNIB) in London runs a low vision clinic for the visually impaired.[25]

2.2.2 Extended Roles of Hospital Optometrists

2.2.2.1 Therapeutics

The College of Optometrists run all the examinations for optometrists to become independent prescribers. Optometrists who are independent prescribers take responsibility for the clinical assessment of the patient, make a diagnosis and establish the clinical management required (which may include prescribing where necessary).[26]

The College of Optometrists publishes a series of clinical management guidelines (CMGs) which provide a source of evidence-based information on the diagnosis and management of 60 eye conditions that present in primary care.[27]

The independent prescribing qualification will permit hospital optometrists to sign prescriptions providing the condition and drug is within the remit of the optometrist.

2.2.2.2 Accident & Emergency

At Moorfields Eye Hospital in central London there are optometrists who work in the Accident and Emergency (A&E) department. Mr Scott Hau who is one of the optometrists allowed to work in the A&E department evaluated the optometrist's ability to correctly identify and manage patients with ocular disease in the A&E department of an eye hospital.[28]

He concluded that there was good agreement in both the diagnosis and management plan between optometrists and ophthalmologists. The study highlighted that optometrists could potentially work safely in an A&E department of a busy eye hospital.[28]

2.2.2.3 Cataract

Hospital optometrists have been involved in the pre-screening of patients for cataract surgery. This has included assessing the level of cataract to determine if surgery is warranted. At Barts Health NHS trust, specialist optometrists who work in the cataract clinic are allowed to consent patients for surgery once they have been observed and signed off by the consultant.

Hospital optometrists are also involved in the post-op assessment and management of patients once they have had cataract surgery. At Barts health the optometrists are permitted to manage the drug therapy of cataract surgery patients in conjunction with the consultant.

There are numerous other ophthalmology cataract clinics which incorporate optometrists as a part of a multidisciplinary team which include, amongst others, Moorfields Eye Hospital, Sunderland, Nottingham and Manchester.

At Liverpool hospital, the optometry department provides a biometry service which involves ultrasound measurements which are used in computerised calculations to help surgeons predict the optical refraction outcome and to assist in the intra-ocular lens selection.

2.2.2.4 Glaucoma

Hospital optometrists actively work in glaucoma clinics within hospital eye departments throughout the UK. Optometrists have developed their clinical skills in glaucoma investigation such as Goldmann tonometry, Volk lens examination, gonioscopy and visual fields assessment.

It can also be argued that having hospital optometrists working in glaucoma clinics will develop their skills and ability to manage more complex glaucoma cases. This could be utilised in developing hospital based optometry run glaucoma clinics which would still be under the lead of the consultant ophthalmologist.

Bristol Eye Hospital has been at the forefront of using hospital optometrists to work in an extended role capacity in the glaucoma clinic. They currently have a whole optometrist-led glaucoma shared care department in the hospital.[29]

2.2.2.5 Diabetes

There are numerous hospital eye departments where hospital optometrists are working in extended roles in the diabetic clinics. Their primary roles in these clinics are to perform an external examination, Goldmann tonometry and dilated fundus examination. They work in conjunction with junior doctors and consultants in assessing and grading diabetic retinopathy.

They are involved in arranging optical coherence tomography (OCTs), fundus photography and fundus fluorescein angiography to aid diagnosis. They also conduct follow-up appointments of patients who have had pan retinal photocoagulation laser treatment as well as other types of diabetic laser treatment.

In May 2010, an optometrist-led diabetic maculopathy M1 clinic was set up. Its main aim was to reduce the number of false positive M1 diabetic maculopathy referrals. Additionally, these clinics have been used to manage those patients with confirmed M1 diabetic maculopathy status but who do not require ophthalmologist intervention.[30]

This clinic was audited and they concluded that there were a large number of false positive referrals (true false positives 42%) into the hospital diabetic clinic. The majority of M1 diabetic maculopathy referrals did not require immediate ophthalmological intervention (89% discharged or managed by the optometrist). It was found from the audit that the clinic had high levels of grading specificity and created very low numbers of false positive referrals (7%).[30]

It was found that there was a good level of sensitivity for detecting M1 diabetic maculopathy (75%) and this was in line with previous studies. The audit concluded that the clinic provided a safe way of reducing the number of false positive referrals.

2.2.2.6 Age Related Macular Degeneration

At Moorfields Eye Hospital selected optometrists have been involved in the lucentis clinic. Lucentis also know as ranibizmab is a vascular endothelial growth factor (VEGF) inhibitor. It is used in the treatment of neovascular (wet) age-related macular degeneration.[31] At Moorfields, most intravitreal injections are given by junior doctors or nurses.

At York Hospital there is a consultant-led AMD service, where hospital optometrists examine patients and decide if further treatment is warranted with the consultant being called to administer injections or assist in making decisions on unusual or complex cases.[32]

There has been debate on extending the hospital optometrists role in AMD treatment to administering injections, however many ophthalmologists have been against the idea. The Royal College of Ophthalmologists have suggested the idea of training and accrediting health care practitioners and nurses to administer injections.[33]

2.2.2.7 Paediatric Ophthalmology

In many hospitals optometrists work in conjunction with orthoptists in the triage of paediatric referrals. Optometrists will perform a cycloplegic refraction and a head-mounted indirect ophthalmoscopy and work together with the orthoptists to forward only those patients that really need a consultant opinion.

At Barts Health NHS trust they have set up a paediatric ophthalmology primary care clinic where optometrists and orthoptists triage all the new paediatric referrals to the hospital.

Additionally, at Barts Health, hospital optometrists are permitted to actually work alongside doctors in the paediatric ophthalmology clinics under the guidance of a consultant paediatric ophthalmologist.

2.2.2.8 YAG Laser Capsulotomy

At Moorfields St Georges out reach, certain selected optometrists have been trained to perform YAG laser capsulotomies for posterior capsular opacification following cataract surgery.

It is important to emphasise that the numbers of optometrists doing this technique is small and with the extension of the optometrist's roles into these areas, the development of enhanced clinical governance is essential to ensure safe efficient practice.

2.3 Clinical Governance

2.3.1 Definition

Clinical governance is defined as a framework through which NHS organisations are accountable for continuously improving the quality of their services and safeguarding high standards of care by creating an environment in which excellence in clinical care will flourish.[34]

2.3.2 Clinical Governance Pillars

The following are the pillars of clinical governance:

- Education, training and continuing professional development (CPD)
- Codes of conduct and professional guidance
- Clinical audit
- Research
- Information
- Openness
- Risk management
- Patient and public involvement
- Clinical data management

2.3.2.1 Why is Clinical Governance Important?

Through the years there has been an expansion of the roles of optometrists in terms of shared care schemes involving the community and the hospital eye service.

There has also been an extension of the roles of hospital optometrists into various ophthalmology specialities within the hospital eye service.

As the roles and responsibilities of the UK optometrist change there is a need for the profession to have support to ensure that they are practicing optometry in the safest and most efficient manner possible.

Clinical governance is important to ensure optometrists practice in the safest way for the delivery of optimum patient care. It allows evidence based clinical practice to be applied to patient care and it allows current practice to be assessed and developed along with the knowledge and skills of the clinician. Clinical governance permits the application of risk management to clinical processes to improve safety.

2.3.2.2 Current levels of Clinical Governance in Optometry

There is no legal or contractual requirement for a formal process of clinical governance as a part of the general ophthalmic services (GOS) contract. This is the process through which optometrists and ophthalmic medical practitioners provide NHS sight testing. The College of Optometrists Code of Ethics and Guidelines for Professional Conduct nevertheless contains the principles of good governance.[35]

Primary care trusts (PCTs) are involved in monitoring standards through periodic practice visits to check on GOS contract compliance which may include checking on the maintenance of full and contemporaneous clinical records.

The NHS contract regulations make specific reference to record keeping: "The contractor shall ensure that a full, accurate and contemporaneous record is kept in the patient record in respect of each patient to whom it provides services under the contract, giving appropriate details of sight testing".[36]

A toolkit for clinical governance has been produced by Professional and Representative bodies in Optometry. Quality in Optometry (QiO) is an online resource, which consists of a series of interactive checklists that can be used to compare current practice against defined standards.

2.3.2.3 Clinical Governance in relation to Expanded and Extended roles in Optometry

The QiO consists of various levels, level 1 is for the GOS contract. Level 2 is for enhanced service provision and level 3 is for advanced governance. The QiO also has a record keeping audit, infection control audit and information audit templates.[37]

2.3.2.4 Education and Training

Educating, training and developing staff are essential parts of clinical governance. The importance of education was highlighted in the NHS plan in 2000.[38]

There are opportunities for optometrists to undergo specialist training in different areas of optometry. This training can be done informally or formally through the College of Optometrist specialist diplomas. These include higher diplomas in contact lens practice, glaucoma, low vision, medical retina and paediatric eye care. As a result of recent changes to the medicines legislation, there is the option for optometrists to become therapeutic prescribers. This could be in the form of additional supply optometrists, supplementary and independent prescribers.[39]

Additional supply optometrists are optometrists that have been registered with the GOC for at least two full years and who train in competences which focus on the consultation, prescribing effectively and prescribing in context. Further to this, provided it is in the course of their professional practice and in an emergency, additional supply optometrists can sell or supply prescription only medicines containing certain defined drugs.

Supplementary optometrists are optometrists who set up a voluntary partnership between themselves and an independent prescriber (a doctor or dentist) to implement an agreed patient-specific clinical management plan with the patient’s agreement. It is essential that both prescribers must also share access to a common patient record.

Independent prescribing optometrists are suitably qualified optometrists that are able to prescribe any licensed medicine (except for controlled drugs or medicines for parenteral (injected) administration) for conditions affecting the eye, and the tissues surrounding the eye, within there recognised area of expertise and competence.

Along with the specialist training available through the College of Optometrists, there is less formal training that occurs in various hospital and community settings so that optometrists are able to work in expanded and extended roles. These training programmes vary across the country and there is no standardisation.

This issue has been addressed by the Local Optical Committee Support Unit (LOCSU) who have developed training packages linked to defined eye care pathways that are being taken up nationally.[40]

2.3.2.5 Codes of Conduct and Professional Guidance

Codes of conduct and professional guidance have been developed in relation to independent prescribing optometrists. The College of Optometrists has developed clinical management guidelines (CMGs) for therapeutic prescribers to provide a source of evidence based information on the diagnosis and management of a number of eye conditions that present with varying frequency in primary and first-contact care.[41]

The CMGs represent the consensus view of how an independent prescribing optometrist should manage each specific condition. A requirement for these CMGs is that the diagnosis and management of the condition should fall within the area of the optometrist's expertise.

2.3.2.6 Clinical Audit

Clinical audit is defined as a quality improvement process that seeks to improve patient care and outcomes. The QiO and the College of Optometrists websites both have very clear and helpful frameworks.

Active audit within enhanced service provision is growing, however there is a need for best practice to be established to allow the audit process to be effective. An example of an audit in this area is in Hinchingbrooke, where direct referrals from accredited optometrists were audited against current best evidence.[21]

Good clinical audit is essential given the ever expanding roles of optometrists. An in-built audit process is recommended with the introduction of any new service.

2.3.2.7 Research

The establishment of best practice is essential to any service provision. There have been a large number of processes that have been introduced but there has been little or no assessment of cost-effectiveness or acceptability (to patients or practitioners). To date the only cost-effectiveness study was undertaken for a novel care delivery pathway in Bristol. The results showed the model not to be cost-effective due to re-referrals back into the hospital eye service.[42]

There is a clear requirement for more research and assessment of public, patient and practitioner attitudes to optimise service provision.

2.3.2.8 Openness

There are two aspects to openness. The first is professional openness, where optometrists look at their clinical practice and openly acknowledge deficiencies in order to develop remedies. The second is public scrutiny in optometric processes and care. Openness is supported by the freedom of information act.[43]

Critical incident reporting is a system of reporting a significant adverse event that has led to harm, or could have led to harm if it had been allowed to progress.[44] All of these aspects of openness are essential to expanded and extended roles in optometry in order to ensure optimum and safe clinical practice.

2.3.2.9 Risk Management

Risk assessment is essential in developing risk management policies which would be adequate to the scope of practice of standard, expanded and extended optometric roles. The Quality in Optometry and College of Optometrists website both give information on the principles of risk management in optometry.

As optometry expands into enhanced services such as glaucoma shared care and diabetic shared care, there is a need for the risk management to be developed to support the expanded role. Similarly, optometrists working in extended roles within the hospital eye service such as medical retina, cataract and those who are involved in YAG laser procedures require relevant and adequate risk management guidelines in place to support the role.

2.3.2.10 Clinical Data Management

The sharing of patient information is essential in the effective and safe management of patients. Optometry generally has poor accessibility to patient information outside local practice.

The spine is part of the NHS Care Records Service, which is creating an electronic care record for all the UKs over 50 million patients. It is a national central database where a summaries of patient records are stored.[45]

At present optometry is not linked to the national spine, however this needs to be changed to allow for the inclusion of optometry. This would help in the integration of optometry and ophthalmology which would be very beneficial in expanded roles within enhanced service provision.

The inclusion of optometry into the national spine would be particularly beneficial as the profession expands into therapeutics and independent prescribing. This would allow access into patient clinical records and medical history to prevent patient safety issues arising e.g. drug interactions.

2.3.3 Future of Clinical Governance in Optometry

Currently optometry is already practising clinical governance in many areas. The roles within the profession are changing and optometrists need to be aware of new issues that might arise as a result of these changes.

Expanded and extended roles have created additional need for a more rigorous and formal process of clinical governance, with a greater priority on training, risk management and audit.

2.4 Glaucoma

2.4.1 Definition

Glaucoma is defined usually as a chronic progressive optic neuropathy associated with characteristic structural damage to the optic nerve and associated visual dysfunction that may be caused by various pathological processes.[46]

2.4.2 Classification

2.4.2.1 Types of Glaucoma

There are many different ways in which glaucoma can be classified. Glaucoma can be divided into primary and secondary types. It can also be classified by age of onset (acquired or congenital), or by open and closed angles.

In primary glaucomas, there can be elevated intraocular pressures or more rarely intraocular pressures within the normal range which is called normal tension glaucoma.[47] In secondary glaucomas, the main aqueous outflow route becomes obstructed which results in raised intraocular pressure.

2.4.2.2 Glaucoma Classification

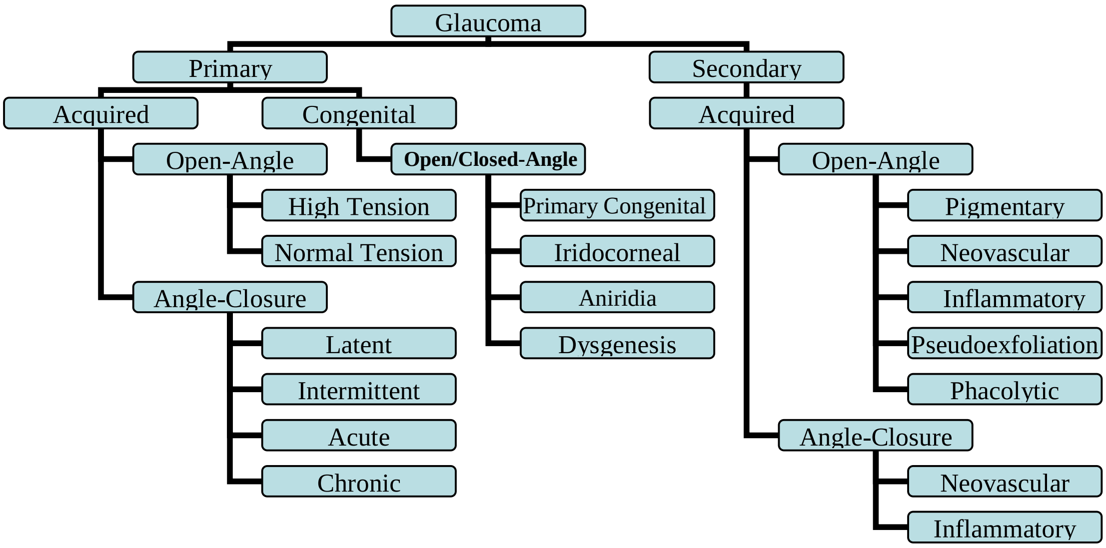

Figure 2.1: Glaucoma classification

The diagram above shows that glaucoma can generally be divided into primary and secondary glaucoma. Primary glaucoma can be further sub-divided into acquired or congenital. Both of these categories can be split into open and closed angle. Secondary glaucoma is only of the acquired variety and can also be divided into the open and closed angle.

The primary acquired angle closure glaucoma is classified in relation to the duration and speed of onset. The primary congenital open and closed angle glaucoma is classified in terms of anatomical features. The secondary acquired open and closed angle glaucoma are classified due to the underlying causes such as for example inflammatory or vascular factors.

2.4.2.3 Primary Open Angle Glaucoma

In the past it was a widely held belief that raised intraocular pressure was a defining characteristic of glaucoma. However there have been several population based studies that have shown typical glaucomatous optic disc changes and field damage even though the patient has had a statistically normal IOP.

Sommer however described the link between IOP and POAG as a broadly speaking dose-response relationship and he suggested that the association between the two was a more casual one. He highlighted the importance of taking other risk factors into consideration.[48]

2.4.2.4 Levels of Evidence

Foster states that the vertical cup-disc ratio is a continuous variable within the population. There is overlap between the range of cup-disc ratios in those with and without glaucomatous visual loss. They also discuss the complex relationship between vertical cup-disc-ratio and proved visual field abnormalities.[46]

This has led Foster et al to propose that the levels of evidence be used to classify cases of glaucoma. The highest level of certainty requires optic disc abnormalities (vertical cup to disc ratio >97.5th percentile in the normal population) and visual field defect compatible with glaucoma.

In the second level they state that if a visual field test could not be performed satisfactorily, a severely damaged optic disc (vertical cup to disc ratio>99.5th percentile of the normal population) would be sufficient to make the diagnosis.

Finally, they propose that if the optic disc could not be examined due to media opacities and, hence, a visual field test was not possible then an IOP >99.5th percentile of the normal population or evidence of previous glaucoma filtering surgery, may be enough for the diagnosis of glaucoma.

Foster et al therefore recommend that POAG is defined as optic nerve damage meeting any of the three criteria above, in an eye which does not have evidence of angle closure on gonioscopy, and where there is no identifiable secondary cause.[46]

The purpose of Fosters classification was primarily for agreement in studies so there was cross comparability between glaucoma studies.

2.4.2.5 Primary Angle Closure and Narrow Drainage Angles

According to population based surveys in African and Asian settings [49-52], the dramatic acute symptomatic phase occurs only in a minority of those with diagnosed primary angle closure glaucoma (PACG). Instead a chronic, asymptomatic form of PACG predominates. Foster et al suggest a full re-evaluation of the definition of the disease is appropriate with emphasis on visual loss rather than symptomatic disease.

They suggest it would be useful to distinguish between the mechanism through which the intraocular pressure (IOP) becomes elevated and the resultant damage that is caused by PACG. Therefore, patients classified with primary angle closure (PAC) would be those who meet gonioscopic criteria for narrow angles and with evidence of significant obstruction of the functional trabecular meshwork by the peripheral iris. Conversely those in whom PAC had led to significant glaucomatous damage to the optic nerve would be defined as having PACG.[46]

2.4.2.6 Glaucoma with Secondary Ocular Pathology

Foster et al estimate the proportion of glaucoma damage that is secondary to other ocular or systemic disease or trauma may be as much as 20% of all glaucoma.[46]

Secondary glaucoma is defined as those eyes in which a second form of ocular pathology has caused IOP above the normal range, leading to optic nerve damage. Foster et al propose that the diagnosis of secondary glaucoma only be based on the presence of optic neuropathy, in the presence of a second ocular pathological process, which may include neovascularisation, uveitis, trauma or lens related pathology.

2.4.2.7 Glaucoma Suspects

A glaucoma suspect describes a person with one or more risk factors that may lead to glaucoma including an optic nerve or nerve fibre layer defect suggestive of glaucoma, a visual field abnormality consistent with glaucoma, an elevated IOP of greater than 21mmHg. However further follow up appointments are needed over time to confirm the diagnosis.

2.4.3 Risk Factors

2.4.3.1 Risk factors for Primary Open Angle Glaucoma

The International Glaucoma Association (IGA) list the risk factors for POAG as follows:[53]

2.4.3.1.1 Age

POAG becomes more common with increasing age. It is uncommon below the age of 40 but affects 1% of people of European origin over the age of 40 and about 4% of those over the age of 80.[54]

2.4.3.1.2 Ethnicity

If a person is of African-Caribbean origin, they are about four times more at risk of POAG than a person of European origin, and the disease may have onset at a younger age and have greater severity.[54]

2.4.3.1.3 Intraocular Pressure

Leske et al investigated the POAG risk in the Barbados Eye Studies. They concluded that elevated intraocular pressure increased risk.[55;56] Leske et al further investigated the risk factors for incident open-angle glaucoma over a 9 year follow up. Intraocular pressure was again found to contribute to risk.[57]

2.4.3.1.4 Family History

Tielsch et al investigated the association between family history and the risk of primary open angle glaucoma by using data from the Baltimore Eye Survey. They found that age-adjusted associations of primary open angle glaucoma with a history of glaucoma were higher in siblings than in parents or children. They concluded that family history was an important risk factor for primary open angle glaucoma, although they felt that clinic-based studies were likely to overstate its impact.[58] In cases of a positive family history, the importance of an eye examination is stressed.

2.4.3.1.5 Myopia

People with a high degree of myopia or short sightedness are more prone to POAG.

2.4.3.1.6 Vascular Factors

If a patient suffers from migraine or cold hands and feet, then that patient maybe more at risk of normal tension glaucoma (NTG).

2.4.3.1.7 Diabetes

The link between diabetes and POAG has been controversial. However, a detailed meta-analysis of studies by Bonovas et al showed that diabetic patients are at significantly increased risk of developing primary open angle glaucoma.[59]

2.4.3.1.8 Thin Corneas

Leske et al also found as a part of their investigation into risk factors for incident open-angle glaucoma that having a thinner central corneal thickness was also a risk factor.[57] [54]

2.4.3.2 Risk factors for Primary Angle Closure Glaucoma

2.4.3.2.1 Age

As a person gets older there in an increase in the risk of developing PACG. This may be because as you get older cataract can form resulting in thickening and narrowing of the anterior chamber drainage angle.[60]

2.4.3.2.2 Ethnicity

Persons of Asian or Eskimo descent often have narrower angles than Caucasians. This can predispose them to PACG.

2.4.3.2.3 Gender

PACG is more common in females than in males. It is generally believed that females compared to males have smaller eyes and hence smaller anterior chambers and narrower drainage angles.

2.4.3.2.4 Hyperopia

Hyperopic or far-sighted people tend to have smaller eyes compared to near-sighted or myopic people. The smaller anterior chamber depth and narrower drainage angle increase the risk of PACG.[60]

2.4.3.2.5 Positive Family History

It has been reported that up to 20% of relatives of PACG patients have anatomically narrow drainage angles. It is generally believed that eye size is inherited, which could explain the inheritability of PACG.

2.5 Expanding Problem

2.5.1 Population Trends

In England the male period life expectancy at birth rose from 71.7 years in 1985 to 79.8 years in 2015, an increase of 8.1 years. In the future, it is projected to increase a further 4.0 years to 83.8 years in 2035.

The female period life expectancy at birth rose from 77.4 years in 1985 to 83.6 years in 2015, an increase of 6.2 years. In the future, it is projected to increase a further 3.5 years to 87.1 years in 2035.[61]

There are similar patterns exhibited for cohort life expectancy, however it is important to mention that the increases are smaller than period life expectancy. Under the main projection, cohort life expectancy at birth rose 5.2 years for males and 4.6 years for females between 1985 and 2015. Between the period of 2015 and 2035, the cohort life expectancy at birth is projected to increase by 3.0 years for males and 2.8 years for females.[61]

2.5.2 Definitions

2.5.2.1 Period Life Expectancy at Birth

This is defined as the average number of years a person would live, if he or she experienced the age-specific mortality rates at the time of their birth throughout their life.[61]

2.5.2.2 Cohort Life Expectancy at Birth

This is calculated using age-specific mortality rates which allow for known or projected changes in mortality throughout a person's life.[61]

2.5.3 Glaucoma Prevalence

The Beaver Dam study undertaken by Klein et al determined the prevalence of glaucoma in Beaver Dam. They found that the overall prevalence of definite open-angle glaucoma was 2.1%. It was also found that prevalence increased with age from 0.9% in people 43 to 54 years of age to 4.7% in people 75 years of age or older. They concluded that the prevalence of open-angle glaucoma in Beaver Dam was similar to other white populations.[62]

Quigley et al carried out a study to estimate the number of people with glaucoma worldwide in 2010 and 2020. He predicted that there would be 60.5 million people with open glaucoma and angle closure glaucoma in 2010, increasing to 79.6 million by 2020. He also predicted that bilateral blindness would be present in 4.5 million people with open angle glaucoma and 3.9 million people with angle closure glaucoma in 2010, rising to 5.9 and 5.3 million people in 2020, respectively.[63]

The World Health Organisation has stated that new statistics show that glaucoma is now the second leading cause of blindness globally, after cataracts. Glaucoma, however presents a greater challenge to public health than cataracts because the blindness it causes is irreversible.[64]

2.5.4 Expanding Hospital Glaucoma Clinics

The Beaver Dam study showed that the prevalence of glaucoma increased with increasing age. This factor coupled with the Office for National Statistics data which shows that life expectancy is increasing, means that there are going to be increased volumes of glaucoma patients attending hospital glaucoma clinics in the UK.

These glaucoma patients require lifelong review hence there is going to be a sustained and increasing demand placed on hospital glaucoma clinics.

The ratio of patients to ophthalmologists is another factor in hospital glaucoma clinics. According to the Royal College of Ophthalmologists response to liberating the NHS: Eyecare, making a reality of equity and excellence by Professor Nick Bosanquet, less than 1% of all medical students will proceed to a career in Ophthalmology.[65]

2.6 Glaucoma Pathways

2.6.1 Current Standard Diagnostic Management Pathways for Glaucoma Patients

The current standard model involves an optometrist based eye examination in the community. Any glaucoma suspects are referred on to the GP usually using the standard GOS18 referral form. The GP adds relevant medical history to the referral and counter signs. The GOS 18 is sent to the hospital eye service.

The consultant led hospital glaucoma clinic will perform standard glaucoma investigations for the patient as well as baseline measurements. The patient will be followed up with repeat measurements before a diagnosis is made. If a positive diagnosis is made, then an appropriate management plan will be implemented and the patient will be followed up as necessary.

2.6.2 National Institute for Health and Care Excellence (NICE) Guidance on Glaucoma

The original National Institute for Health and Care Excellence (NICE) guidance on glaucoma was issued in April 2009.[66] They defined Ocular Hypertension as untreated IOP above 21mmHg, confirmed on repeated assessment. They also stated that Ocular Hypertension be formally diagnosed using Goldmann applanation tonometry (slit lamp mounted), Pachmetry, Gonioscopy, automated perimetry (central thresholding) and optic nerve assessment, with dilated slit lamp binocular indirect ophthalmoscopy.[67]

These guidelines were revised on 27th January 2010 as detailed by the Local Optical Committee Support Unit. The main guidance in the revision was the definition of ocular hypertension and the clinical tests that have to be carried out to confirm the diagnosis and also to monitor the condition. The essential tests were slit lamp mounted Goldmann tonometry, pachmetry and gonioscopy.[67]

These essential clinical tests are beyond the requirements of general ophthalmic sight testing. The potential impact of these revised guidelines on the standard referral pathway of patients from the community optometrist to the hospital glaucoma clinic would be an increase in referrals of potential ocular hypertensive patients. These patients would be referred for essential clinical tests to be performed to aid in diagnosis.

The Association of Optometrists guidance in response to the NICE Guidelines on glaucoma was to advise all its members to refer all patients with a repeated intra-ocular pressure over 21 mmHg to an ophthalmologist.[67]

The Joint College of Ophthalmologists and Optometrists gave guidance on certain aspects of the NICE glaucoma guidelines. The NICE glaucoma guidelines recommended that certain areas of Glaucoma-related work should be undertaken only by an optometrist with a specialist qualification or who is working under the supervision of a consultant ophthalmologist.

The Guideline did not define the term working under the supervision of a consultant ophthalmologist. The purpose of the joint college guidance was to set out principles of supervision in the context of the NICE Guideline on Glaucoma.[68]

The guidance also gave advice on non-referral in specific scenarios. They suggested that practitioners may consider not referring patients at low risk of significant visual field loss in their lifetime. These include patients aged

80 years and over with measured IOPs <26mmHg with otherwise normal ocular examinations (normal discs, fields and van herick). The other category was patients aged 65 and over with IOPs of <25mmHg and with otherwise normal ocular examinations (normal discs, fields and van herick). It was advised that these groups of patients be reviewed by a community optometrist every 12 months.[69]

2.6.3 Community Optometrist Practice Equipment

The large optical chains such Specsavers, Boots, Vision Express and Optical Express attempt to standardise the equipment and layout of all their practices as a part of their business model. However, there can be variability between optical chains and to a greater degree between multiples and independents.

There is a large variation between practices. Different practices have a range of equipment such as Heidelberg Retinal Tomography (HRT), Goldmann tonometers, Fundus cameras, Optical coherence tomography and Humphrey Visual Field Analysers. There are however practices that use non-Humphrey field equipment and non-contact tonometry. There is also a variation in the skill sets of community optometrists with some able to perform additional clinical examinations such as Volk lens examination, Goldmann tonometry, HRT interpretation and gonioscopy.

These differences in practice equipment and clinical skills have the potential to impact on the quality of referral from the community to the hospital glaucoma clinics.

Strong in 1992 published the results from a survey which was undertaken in Leicestershire. One aspect of the survey examined what facilities optometrists had for glaucoma screening and what tests were performed. The results showed that all the respondents examined the optic discs of all the patients. 99% of the optometrists had tonometry available but most used it selectively, based on age, family history and disc appearance.[70]

Although 88% had field testing equipment, this was not usually the type likely to be effective in screening a general population. 38% had automated or semi-automated perimetry. This survey was performed over 20 years ago and it is reasonable to expect that the outcomes may be different based on current optometric practice.

In 1998 Vernon published his findings after investigating any changes in optometric referral patterns for suspected glaucoma over a 5-year period. He found that the increased false positive rate appeared to be associated in part due to the increased use of visual field analysers by optometrists. Prior to referral, he found that optometrists performed visual fields on 28% of patients in 1988 and on 48% in 1993 ($p<0.01$).[71]

In 2008 Myint et al carried out a national web-based survey to determine current diagnostic tests used by optometrists in glaucoma case finding. The survey was open for 16 weeks between April and July 2008. The results showed that direct ophthalmoscopy was only used by 25% of respondents with the majority (62%) using a combination of direct and slit-lamp binocular indirect methods.[72] The assessment of intra-ocular pressure was mainly undertaken using non-contact tonometry (78%) with only 16% routinely using a Goldmann or Perkins applanation tonometer. The perimeter frequently used was either one from the Henson range (39%) or the Humphrey Field Analyser (22%).

It was concluded that only a small number of optometrists (<5%) had access to specialised imaging equipment, such as HRT, GDx or OCT. One of the conclusions of the study was that there was a lack of standardisation with respect to equipment used by the optometrists.[72]

2.6.4 Community Optometrist Glaucoma Referrals

Prior to the National Institute of Health and Care Excellence (NICE) guidelines (Glaucoma: diagnosis and management of chronic open angle glaucoma and ocular hypertension) in April 2009, a review of the literature showed that the false positive rate for optometric referrals was approximately 40%. In 2011 Shah and Murdoch investigated the impact of the publication of the NlCE guidelines (Glaucoma: diagnosis and management of chronic open angle glaucoma and ocular hypertension), on the referrals for suspect glaucoma to Moorfields Community Eye Clinic (MCEC) at Ealing hospital.[73]

A total of 110 new referrals were assessed during the collection period. This reflected a significant increase in numbers attending. However, there was no increase in the absolute numbers of glaucoma and glaucoma suspects identified. The Positive Predictive Value (PPV) fell to 0.25, which was lower than found in previous studies.[73]

This made the investigators question what advantage in improved case detection the NICE guidelines represented and whether this was a cost effective strategy.

A comparative study of glaucoma referrals in Southeast Scotland looked at the impact of the NICE guidelines. They concluded that that the NICE guidelines have provided clinical guidance without increasing the number of referrals. This was in contrast to Shah et al’s finding.[74]

2.6.5 Community Optometrist Referral Letters

In general community optometrists complete a GOS 18 referral form to be sent to the GP when referring a patient on for hospital ophthalmological investigation. Even though the GOS 18 form is detailed, there can be variability in terms of referral content between optometrists.

The NICE guidelines on Glaucoma give evidence based professional guidance. They don't give recommendations on what should be detailed in community optometrist referral letters.

Lash et al undertook an audit on the information included on GOS18 forms used by UK optometrists when referring patients to an ophthalmologist. A total of 444 forms were analysed. They found that the two most common referral categories were cataract 36.7% (n=163) and glaucoma 18.4% (n=82).[75]

They found that only 7% (n=11) of cataract referrals included information on a patient's lifestyle and willingness for surgery. They also found that 82% (n=67) of referrals for glaucoma included disc assessment, intraocular pressure and visual fields. Five per cent (n=22) of optometrists gained the patients consent for release of clinical information. The audit found that 31% (n=137) of forms had no practitioner name and 6% (n=27) gave no practice address.[75]

The main conclusions from the audit were that information included on GOS 18 forms could be improved with regard to cataract referrals. It was also found that inclusion of practitioner/practice details and completion of the consent section on the GOS 18 would improve ophthalmologists feedback.[75]

Scully et al in their study evaluated the quality of content of optometrist-initiated glaucoma referral letters arriving at the appointment booking centre at Moorfields Eye Hospital (MEH). The results from the study showed that forty-nine per cent of referral letters were found to be of “acceptable” quality. 7% “ideal” quality and the remainder classed as “fail”. The main reason for failure was an omission of non-clinical information, including patient and/or referring practice details.

It was found from the investigation that 26% of letters failed to include an optic disc evaluation and 6% failed to provide intra-ocular pressure measurements. Two-thirds of ‘acceptable’ letters did not reach the ‘ideal’ standards due to a lack of discussion of risk factors, visual field analysis or recommendation for referral speed.[76]

The results from this study indicate a need to improve the quality of optometric glaucoma referral letters, especially with respect to completion of all the items set out on the GOS 18 referral form. This outcome coincided with the results from the Lash et al audit.

2.6.6 Referral Refinement Schemes

Referral Scheme	Description	Key Outcomes
Manchester Community referral refinement (2000)[77]	Suspect glaucoma patients in Manchester were referred to a group of specially trained community optometrists. After being assessed these patients were either referred to the hospital eye service or sent back to the optometrist.	The number of suspect glaucoma cases referred to the Manchester Royal Eye Hospital was reduced by 40%. The scheme also produced a small financial cost saving to the NHS of approx £17 per patient.
The Carmarthenshire glaucoma referral refinement scheme (2009)[78]	Trained optometrists were used to examine and investigate the patients referred with suspected glaucoma in order to reduce false-positive rates in accordance with an agreed protocol.	The total number of referrals to the HES was reduced by 53% with a cost saving of £117 per patient.
The Community and Hospital Allied Network Glaucoma Evaluation Scheme (CHANGES) (2006)[79]	Eight optometrists with a specialist interest in glaucoma were trained to perform a community-based comprehensive glaucoma evaluation of low-risk glaucoma hospital referrals using equipment standardized to that of the Hospital Eye Service (HES)	138 (27%) of a total of 512 glaucoma-related referrals were deemed 'low risk'. The optometrist discharged 40 (35%). There was good agreement between the optometrist and the consultant for the 99 referred patients.
Bridlington Eye Project (2011)[80]	This study analysed referrals for OHT in people over 65 years of age by community optometrists post-NICE guidelines.	This study found that if community optometrists used Goldmann Applanation Tonometry and Pachymetry along with joint College

		guidelines, referrals for OHT could be reduced to 1/5th of those under previous guidance (Vernon et al 2011). The study identifies potential savings of £16,463,570. This figure is based on the assumption that in England and Wales in 2009, 4.3 million sight tests were performed on patients aged over 65 years.
LOCSU repeat readings Ocular hypertension monitoring pathways (2009)[81]	Evaluation of data in Stockport, Bexley and North Tyneside PCTs	There was up to 76% reduction in referrals following the implementation of the scheme. The scheme assumed savings of £87 per patient from averted hospital referrals.

Table 2.2: Referral refinement schemes

2.6.6.1 The Manchester Community Refinement Scheme

This scheme was one of the early schemes of glaucoma referral refinement that investigated the impact on suspect glaucoma referrals and cost analysis. This study found a 40% reduction in the number of suspect glaucoma cases referred to Manchester Royal Eye Hospital.[77] The authors found that this figure was close to the percentage of false-positive referrals measured at Manchester Royal Eye Hospital before the study started.

This scheme used specially trained community optometrists working to an agreed set of referral criteria to examine patients with suspected glaucoma who had been referred to them instead of going through the normal referral process with the GP. They concluded that community refinement of suspect glaucoma was beneficial when compared to the current referral pathway.[77]

Murdoch and Theodossaides wrote an editorial in response to the Henson et al paper. They wanted to highlight the epidemiological principles behind the Manchester scheme. They felt that epidemiological principles could explain the Henson et al findings regarding the similarity between the accredited optometrists discharging false positive value and the false positive value at the hospital prior to the commencement of the scheme. The similarity may simply be explained due to the enriched sample which presented to the accredited optometrists rather than being attributable to better patient examination or decision making. Murdoch and Theodossaides discussed further the need to investigate the false negatives. They suggested optimising the optometrist accreditation process.[82]

2.6.6.2 The Carmarthenshire Glaucoma Referral Refinement Scheme

The Carmarthenshire referral refinement scheme aimed to explore the false positive and false negative aspects of glaucoma referral refinement. The aim of this scheme was to report on the success of this model as well as assess and attempt to control for the false negatives.[78]

The scheme used trained optometrists to examine patients referred as glaucoma suspects before deciding whether they actually needed a hospital referral. 100 random files of patients who were referred onwards to the hospital and 100 files of patients who were retained in the community were analysed to determine the efficiency and safety of the scheme.

The scheme resulted in a 53% reduction in the total number of referrals to the hospital eye department. There was an associated cost saving of £117 per patient. 83% of those patients referred resulted in a diagnosis of glaucoma or retention of patient within the hospital.

There was good correlation between hospital and optometric measurements and analysis of notes of those patients not referred indicated no compromise on patient safety.[78]

The Carmarthenshire referral refinement scheme did not perform a power calculation therefore the exact reliability of the outcomes cannot be confirmed especially as the outcome of disease is relatively rare. They also did not perform a sample size calculation hence selecting 100 files to assess safety may not be sufficient.

2.6.6.3 The Community and Hospital Allied Network Glaucoma Evaluation Scheme

Bourne et al in 2010 described the design, activity and quality of the referral refinement phase of their glaucoma shared care scheme. Their scheme was called the Community and Hospital Allied Network Glaucoma Evaluation Scheme (CHANGES).

Eight community optometrists with a specialist interest in glaucoma were accredited to assess and evaluate 'low risk' glaucoma hospital referrals. The equipment used in the community assessments was standardized to that of the hospital glaucoma service.[79]

Of all the referrals 138 (27%) were deemed 'low risk'. The optometrist discharged 40 (35%) of which the consultant agreed virtually with 28 (70%) using a link to the electronic patient record. A comparison was undertaken between the optometrist and consultant for 99 referred patients. There were good levels of sensitivity, specificity and negative predictive values for various aspects of the examination.

The CHANGES scheme reached the same conclusion as the Manchester and Carmarthenshire schemes, whilst showing in more detail that a high level of examination quality was retained.

2.6.6.4 The Local Optical Committee Support Unit (LOCSU) IOP Refinement Enhanced Service Pathway

This pathway was designed to provide support services for local optical committees (LOC) in coping with the increase in referrals of patients with raised pressures. The scheme was designed to minimise the additional glaucoma referrals to the hospital eye service, reducing patient anxiety and increasing capacity within the already over stretched hospital glaucoma clinics.

The pathway provided a more cost effective service with greater patient numbers managed within the primary care setting. In order to support the scheme, LOCSU developed an electronic reporting system for the pathway.

NHS Stockport was one of the first PCTs to adopt the LOCSU IOP Refinement pathway, and the first to pilot the electronic reporting system. In the first 6 months of operation in Stockport, 311 patients were rechecked under the LOCSU scheme and 240 or 77%, were deflected from the referral that would have occurred due to NICE. 59% were deflected by just one repeat, with a further 18% deflected by the 2nd repeat. It was found that only 40% needed a 2nd repeat measure. The savings are considerable, with Stockport projecting savings of around £80000. Currently 77% of the practices in the area are using the system.[81]

2.6.6.5 The Bexley Referral Refinement Scheme

There were two optometric-led enhanced glaucoma referral schemes in the Bexley Care Trust area. Over a 12-month period all suspect glaucoma/ocular hypertension (OHT) referrals from optometrists relating to patients registered with Bexley GPs were analysed. All these patients were examined under one of two schemes.

One was an enhanced glaucoma repeat measure (EGRM) scheme in which the referring optometrist conducted the repeated tests him/herself prior to referral or non-referral. The alternative was a refinement pathway (RCAS) using a small team of accredited community optometrists.

During 2007, repeat measures using the EGRM scheme resulted in 76% of patients not being referred. In 44.5% of all EGRM patients, where raised IOP was found by non-contact tonometry (NCT), repeated measurement by Goldmann/Perkins tonometry resulted in readings that were <22mmHg, or that had less than a 5mmHg difference between the two eyes.

An economic review of the schemes demonstrated that the EGRM achieved 62% saving when compared with HES tariff while RCAS resulted in a saving of 3.5%. They concluded that using a primary care repeat measurement scheme to support referral decision-making demonstrated substantial cost benefit while onward referral for refinement was essentially cost-neutral compared with HES tariff.[83]

A similar LOCSU pathway was setup in North Tyneside. The enhanced assessment of intra-ocular pressure lead to a 50% avoidance in referrals to glaucoma outpatient clinics.

2.6.6.6 The Bridlington Referral Refinement Scheme

Vernon et al in 2011 constructed an epidemiological based model using

Bridlington eye assessment project (BEAP) data. Ocular hypertensive suspect data was subjected to two algorithms (Association of Optometrists (AOP) and Joint College).[67-69] This was in order to determine referral of suspects if community optometrists followed either algorithm.

The BEAP data showed that 85 of 1643 people (5.2%), with normal acuity and visual fields, recorded Goldmann IOPs of >21mmHg in either or both eyes. In the absence of pachymetric information, all 85 would be referred under the AOP algorithm, decreasing to 31 (1.9%) under the joint College algorithm. This represented a 63% reduction. If central corneal thickness readings influenced referral, 39 (2.4%) would be referred as a result of the AOP algorithm and 13 (0.8%) under the joint College algorithm.

The authors reached the conclusion that if community optometrists use

Goldmann tonometry and pachymetry, following the joint College guidelines, referrals of OHT suspects could be reduced to a 1/5th of those under the original AOP guidance. It was recommended that community optometrists should be encouraged to use Goldmann tonometry and pachymetry in order to refine referrals when another examination is normal.

The study identifies potential savings of £16,463,570. This figure was based on the assumption that in England and Wales in 2009, 4.3 million sight tests were performed on over-65s.[80]

2.6.6.7 The Health Innovation and Education Cluster Glaucoma Pathway Project

This project was designed to assess the impact of referral refinement on the number of patients referred to, and first visit discharges from, the hospital eye service in relation to NICE glaucoma guidelines, joint College guidance guidelines (JCG) and NICE commissioning guidance. (see section 2.6.2).

There were two groups of patients examined between 2006 and 2011. The first group was low-risk referrals that were examined by optometrists with special interest in glaucoma (OSI).

The second group was high risk referrals which were referred directly to the hospital eye service. Two thousand nine hundred and twelve patient records were analysed. The highest consultant first contact discharge rates were for referrals based on IOP alone (45% for IOP 22-28mmHg) and IOP asymmetry (53%), visual field defect alone (46%) and for abnormal IOP and visual field (54%).

The lowest first visit discharge rates were for referrals for suspicious optic disc (19%) and IOP>28mmHg (22%). 73% of patients aged 65-80 and 60% of patients aged >80 referred by the OSI due to IOP between 22-28mmHg would have satisfied the JCG criteria for non-referral. 6% fewer referrals would have resulted if the NICE commissioning guidance was followed, for patients referred with an IOP>28mmHg and otherwise normal examination. In 2010 this scheme reduced the number of patients attending the hospital eye service by 15%, which resulted in a saving of £16 258 (13%).

This project shows that referrals for a raised IOP alone or in combination with an abnormal visual field could be classified as low-risk and undergo referral refinement. It also highlighted that adherence to the JCG and NICE commissioning guidance as onward referral criteria for specialist optometrists in this referral refinement scheme would result in fewer referrals.[84]

2.6.6.8 Conclusion

This review of the referral refinement schemes has shown that many of these schemes reduce the number of referrals to the hospital eye service with the majority showing a financial cost saving.

There is plenty of evidence to show that such schemes are beneficial, however, more research is needed to show if they can be set up in different regions and more work is needed on the clinical governance to support such schemes.

2.6.7 Shared Care Schemes

Scheme	Description	Outcomes
Bristol shared care scheme (2000)[85]	This is the only randomised controlled trial. Stable glaucoma patients were reviewed and were followed up either in the hospital or by community optometrists.	The scheme was not shown to be cost effective. However, it did show that community optometrist measurements were of comparable accuracy to those made in the hospital. Annual cost per patient follow up by a community optometrist was £68.98-£108.98 compared to £14.50-£59.95 in the hospital. Even though the scheme was found not to be cost effective, it did free up capacity within the hospital eye service.
Community and Hospital Allied Network Glaucoma Evaluation Scheme (CHANGES) (2006)[86]	This scheme involved monitoring Ocular Hypertensive patients by community optometrists under the virtual supervision of the hospital glaucoma service. The optometrists used contact applanation tonometry, slit lamp biomicroscopy, automated visual field testing and digital optic disc photography	One hundred and sixty-eight OHT patients were invited for their first appointment with an optometrist with special interest in glaucoma (OSI). One hundred and forty-four patients attended (attendance rate 85.7%) Outcomes of one hundred and thirty patients reported. Sixteen patients (12.3%) were referred back to the hospital. The consultant retained eight patients (6.1%) within the hospital glaucoma service.

The Peterborough scheme for community specialist optometrists in glaucoma: a feasibility study (2005)[87]	The study assessed the role of specialist Optometrists working in the community and sharing the care for glaucoma patients with, and under close supervision of a consultant ophthalmologist in the hospital eye service.	This study included 1184 new patients seen by the optometrist. A total of 32% of patients were referred on to the hospital. The following levels of disagreement were observed between the specialist optometrist and the consultant ophthalmologist. On cup:disc ratio (11%), visual field interpretation (7%), diagnosis (12%), treatment plan (10%), and outcome (follow-up interval and location) (17%)
East Devon Scheme (2005)[19]	The project aimed to reduce pressure on outpatients at the West of England Eye Unit (WEEU), based at the Royal Devon and Exeter NHS Foundation Trust, by transferring the monitoring of selected patients to community optometrists with a specialist interest (COSIs) in the community setting.	44 follow-up assessments per month on average during 12 months to July 2006 357 patients and 641 assessments between Jan 2005 and July 2006. This was based on available data for 6 COSIs.
The Waltham Forest Scheme (2005)[19]	The project aimed to introduce a new pathway for screening suspected glaucoma cases, diagnosis and treatment of simple glaucoma, and follow-up of stable glaucoma or ocular hypertensive patients in community settings using an optometrist with a special interest (OSI) role.	OSIs were working in community centres. The OSI could initiate medical treatment (via letter to GP) without patient notes being reviewed by a consultant ophthalmologist.

		Some patients however did require consultant assessment or review of notes Clinical audit indicated strong support for skills of COSIs
Nottingham Scheme (2003)[88]	**Ocular hypertension scheme** Optometrists review ocular hypertensive patients in their practices. Doctors reviewed patients in 15% of cases.	In the Ocular hypertensive scheme, optometrists reviewed patients at a cost of £35 per patient. In the glaucoma clinic the optometrists were paid £100 per patient. Between 2003-2006, 200 new patients seen. There was a 1.5% non-attendance rate. There was a 6% re-referral rate.

Table 2.3: Shared care schemes

It was reported by Vernon et al that in mid 2006 that there were 66 shared care schemes operating in 62 departments. Of these schemes 14 were community based shared care schemes (predominately run by optometrists) and 52 were 'in house' (predominately run by nurses and optometrists).[89] Table 2.3, shows the structure and outcomes of some of these schemes.

2.6.7.1 Agreement/Safety

The Bristol Scheme was the only randomised controlled trial. One of the outcomes from this scheme was that the community optometrists measurements were of comparable accuracy to those made in the hospital.[85] In the Waltham Forest scheme, clinical audit indicated strong support for the skills of specialist community optometrists.[19] There was also strong agreement between the consultant ophthalmologist and the optometrist in the Peterborough scheme.[87]

The performance of the community optometrists could be attributed to the training given in many of these schemes. In the Bristol scheme the optometrists received 15 hours of lectures and 10 hours of practical experience at Bristol Eye Hospital. At the end of the training the optometrists were assessed to ensure they were able to make the relevant visual measurements.[85]

The community and hospital allied network glaucoma evaluation scheme for optometrists in Huntingdon had training at the hospital combined with completing the City University post-graduate Certificate in glaucoma shared care. The Peterborough scheme had hospital based theory and practical training but the optometrists were not formally assessed. Instead the optometrists were selected based on clinical agreement between them and the consultant ophthalmologist.[87]

Competency based training was undertaken in the East Devon scheme. This was provided by the ophthalmology lead and the nurse specialist lead. Theoretical and practical training was given at the West of England Eye Unit. The nurse specialist also carried out some additional training at the optometric practices. This aspect was unique to this scheme.

In the Waltham Forest scheme, one of the optometrists had already been at Whipps Cross Hospital on a voluntary basis and had worked with the lead Consultant Ophthalmologist for 2 years. This optometrist was accredited without training. The second optometrist received a training package which included one session a week with the project lead Consultant Ophthalmologist. This optometrist was then assessed and accredited.[19]

The training structures of the various schemes listed above have shown many similarities, however there are still some differences.

A recommendation for standardisation of the glaucoma shared care training of optometrists who wish to participate in such schemes is warranted. This training program needs to be validated across the UK with the Royal College of Ophthalmologist and College of Optometrists approval.

2.6.7.2 Cost

In the Bristol scheme it was found that there was a greater cost in examining the patient in the community compared to the hospital setting. There were two reasons for this.

The first was the fact patients were followed up at 6 monthly intervals in the community compared to 10 months in the hospital setting. This was actually due to the study protocol. The second reason was the re-referral rate of 22% of patients from the community back into the hospital. This re-referral resulted in a double cost for the patient.

The annual cost per patient follow-up by a community optometrist was £68.98-£108.98 compared to £14.50-£59.95 in the hospital. As one of the causes of this inflated community figure was the study protocol, a recommendation to improve cost effectivity of the scheme could be to change the protocol. The other aspect to consider is to reduce the re-referral percentage.

The Nottingham scheme had a much lower re-referral percentage of 6%. The Bristol scheme is the only scheme that shows the costs comparison between the community glaucoma clinics and the hospital glaucoma clinics. The other schemes attempt to make a comparison but the results are limited as a result of lack of data on costs related to the clinics. In the Peterborough scheme there were no costs data available for the consultant-led hospital glaucoma clinic. In the Waltham Forest scheme, it was the opposite, where they were unable to obtain costs data for the community glaucoma clinics in the optometric practices.

The East Devon scheme in 2005 had a unique structure in that it was based upon an existing and well established nurse-led scheme. The scheme looked at transferring glaucoma patients from the West of England Eye Unit into community hospitals as well as community optometric practices. In both of these community locations community optometrists with special interest were used to examine glaucoma patients.[19]

In the East Devon scheme overhead estimates were used to calculate approximate figures for patient costs per assessment in the community.

The results were £43 per assessment in the community hospital compared to a practice based figure of £50 per assessment plus an additional overhead cost relating to administration and clinical governance which escalated the practice based figure.[19] In the scheme they planned for six patients to be seen per session. In the Sidmouth location of the East Devon scheme, patients preferred to attend the community hospitals compared to community optometric practices.

There were variations in the community optometrist fees per patient between the schemes. In the Peterborough scheme during June 2006, the specialist optometrist fee was £60 for new patient assessments and £35 for follow up assessments. This was based on 10 patient slots per month.[19] The Waltham Forest scheme in 2005 had a sessional fee of £175. However, the data showed that out of the two community optometrists, the first carried out 3.1 assessments on average per clinic and the second 1.8 assessments.

The number of patients seen in the community arm of these schemes appears to be small. This could have a bearing on the costing and long term viability of such schemes. It would be interesting to ascertain how the number of patients allocated per community optometrist was agreed, whether it was protocol driven or optometrist driven. It is also important to appreciate that costs do vary with time hence cost comparability of studies becomes more difficult.

2.6.7.3 Clinical Governance

The Waltham Forest scheme allowed the optometrist with special interest to instigate treatment via a letter taken by the patient to their GP for patients diagnosed with glaucoma in the community. They state that this arrangement was facilitated by the high level of trust between the lead consultant ophthalmologist and the two community optometrists. There is no doubt that this is a step forward in managing the care of glaucoma patients in the community, however it is vital that adequate clinical governance is in place before we move forward in this manner. The author of the Waltham Forest scheme does not elaborate on the details regarding clinical governance within the scheme.

The need for glaucoma shared care schemes is essential especially as the elderly population increases in number. There is ever increasing pressure on hospital glaucoma departments to cope with this increasing demand. The key aspects that must be addressed for the future are standardisation of optometrist training, open access to costing data to allow better evaluation of cost effectivity of schemes and, probably the most important of all, establishment of clinical governance.

2.6.7.4 Integrated Glaucoma Management Model

The model we developed was termed the Integrated Glaucoma Care Model. This involved training and accrediting community optometrists to manage Moorfields glaucoma patients in the community. These optometrists then ran Moorfields glaucoma clinics in their optometrist practices whilst alternating attending glaucoma clinics in the hospital.

All stable cases from the hospital settings who had a routine 6 month follow up appointment in the hospital were selected to be followed up in the community setting. The next appointment that the patient attended was in the community optometrist practice where community data collection was done. The scheme was designed in this way to allow as many stable patient cases to be seen in the community as safely possible.

3.0 Methodology

3.1 Glaucoma Training Programme

3.1.1 Aim

The aim of the glaucoma course was to prepare the community optometrists to manage and detect change in ocular hypertensive and primary open angle glaucoma patients in their community optometric practices and the hospital eye service.

3.1.2 Optometrist Recruitment

Optometric practices were contacted by telephone in the catchment areas of the Moorfields outreach clinics involved in the project.

3.1.3 Recruitment Issues

It was extremely difficult to recruit community optometrists to participate in the project. A large number of practices were contacted by phone but the majority of optometrists were not able to participate mainly due to financial demands of the practices. In total there were 50 optometrist practices contacted.

The other reason why the community optometrists could not participate was because they were unable to allocate the necessary time away from their practices due to loss of testing capacity and therefore practice income.

The possibility of locum optometric cover for their practices was considered by the optometrists but they felt this was too financially demanding on the practice. They also felt the cost of locum cover or loss of practice revenue would be far greater than any remuneration received as a result of participation in the project.

After overcoming the various issues during the recruitment process, nine community optometrists were established for the project. Four were linked to Moorfields Ealing outreach, two were linked to Moorfields Upney out reach, one was linked to Moorfields Mile End outreach and the final two were linked to the Royal London Hospital.

An agreement was reached between the project co-ordinators and the optometrists that the optometrist time would be remunerated, however their optometric practice would be provided at no cost for the community aspect of the project.

3.1.4 Training Structure

The training programme had a competency base and a clinic base. The main focus of the training was to manage glaucoma and detect change.

3.1.4.1 Accreditation Pathway

The optometrist accreditation process consisted of a multi-staged pathway.

3.1.4.1.1 Part 1 - Didactic Lectures, Patient Demonstrations and Case Discussion Workshop

Examination:

All examinations were set and marked by Mr Ian Murdoch and Professor John Lawrenson. The examinations comprised of the following:

a. Written examination (multiple choice questions, short answer questions and case scenarios)

b. Objective structured clinical examination (OSCE) to examine history taking, applanation tonometry and disc interpretation. Retake examinations were held for those candidates who failed.

Only once the optometrist had passed both sections could they move on to the next stage of the accreditation process which was the mentored clinical placement.

3.1.4.1.2 Part 2 - Clinic/Hospital Based Learning

The optometrists were required to undertake a period of clinic-based learning in a glaucoma outreach clinic under the supervision of a consultant ophthalmologist. This was in order to facilitate the integration of theory and practice. It was a requirement that during their clinical placement the optometrists had to complete a portfolio which was then to be provided to the examiners as evidence of work undertaken during the clinical placement.

3.1.4.1.3 Clinical Placement and Portfolio

The portfolio was a folder of practice evidence consisting of:

- A log of clinical experience (patients seen, clinical sessions attended, involvement of trainee in each patient episode)

- Accuracy of clinical observation (This was assessed by using the Bland-Altman method and determining the level of agreement of repeated measures of IOP and C/D ratio between the trainee and the Consultant Ophthalmologist).[90] It was important to the model that the community optometrists had a good level of agreement with the expert clinician (consultant). The two clinical measurements were the main assessments that the optometrists were making when running the Moorfields glaucoma clinics in their practices. Visual fields were not required to be performed by the optometrists in our model for the community clinics.
- Agreement was established by plotting a Bland-Altman for intraocular pressure and cup-disc ratio. A distribution of points close to mean indicating good agreement,
- Skill development form. The mentors (Consultant Ophthalmologists) were asked to complete a skill development form against pre-determined outcomes.

3.1.4.1.4 Examination

Once the mentor and trainee were in agreement, which we established by plotting a Bland-Altman for intraocular pressure and cup-disc ratio. A distribution of points close to the mean indicating good agreement. The trainee was then put forward for the part 2 assessment. This assessment consisted of a structured oral examination conducted by a consultant ophthalmologist and Professor of optometry.

The final assessment also required trainees to submit five extended case reports with their portfolio, based upon a chosen selection from the cases seen during their placement. The portfolio was formally examined and unseen virtual case scenarios were used to assess clinical decision making. Specialist accreditation was based on successful completion of the exit examination.

3.1.4.2 Main Training Competencies

A meeting was held between Mr Ian Murdoch and Professor John Lawrenson. During the planning stage, training competencies were established for the community optometrists, in order to run a community based glaucoma clinic. In the design phase, the training competencies were expanded and the teaching method and assessment method for each of the competencies established. The examinations were then conducted, however an evaluation and revision of the accreditation process has yet to be carried out.

The following eight competencies were agreed upon.

Training competency	**Teaching Method**	**Assessment Method**
Knowledge of the risk factors, pathophysiology, clinical features and natural course of OHT and POAG	This consisted of part of two days of didactic lectures	-Written examination (multiple choice questions, short answer questions and case scenarios)
An ability to take a comprehensive ophthalmic history	This consisted of part of two days of didactic lectures	-Objective structured clinical examination (OSCE)
An ability to examine a patient with OHT or POAG using agreed instrumentation and clinical techniques: (Goldmann tonometry, C/D ratio measurements and Visual field analysis)	This included a one day workshop of patient demonstrations and case discussions	-Objective structured clinical examination (OSCE) -Structured oral viva examination of portfolio, Bland-Altman on IOP and C/D measurements. Five extended case reports and unseen virtual case scenarios
An ability to interpret clinical signs and the results of clinical investigations	This consisted of part of two days of didactic lectures	-Written examination (multiple choice questions, short answer questions and case scenarios) -Structured oral viva examination of portfolio, five extended case reports and unseen virtual case scenarios
An ability to monitor the response to treatment and modify the management plan or refer if necessary	Case discussions	-Structured oral viva examination of

		portfolio, five extended case reports and unseen virtual case scenarios
Knowledge of the cautions, contraindications, interactions and side effects of anti-glaucoma medications	This consisted of part of two days of didactic lectures	-Written examination (multiple choice questions, short answer questions and case scenarios) -Structured oral viva examination of portfolio, five extended case reports and unseen virtual case scenarios
An awareness of clinician's own limitations and ability to make clinical decisions based on the needs of the patient	Case discussions	-Structured oral viva examination of portfolio, five extended case reports and unseen virtual case scenarios
Critically analyses and evaluates his or her own performance in relation to the examination and management of patients with OHT and POAG	This included a one day workshop of patient demonstrations and case discussions	-Structured oral viva examination of portfolio, five extended case reports and unseen virtual case scenarios

Table 3.1: Main training competencies

3.1.4.3 Accreditation Issues

At the initial training stage of the accreditation process where the optometrists were undertaking written and OSCE examinations, one of the optometrists failed the examination. This candidate attended further lectures and training sessions and was given a second opportunity to re-take the examinations but they were again unsuccessful.

This candidate's case was reviewed by Mr Ian Murdoch and Professor John Lawrenson. It was decided that it was in the best interests of the candidate to gain further experience in practice and that he would be welcome to re-sit the examination if he still wanted to in the future.

3.2 Overall Project Design for the Integrated Glaucoma Management Model and data collection involved

Below is a flow diagram to illustrate the overall project design.

Aim: The aim of this project was to investigate the cost-effectiveness, efficiency, safety and capacity of running a Moorfields glaucoma clinic in community optometric practices.

↓

Community optometrists were recruited to participate in the project

↓

The community optometrists were trained and accredited to examine glaucoma patients

↓

Data collection tools were developed to capture data on the various aspects under investigation in the project

↓

Hospital data was collected on cost effectiveness, efficiency, safety and capacity

Moorfields glaucoma clinics were started in the approved community optometric practices

Once the community glaucoma clinics had been running for a period of time, community data collection was initiated

Cost effectiveness, efficiency, safety, capacity and patient feedback data were collected from the community sites

Hospital micro-costing was undertaken and consensus meetings were held with the community optometrists for establishing community fees

Hospital and community data were analysed and compared. The findings were reported

Conclusions were made on whether it was feasible to operate Moorfields glaucoma clinics in community optometric practices using the accredited optometrists

Figure 3.1: Overall project design

3.2.1 Data Type Collected

Below is a flow diagram to illustrate the data that were collected during the project. Ethical approval was not sought as this research was conducted under the umbrella of audit of service delivery.

Hospital and community costing data

Hospital micro-costing and community consensus meeting for establishing fees

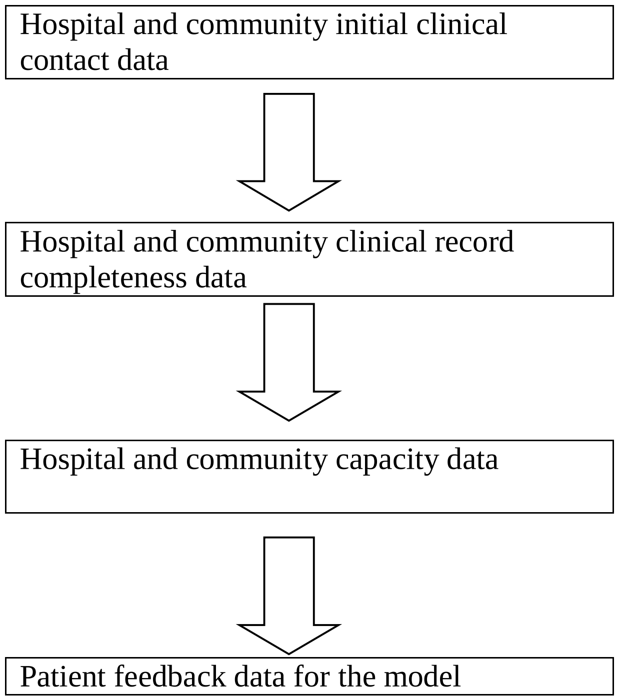

Figure 3.2: Data type collected

3.2.1.1 Hospital Data – Patient Based Costs

Data collection involved collecting data on patient based costs in attending hospital based glaucoma clinics.

3.2.1.1.1 Hospital Sites

The hospital sites that were used to collect patient based costs were

Hospital Sites (Moorfields outreach clinics)
Ealing hospital
St Georges hospital
Mile End hospital
Upney
St Anns
Royal London Hospital

Table 3.2: Hospital sites for patient based costs

3.2.1.1.2 Development of Data collection Proforma

A cost questionnaire developed by Wordsworth and Thompson was used to undertake a pilot study.[91] This was piloted at Ealing hospital at the start of the project. There were a total of 30 patients that were interviewed through convenience sampling. The data collected was then entered into the Epiinfo program (WHO v3:4:1). The outcomes of this pilot study showed a need for more detail in the costs data collection proforma.

In addition to demographic details for patients, further fields were added onto the data collection form including travel costs, opportunity costs and companion costs. Ethnicity was coded according to the NHS information standards board. Bangladeshi was coded under Pakistani. Occupation was coded according to the national statistics socio-economic classification (NS-SEC): the standard occupational classification 2000.[92] The final costs questionnaire can be located in Appendix A.

3.2.1.1.3 Data Collection Methodology

For this patient costs survey, verbal consent was obtained from each patient. In order to comply with data protection, patient data were collected using ID numbers and date of birth only. The data were kept encrypted according to normal NHS standards. Six ophthalmology units across London were visited as shown in Table 3.2.

A quota of 100 patients were sampled from each site with the clinics being visited on 12-18 occasions with data collection from 7-8 patients per clinic until the quota was reached.

Convenience sampling was used to approach patients visiting for review or appointments. Once the patients had completed their clinic journey, they were approached for interviewing. A private room was used to complete the structured questionnaire.

3.2.1.1.4 Data Analysis

Data were double entered using the Epiinfo program (WHO v3:4:1).[93] Contingency tables and cost analysis were undertaken using Intercooled Stata 7.0 (Stata Corporation, College Station, TX, USA).[94] The results were analysed and the findings reported.

3.2.1.2 Community Data - Patient Based Costs

Data collection involved collecting data on patient based costs in attending community optometric based glaucoma clinics.

3.2.1.2.1 Community Sites

Community sites
Ealing - Four optometric practices (Two practices were large multiples and two were small independent practices)
Upney – Two optometric practices (Both practices were small independent practices)

Table 3.3: Community sites for patient based costs

3.2.1.2.2 Community Site Issues

For the community arm of the project, there were only two sites that were active. The first was Moorfields Ealing Outreach, which had four optometric practices linked to it.

The second was Moorfields Upney Outreach, which had two practices linked to it. The other sites did not become active due lack of accredited community optometrists within the region, funding issues and logistical problems with setting up the community clinics.

The comparison between hospital and community settings was only undertaken between the Ealing and Upney sites.

3.2.1.2.3 Hospital vs Community comparison

The fact that there were only two community sites that became active during the project restricted our comparisons to only the same hospital sites. Only Ealing and Upney data, hospital vs community were compared for the Integrated Glaucoma Management Model.

3.2.1.2.4 Community Data Collection Proforma

The same patient costs questionnaire that was used to collect data in the hospital setting was also used to collect the community patient cost data (Appendix A).

Information was obtained from the patient concerning method of transport used to travel to the community clinic, miles travelled by car users and costs incurred from public transport or taxi use. In addition, patients were asked whether they had taken time off work, whether wages had been lost as a result of attending the clinic. Data were also gathered on whether they had been accompanied to the clinic and whether dependants had to be cared for to enable them to attend.

Non-healthcare direct costs were identified for patients as out-of-pocket expenses arising from attending the community clinic. The direct cost of travel was based on the costs of a return journey for those travelling by public transport or taxi. The cost of travel was calculated at £0.55 per mile.[95] Wages loss calculations were calculated from information provided by patients.

Indirect costs are those costs that refer to the activity or opportunity foregone as a consequence of attending the glaucoma clinic. In order to keep in line with assumptions made in previous work on time costs, where patients and companions time was not given up from work, the time was classified as “leisure time” and was valued as 30% of the average gross wage.[96] The published patient costs were adjusted for this analysis with the average inflation rate to reflect the current costs.

3.2.1.2.5 Data Collection Methodology

Community costs data were collected as a part of this longitudinal study through telephone interviews of patients within 3 days of having had their community clinic appointment. Patients gave written consent at the time of attending their appointment in the community clinic. This data collection occurred over a period of a year where in Ealing there were 100 consultations and in Upney there were 94 consultations.

3.2.1.2.6 Data Analysis

The data was entered using Epiinfo (WHO v 3:4:1).[93] The results were analysed using Stata.[94] The findings were then reported.

3.2.1.2.7 Repeatability of Patient Data collection

The sampling methodology resulted in six patients having repeat data collection (all at Upney). Four patients gave the same responses for employment. One changed from unemployed to employed and one changed from professional to retired. Out of the six patients, five used the same method of transport. In three instances the patient was accompanied on both visits. Since these six patients had been questioned twice, the second responses were removed from the analysis.

3.2.1.3 Integrated Glaucoma Management Model

3.2.1.3.1 Costings involved in setting up the Integrated Glaucoma Management Model

3.2.1.3.2 Ealing Hospital Micro-costing

Micro-costing was undertaken for the hospital clinic in Ealing by the finance department at Moorfields Eye Hospital NHS foundation trust. The Ealing micro-costing data was taken to represent all the hospital sites for comparison purposes.

3.2.1.3.3 Micro-costing Method

Micro-costing was based on following up a sample of patients through the process of a visit combined with time lines for patients in clinics. The method used was micro-costing quantity data collection methods.[97]

The Ealing service is run as a Monday full day clinic. An assessment of patient contact time was formed by taking a sample of patient times as well as a discussion with the lead consultant. Staff costs and non-pay costs were analysed and allocated to the hospital clinic in Ealing. This included staff time not directly related to time spent with a patient and fixed/semi-fixed costs for the clinic that were not dependent upon the clinic.

Mr Ian Murdoch and a member of the Moorfields finance team used data from the Moorfields finance department for the Ealing Hospital outreach site. The input of the consultant was in the discussion of the structure of the glaucoma clinic. There would also have been discussion around the patient pathway and flow through the clinic.

3.2.1.3.4 Community Costing

In order to elicit the cost of the service in the community, micro-costing was not feasible due to the diverse nature of practices participating.

3.2.1.3.5 Community Costing Methodology

At the end of the data collection period, a consensus meeting was held with all the optometrists involved in the project in addition to the representatives of the multiple chain optometric practices that had participated. Participants had completed individual estimates of the rental (including equipment and services) and opportunity costs of running a half day glaucoma session in clinics in the community.

The fact that we were looking at specific areas in London may have biased the community costing outcomes. Optometry practices in different areas of London or in other areas of the UK could have yielded different community costing outcomes. The size of the practices we used in our model for both the independents and multiples may also have influenced the community figures due to the impact of ground rental.

The fact that the opportunity cost was seen as a negative in our consensus meeting may not necessarily reflect the overall opinion of other optometry practice directors. Other directors may have thought that the running of a Moorfields community glaucoma clinic was a positive thing and would enhance the clinical reputation of their practice.

After several rounds of discussions on what that cost might be, the consensus meeting reached agreement on costs. There were two separate figures that were agreed. The figure for running a half day glaucoma clinic for independent optometrist practices was £640 and for multiple chain practices it was £834. Costs were calculated on the basis of prices for the 2010-2011 financial year. Sensitivity analysis was performed exploring the impact of the number of patients' seen on the cost per attendance in the community setting.

3.2.1.4 Hospital Time to Consultation

3.2.1.4.1 Hospital Sites

The hospital sites that were used to collect time to consultation data were:

Hospital Sites (Moorfields out reach clinics)
Ealing hospital
St Georges hospital
Mile End hospital
Upney
St Anns
Royal London Hospital

Table 3.4: Hospital sites for time to consultation

3.2.1.4.2 Time to Consultation Proforma

The data collection proforma used to collect contact times is located in Appendix B.

3.2.1.4.3 Data Collection Methodology

Five Moorfields outreach clinics and the Royal London were visited on different days and at different times in the day. The five Moorfields outreach clinics included Ealing, St Georges, Mile End, Upney Centre and St Anns. On each visit 5-6 patients were selected through convenience sampling as they completed their clinic journey and interviewed in a separate room until the quota of at least 100 patient data sets per site was reached. Convenience sampling is a type of non-probability sampling where the sample is taken from a group of people easy to contact or to reach. There are no other criteria to the sampling method except that the people are willing to take part in the research and are available.

Each patient was asked to estimate the time they arrived to the time they were seen by the nurse, the field technician and the doctor. It was noted after the initial data collection that we needed to factor in nurse and fields duration time. It was decided that this data would be collected at Ealing Hospital and Mile End Hospital.

A further sample of 50 patients was obtained through convenience sampling at these two sites. The nurse and fields test duration time were subtracted from the original waiting time data set to yield time to consultation.

3.2.1.4.4 Data Analysis

After data collection was completed, it was entered into Microsoft Excel and analysed.[98]

3.2.1.5 Community Setting - Time to consultation

3.2.1.5.1 Community Sites

Community sites
Ealing - Four optometric practices (Two practices were large multiples and two were small independent practices)
Upney – Two optometric practices (Both practices were small independent practices)

Table 3.5 Community sites for time to consultation

3.2.1.5.2 Data Collection Proforma

A modified data collection proforma was used in the community setting (Appendix C).

3.2.1.5.3 Data Collection Methodology

Written consent was obtained from the patients at the community practices allowing them to be contacted by telephone to obtain community time to consultation data. A sample size of 100 patient data sets was collected from each site. There were no nurse assessments undertaken in the community practices and visual fields examination was not a requirement in the community arm of the study.

3.2.1.5.4 Data Analysis

The community data was entered into Microsoft excel programme and analysed.[98]

3.2.1.6 Hospital - Record Completeness

3.2.1.6.1 Hospital Sites

Hospital Sites (Moorfields out reach clinics)
Ealing hospital
St Georges hospital
Mile End hospital
Upney
St Anns
Royal London Hospital

Table 3.6: Hospital sites for record completeness

3.2.1.6.2 Data Collection Proforma

A data collection proforma was developed after a meeting between myself and Mr Ian Murdoch. This proforma was to be used to capture record completeness data. This proforma is located in Appendix D.

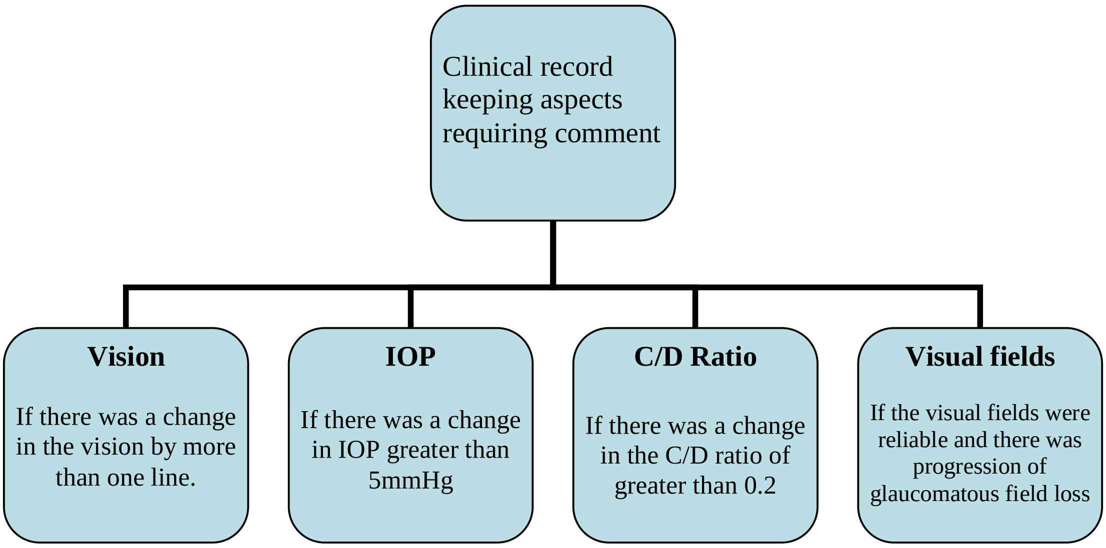

Figure 3.3: Aspects of clinical record keeping that required comment

3.2.1.6.3 Data Collection Methodology

Clinical record completeness data collection was undertaken at the same five Moorfields outreach glaucoma clinics and the Royal London hospital in Whitechapel. The sites were again visited on different days and at different periods in the day. Once the full clinical examination of the patient had been carried out, the clinical records were put aside. The patient file was examined using the data collection form. A total sample size of 100 was used for each of the sites.

3.2.1.6.4 Data Analysis

Once all the data had been collected it was double entered using Epi Info.[93] The data were then analysed using the Stata programme.[94]

3.2.1.7 Community Setting – Record Completeness

3.2.1.7.1 Community Sites

Community sites
Ealing - Four optometric practices (Two practices were large multiples and two were small independent practices)
Upney – Two optometric practices (Both practices were small independent practices)

Table 3.7: Community sites for record completeness

3.2.1.7.2 Data Collection Proforma

The same data collection table was used as in the hospital setting. This is located in Appendix D.

3.2.1.7.3 Data Collection Methodology

After all the hospital glaucoma patients had attended their glaucoma appointment in the optometric practices, the clinical records were then sent back to Moorfields City Road.

An identical data collection form was used to carry out the community clinical record completeness analysis as was used in the hospital setting. A sample size of 100 patients was used for the community sites. There were no nurse assessments in the community practices and visual fields were not required to be performed in the community clinics.

3.2.1.7.4 Data Analysis

Once all the data had been collected it was double entered using Epi Info.[93] It was then analysed using Stata.[94] A comparative analysis between the hospital clinical record completeness and the community data was carried out and the results reported.

3.2.1.8 Hospital - Patient Capacity

3.2.1.8.1 Hospital Sites

Hospital Sites (Moorfields out reach clinics)
Ealing hospital
St Georges hospital
Mile End hospital
Upney
St Anns
Royal London Hospital

Table 3.8: Hospital sites for patient capacity

3.2.1.8.2 Data Collection Methodology

Hospital patient numbers per community optometrist were obtained by requesting the optometrists to keep a record of the number of patients they saw at each hospital glaucoma session over a period of four months.

3.2.1.8.3 Data Analysis

These were then used to calculate an average of the number of patients seen per community optometrist in a hospital session.

3.2.1.9 Community Setting

3.2.1.9.1 Community Sites

Community sites
Ealing - Four optometric practices (Two practices were large multiples and two were small independent practices)
Upney - Two optometric practices (Both practices were small independent practices)

Table 3.9: Community sites for patient capacity

3.2.1.9.2 Data Collection Methodology

As the patient files for the community setting were being analysed for clinical record completeness at Moorfields City Road, the number of patients seen per clinician for one session was also recorded.

3.2.1.9.3 Data Analysis

Average patient numbers seen in the community per optometrist were calculated from these data. The hospital patient number averages were compared with the community averages for Ealing and Upney settings. The results were discussed and reported.

3.2.1.10 Patient Feedback Data for the Model.

3.2.1.10.1 Community Sites

Community sites
Ealing - Four optometric practices (Two practices were large multiples and two were small independent practices)
Upney – Two optometric practices (Both practices were small independent practices)

Table 3.10: Community sites for patient feedback

3.2.1.10.2 Data Collection Proforma

A qualitative patient feedback questionnaire was developed between myself, Mr Ian Murdoch and Dr Helen Baker. The questionnaire consisted of a series of five questions developed to ascertain the positive and negative aspects of the community clinics from the patient's perspective. Additional data were collected on patient's suggestions for improving the community clinics. This questionnaire can be found in Appendix E.

3.2.1.10.3 Data Collection Methodology

Once the patients had been seen within the integrated glaucoma management model, a consent form was signed by the patients. This gave authority for me to contact the patients in order to obtain community based data.

Patient feedback data were collected through telephone interviews using the finalised proforma. Telephone interviews were conducted within 3 days of the community clinic appointment. There were 50 patient's data collected for the Ealing community setting and 50 patients for Upney.

3.2.1.10.4 Data Analysis

The patient feedback responses to the five questions were grouped into positive (%), negative (%) and other. A table was constructed with this format and any interesting comments to the questions asked were also added into the table.

3.2.1.11 Statistical Tests

The Bland-Altman was used to look at agreement between the community optometrists and the consultants during the clinical placement phase of the accreditation process.

Logistic regression was used to look for trends in the data sets collected through this research. The p value was set at the 5% level. Sensitivity analysis was undertaken modelling the number of patients seen in the community clinic per day against cost per attendance.

4.0 Results

4.1 Present/past Occupation of Patients attending Hospital Glaucoma Clinics

Occupation	**Working population N(%)**	**Retired population N(%)**
Managers/Professionals	27(*21%)*	47(*10%)*
Assoc. professional /Admin/Secretarial	30(*23%)*	98(*21%)*
Skilled trade/Service (personal/sales)	44(*35%)*	192(*42%)*
Machine operatives/elementary	22(*17%)*	130(*28%)*
Unemployed	6(*5%)*	0(*0%)*
Total	**129**	**467**

Table 4.1: Present/past occupation of patients attending hospital glaucoma clinics in London

The occupation data above shows that there was a greater retired population compared to working population attending the hospital glaucoma clinics. In terms of the retired population, the most common occupation when they were working was skilled trade/service (42%) and machine operatives/elementary (28%). None of the retired population sampled reported permanent unemployment prior to retirement.

The working population that was sampled commonly consisted of skilled trade/service (35%) and associate professional/admin/secretarial (23%). There were only 5% that were unemployed.

4.2 Transport method and Ethnicity related to Site

	Ealing	St.Georges	Mile End	Upney	St.Anns	Royal London
TRANSPORT N(%)						
Walking	7(7%)	17(18%)	9(10%)	11(12%)	11(11%)	10(11%)
Bus	48(48%)	57(59%)	30(35%)	28(29%)	43(44%)	27(30%)
Taxi/cab	6(6%)	1(1%)	7(8%)	6(6%)	11(11%)	7(8%)
Car	33(33%)	16(17%)	21(24%)	42(44%)	26(27%)	18(20%)
Train	0(0%)	4(4%)	10(12%)	8(8%)	2(2%)	18(20%)
Hospital	5(5%)	1(1%)	9(10%)	0(0%)	4(4%)	10(11%)
Total	**99**	**96**	**86**	**95**	**97**	**90**
ETHNICITY N(%)						
White	48(49%)	51(51%)	55(55%)	73(74%)	45(46%)	50(54%)
Indian/Pakistani	40(41%)	14(14%)	12(12%)	13(13%)	15(15%)	23(25%)
African	3(3%)	13(13%)	13(13%)	9(9%)	11(11%)	12(13%)
Caribbean	7(7%)	22(22%)	20(20%)	3(3%)	27(28%)	8(9%)
Total	**98**	**100**	**100**	**98**	**98**	**93**

Table 4.2: Transport method and ethnicity related to site

The majority of people came to hospital by bus (40%) or car (26%). It can be seen from Table 4.2, that there was some variability in transport method by site. Car and bus were more commonly used at Ealing and St Ann's. Bus (59%) was most commonly used at St George's and car (44%) was most commonly used at Upney. At other sites there was more of a mix in terms of transport method. The results above did not show a link between ethnicity and mode of transport.

There was, however, a clear pattern in ethnic composition between sites. Ealing had more patients of Asian origin while St George's, Mile end and St Ann's had more patients of African and Caribbean origin.

4.3 Logistic regression outcomes

Our results showed that females were more likely to come with someone than males. This was supported by logistic regression which showed that being female (OR 2.21 (1.58-3.09) $P<0.001$) was an explanatory variable to being accompanied.

Overall our results showed that there was a high percentage of patients attending the glaucoma clinics who reported having no qualification. This value was found to be 66.6%. This compared to the 2007 national statistic of 11.4%. Logistic regression analysis did show that having no qualification (OR 1.56 (1.08-2.25) $P=0.019$ was also an explanatory variable to being accompanied

4.4 Mean Cost per Glaucoma clinic visit

	Ealing	St. Georges	Mile End	Upney	St. Ann's	Royal London
Patient Costs						
Travel cost	3	1.8	3.8	4.9	3.2	4.7
Working time	2.4	3.6	3.2	2	2.6	3.4
Leisure time	4.4	4	4.2	4.6	4.4	4
TOTAL (£)	**9.8**	**9.4**	**11.2**	**11.5**	**10.2**	**12.1**
Societal Costs:						
Travelling cost	0.8	1.1	1.7	1	0.8	1.4
Working time (productivity loss)	2.5	2.4	1.9	1.8	2.3	2.5
Working time (companions)	5.6	4.4	6.5	8.5	4.9	8.2
Leisure time (companions)	1	0.9	0.8	1	0.8	0.8
TOTAL (£)	**16.7**	**16.4**	**18.3**	**18.9**	**15.8**	**20.3**
MEAN COST (£)	**13.25**	**12.9**	**14.75**	**15.2**	**13.0**	**16.2**

Table 4.3: Mean cost per glaucoma clinic visit

The Royal London had the highest mean cost per glaucoma visit (£16.20), whereas St George's had the lowest (£12.90). Upney had the second highest mean cost per visit (£15.20). Ealing and St Ann's had similar values of (£13.25) and (£13.0) respectively. The Royal London had the highest total patient costs per visit (£12.10) and the highest total societal costs per visit (£20.30) compared with other clinics. These two values contributed to the Royal London having the highest mean costs per visit. St George's which had the lowest mean costs per visit also had the lowest total patient costs per visit (£9.40). This low patient cost per visit seems to be the result of St Georges having the lowest patient travel cost per visit of all the glaucoma clinics.

The total societal costs per visit were greater than the total patient costs per visit at all the sites. This appears to be driven by the larger companion attendance.

4.5 Ethnic Composition of Patients attending the Hospital and Community clinics at Ealing and Upney

Ethnicity	Hospital clinic N (% accompanied)			Community clinic N (% accompanied)		
	Male	Female	Total	Male	Female	Total
White	63(52%)	58(67%)	121(60%)	71(39%)	81(52%)	152(46%)
Eastern Asian	0	1(100%)	1(100%)	0(0%)	0(0%)	0(0%)
Indian	20(55%)	19(68%)	39(62%)	7 (43%)	9(44%)	16(44%)
Pakistani	10(30%)	4(75%)	14(43%)	3(0%)	5(50%)	8(38%)
African	7(14%)	5(100%)	12(50%)	3(0%)	1(0%)	4(0%)
Caribbean	4(25%)	6(67%)	10(50%)	7(0%)	7(86%)	14(43%)
Total	104(47%)	93(70%)	197(58%)	91(34%)	103(53%)	194(44%)

Table 4.4: Ethnic composition of patients attending the hospital and community clinics at Ealing and Upney.

The table above shows the ethnic composition of patients attending the hospital and community clinics who were accompanied at Ealing and Upney. The table shows that the ethnic composition was similar between the hospital and community clinics.

The data shows that close to half of those patients questioned were accompanied, (58% in the hospital and 44% in the community). There was no significant difference in the numbers accompanied between the ethnicities, however females were more likely to be accompanied than males (176/291 (60%) vs 120/298 (40%) (chi square = 24, p<0.001)). This was supported by logistic regression which showed that being female (OR 2.21 (1.58-3.09) P<0.001) was an explanatory variable to being accompanied.

4.6 The Direct and Indirect costs to Patients of attending Glaucoma clinics in a Hospital and Community based setting

Patient costs	Hospital			Community		
	Ealing	Upney	Mean	Ealing	Upney	Mean
Travel cost	£3.00	£4.90	£3.95	£3.30	£4.15	£3.73
Working time	£2.40	£2.00	£2.20	£2.08	£2.29	£2.19
Leisure time	£4.40	£4.60	£4.50	£4.45	£4.14	£4.30
Total (£)	£9.80	£11.50	£10.65	£9.83	£10.59	£10.22

Table 4.5: The direct and indirect costs to patients of attending glaucoma clinics in a hospital and community based setting.

It can be seen by from Table 4.5 that for Ealing and Upney, the costs were virtually the same for patients attending the community clinics compared to those attending the hospital.

4.7 Number of Optometry practices contacted for the Integrated Glaucoma Care Model

A large number of optometry practices were contacted for optometrist recruitment purposes into the model. A total of 50 optometry practices were contacted by phone to recruit our 9 optometrists.

4.8 Costs of Glaucoma clinic appointments in Hospital and Community based clinics

Resources	Hospital	Community
Service cost		
Total cost per day (2 sessions)	**£7,477.00**	**£1,601.81**
No. of patients per day (2 sessions)	**117**	**11**
Average cost per attendance	**£63.91**	**£145.62**
Glaucoma clinic cost per year/patient	**£102.25**	**£254.17**
Patient cost		
Mean travelling cost for patient	**£3.95**	**£3.72**
Mean time cost for patient	**£2.20**	**£2.19**
Cost per patient attendance	**£6.15**	**£5.91**
Cost per year/patient	**£9.84**	**£10.32**

Table 4.6: Costs of glaucoma clinic appointments in hospital and community based clinics.

The table above shows the estimated costs involved when patients attend a hospital-based glaucoma clinic and a community-based clinic. During the micro-costing of the hospital-based clinics, staff costs included both clinical and administrative staff members (£4,992) and non-pay costs which included facilities, patient transport, domestics, interpreter fees, depreciation, sundries (£1,510). An overhead allocation was made at 15% (an estimate at the time this costing was prepared) and was calculated for satellite sites (£975), and using the timings given to the individual steps of the patient attendance, this produced a clinic cost of (£7,477) and an estimated average cost per attendance of (£63.91), based on an average clinic attendance of 117 patients.

In the community based clinics, the estimated opportunity costs of the resources involved in running a single day optometrist practice based clinic were calculated to be £1601.81. This was an average of complete day costs for independent and multiple practices with a 9% re-referral cost factored in. This figure also incorporated one of the outcomes of the consensus meeting which was a half a receptionist salary to explain to patients why the waiting area was so busy. This resulted in an estimated average cost per attendance of £145.62 which was based on average clinic attendances of 11 patients.

The recall data interval requested following each consultation allowed calculation of the glaucoma clinic cost per year per patient. We compared the data for those patients eligible for the community clinics who were attending the hospital with those who attended the community. This recall period was almost the same for both clinics (7.0 months for hospital and 6.9 months for community) thus gave no change in differential costs between the clinics. The cost to patients per year clinic attendance was similar between hospital and community clinics being £9.84 for the hospital-based service and £10.32 for the community-based service. The numbers seen per clinician in the community clinics were smaller.

4.9 Sensitivity Analysis

The factor in driving the difference in costs per patient was the cost per clinic. Therefore, we undertook a sensitivity analysis (see Table 4.7), investigating the effect of increasing the number of patients seen in the community clinic with and without omitting the nine percent of patients seen in the community who were referred back to the hospital for further investigations and treatment to illustrate the impact that the referral back into the hospital system had on the costs.

No of attendances	**11**	**15**	**20**	**25**
Cost/attendance	£145.62	£106.79	£80.09	£64.07
Cost/attendance omitting re-referral to hospital system	£134.00	£98.27	£73.70	£58.96

Table 4.7: Sensitivity analysis modelling number of patients seen in the community clinic per day against cost per attendance.

From Table 4.7, it can be seen that the number of patients seen in the community clinics has to increase substantially to make the costs comparable with the hospital setting. The 9% re-referral to the hospital clinics had a smaller effect on the costs.

4.10 A Comparison between the Time to Consultation and Number of patients seen per Optometrist between the Hospital and Community settings

	Ealing		Upney		Average	
	Hospital	Community	Hospital	Community	Hospital	Community
Time to consultation (Minutes)	41	12	37	9	39	11
Numbers seen per optometrist per session	7	5	9	6	8	6

Table 4.8: A comparison between the time to consultation and number of patients seen per optometrist between the hospital and community settings

4.10.1 Time to Consultation

The time to consultation for the community was shorter than that at the hospital. This was the same for both Ealing and Upney. The hospital to hospital and community to community comparison for the two locations showed similar time to consultation values.

There may be various reasons to why the time to consultation in the hospital was greater compared to the community, for example the fact that visual fields were only done in the hospital and the interpretation time for these results may have added to the time to consultation. However, in order to fully explain why this difference exists, further work flow investigations need to be carried out at the hospital settings to investigate why the time to consultation is greater within the hospital setting.

4.10.2 Patient Capacity

The number of patients seen by the optometrists in the hospital setting were approximately 45% greater than that in the community. This pattern was the same for both Ealing and Upney locations. This equates to quite a productivity difference between the two settings. An important point to take into consideration was that the community optometrists placed a cap on the number of patients that could be seen in the community setting per session. There was no such cap whilst working in the hospital settings.

4.11 Completeness of clinical records

Please refer to the Table 4.9 Word Document File.

There was excellent documentation of drop history, intraocular pressure and optic discs in both the hospital and community setting. This was not surprising as these are key assessments of glaucoma patients during an ophthalmological examination.

A far greater proportion of patients had their general health documented in the community compared to the hospital setting. The proportion with documentation of enquiry about general medical history was higher in Ealing hospital than in Upney. In both centres there was little difference between community and hospital.

4.11.1 Change in Intraocular pressure

Of the 200 patients seen in the hospital clinics, 20 had a change of greater than 5 mmHg documented. Of these 13 (65%) had a comment recorded. In the community 26 patients out of the 200 sampled had a change in their IOP documented. Of these, 12 (46%) had a comment documented by the optometrist.

	Hospital	**Community**
Comment	13	12
No comment	7	14

Chi squared = 1.62 p=0.20

Table 4.10: Chi squared for change in intraocular pressure and where a comment was recorded.

These results show that the efficiency of the clinician to document comments when a change in IOP was detected was similar between the hospital and community settings.

4.11.2 Change in Optic disc

Of the 200 patients seen in the hospital clinics, 8 patients had an increase in their cup to disc ratio of greater than 0.2 recorded. In all of these patient's cases, the clinician recorded a comment. In the community 2 patients of the 200 sampled had a change in their optic discs recorded. Of these two patients, 1 had a comment recorded by the optometrist and 1 did not.

It is difficult to draw any definitive conclusions from these findings as the sample size of patients who had a change in cup to disc ratio and where a comment was recorded, was very small. There would need to be a study with a larger number of clinical records which have change recorded to allow conclusions to be drawn.

4.12 Patient feedback Questionnaire results

A series of five questions were asked of patients who had attended the Moorfields community optometric glaucoma clinics at Ealing and Upney compared to their normal hospital clinic visit

Question	Positive	Negative	Other	Comments
Overall what did you think of your experience?	97	2	1	It felt different, I am used to Moorfields (1), I was happy (48), It was a nice experience (17)
Was there anything you particularly liked about your community visit?	100	0	0	Convenient (29), short waiting time (17), nice staff (23)
Was there anything you particularly disliked about your community visit?	2	85	13	Tests not as advanced (4), poor clinician discussion (1), clinical space small (3)
Is there anything we can do to improve your experience?	0	85	15	More space (1), more advanced equipment (2), more explanation about eye health (1)
Would you be happy to be seen in the community again?	92	8	0	

All patients responded to all questions hence N= % as the sample size totaled 100

Table 4.11: Patient feedback survey

4.12.1 Types of Questions

The following are the questions asked and the common responses.

Question 1: Overall what did you think of the experience?

The most common answer at both sites was:

Answer: I was happy with the experience.

Question 2: Was there anything you particularly liked about your community visit?

The common answers at both sites were:

Answer: The staff and optician were nice and polite.

Answer: The staff were efficient and the whole appointment was quicker than when I attend the hospital.

Answer: The location of the optometric practice was more convenient than the hospital clinic.

Even though the answer of the optometric practice being convenient was a common response at both sites, this answer was more common at Ealing.

Question 3: Was there anything in particular you disliked about your community visit?

The common answer at both sites was:

Answer: No there was nothing I really disliked about the community visit.

However, there were a few responses at both sites where the patient felt the equipment was not as advanced as the hospital and that the community optometrist could not answer all the management questions.

Question 4: Is there anything we could do to improve your experience?

The most common answer at both sites was:

Answer: No, there is nothing that I can think of to improve my experience.

There were a few patients who stated that more advanced equipment was needed at the optometric practices but this was not a common response.

Question 5: Would you be happy to be seen in the community again?

The most common answer at both sites was:

Answer: Yes, I would be happy to be seen in the community again.

4.12.2 Patient Feedback

There was a 100% response to this patient feedback survey. The results show that patient feedback in relation to the community run glaucoma clinics was generally positive. When the patients were questioned regarding their overall experience after visiting the community optometric practices in Ealing and Upney, 97% of patients gave a positive response. Additionally, 92% of patients confirmed they would be happy to be seen in the community again.

The reasons behind the positive feedback included convenience of location of the optometric practices, short waiting times and nice staff. The negatives from the visit included small clinical space. There was a comment made regarding poor clinician discussion however this was only one respondent. Some patients also felt that some of the testing equipment was not as advanced. The majority of the community optometric practices that participated in the scheme had modern equipment. It should be noted that visual fields were not required to be performed in the community arm of the scheme so the patients visiting the optometry practices did not have this investigation. Therefore, the last comment could be a patient perception issue.

5.0 Discussion

There is very little research that has been undertaken investigating the economic aspects of glaucoma care. The National Institute for Health and Care Excellence (NICE) has asked for more research to be undertaken on economic investigations into glaucoma care.

5.1 Patient costs

Our research was the first of its kind to investigate the direct and indirect patient costs involved in attending a single outpatient attendance in an inner city environment. Our results showed a moderately narrow range of mean cost figures across six sites. The figures ranged from £12.90-£16.20.[99]

The mean cost figures were derived from patient costs and societal costs. The patient costs consisted of travel cost, working time and leisure time. The societal cost per visit was calculated by adding together the costs of travelling for patients with free passes, costs for patients and companions working and leisure time. The total societal costs were higher than the sum of patient costs for all the glaucoma clinics.

Our results showed that the societal costs had a 62% contribution to the overall costs across all the sites. This was as a result of the high frequency of companions. In our study half (50%) of those questioned were accompanied to the outpatient department. This figure was remarkably constant at all sites with the exception of Upney, where only a third had come with someone (36/98).

A lot of the inner city areas investigated in our study comprised high proportions of ethnic minorities. There could have been cultural issues regarding female support and safety which would have lead to more females being accompanied. Our results showed that females were more likely to come with someone than males (176/291 (60%) vs 120/298 (40%) (chi square = 24, $p<0.001$)). This was supported by logistic regression which showed that being female (OR 2.21 (1.58-3.09) $P<0.001$) was an explanatory variable to being accompanied.

It could be assumed that the elderly would be more likely to be accompanied. Our results showed that there was only a slight trend towards the elderly being accompanied, such that only 55% of those in their 80s were accompanied, however 11/14 (79%) of those aged 90+ years were accompanied. Age was not significant in logistic regression modelling.

Overall our results showed that there was a high percentage of patients attending the glaucoma clinics who reported having no qualification. This value was found to be 66.6%. This compared to the 2007 national statistic of 11.4%. Logistic regression analysis did show that having no qualification (OR 1.56 (1.08-2.25) P=0.019 was also an explanatory variable to being accompanied.[99]

In relation to ethnicity, there was a suggestion that Asians were more likely to be accompanied (Indian 60%, Pakistani/Bangladeshi 57%) and Africans (33%) and Caribbean (43%) less likely. This may be the result of cultural differences within the different communities. Logistic regression modelling however did not show ethnicity to be an explanatory variable to patients being accompanied.[99]

Our findings show that half of the costs of attendance stemmed from accompanying persons. It could be concluded that being female and having less education made it more likely that someone would come with the patient.

These key findings related to inner city areas. In more rural areas the outcomes may very well be different in terms of patient and societal costs. Population demographics may vary from inner city to rural areas in relation to age, sex and ethnicity and qualifications.

In rural areas it could be hypothesized that travel costs could be higher and have a greater impact on overall costs as patients may have to travel further to attend hospital outpatient clinics. This may also have an impact on societal costs if the patient is accompanied due to travel distance. This is because there would be a greater impact on the accompanying person's time. The mode of transport may also be different between the two types of locations which could also have a bearing on patient costs.

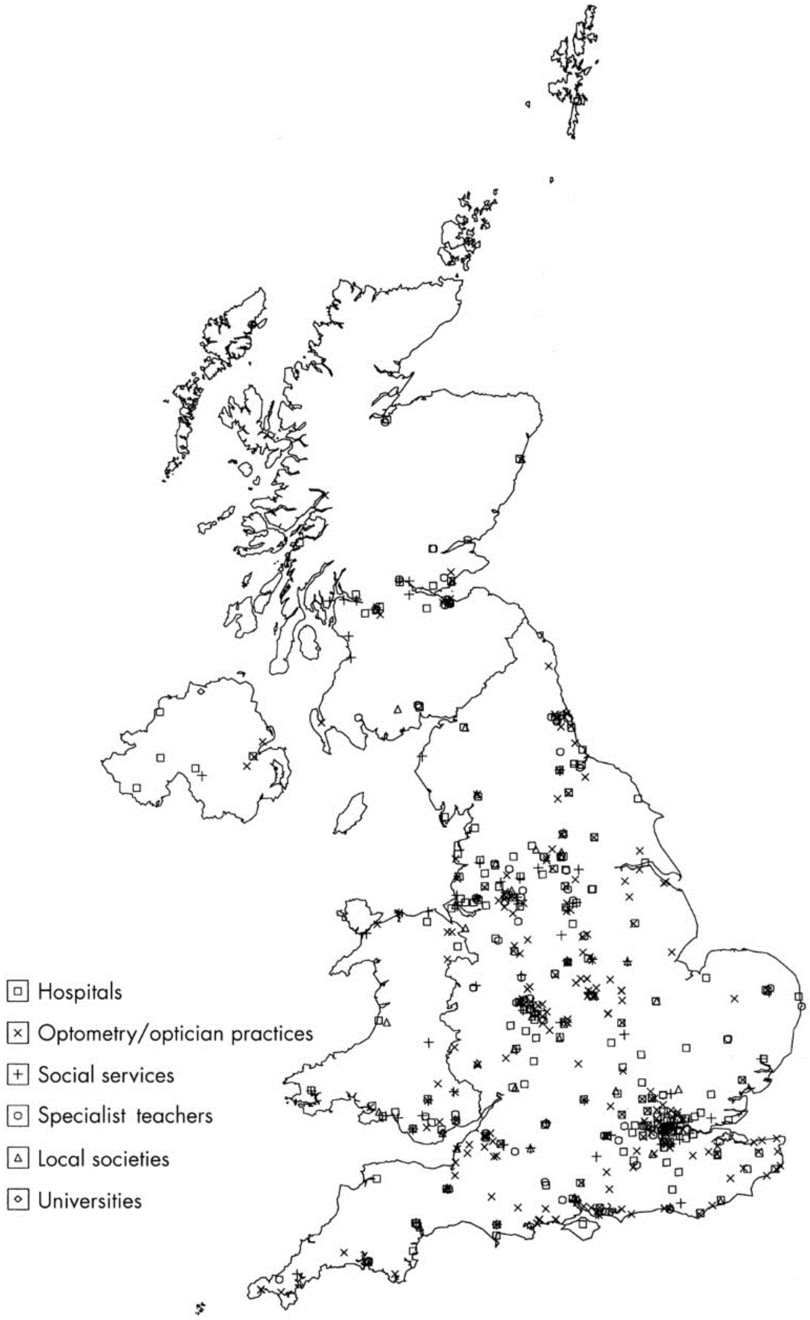

Figure 3.4: Relative distribution of Hospitals and Optometry/Optician practices.

The map (Figure 3.4) showing the relative Hospital and Optometry/Optician Practices distribution does show that there is variability in the spread of these Eye Clinics and Optometry Practices in rural areas of the UK and it is feasible that travel times and costs could be different.

5.2 Qualification

Our findings showed that there was a high degree of lack of qualification reported. It could be that as we were sampling a much older population, this is the reason for the lack of qualification. We found that the association of lack of qualification with age coincided with the national findings which also showed this trend (7.6% had no qualification in the 25-29 years age group which increased to 20.1% in the 55-64 years age group).[100]

There has not been substantial work done in relation to direct and indirect patient based costs in ophthalmology. However there have been some health economic studies in other areas of medicine.

One study looked at estimating time and travel costs incurred in clinic based screening for colorectal cancer using flexible sigmoidoscopy. They looked at the characteristics of mode of travel to screening, they also analysed the time and travel costs involved in attending as well as activities foregone owing to attendance and details of companions. These investigations were undertaken in order to establish whether such costs were likely to bias screening compliance.

Their study involved a large number of questionnaires (3525) across 12 centres throughout the UK. Their results showed that more than 80% arrived at the clinics by car and about 2/3rds were accompanied. On average the travel time was 130 minutes. The mean travel costs amounted to £6.10 per subject. The mean gross direct non-medical and indirect cost per subject was £16.90 and the mean overall gross cost per attendance was £22.40.[101]

The average of the mean cost figures per attendance from our sites was £14.22. This meant that the mean cost per attendance in the Frew study was nearly 60 % more than in our study. The higher mean cost figure in the Frew study is even more significant if you consider that the Frew data was published in 1999 and that there has been quite a bit of inflation since that period.

In the Frew study the non-manual classes were more strongly represented and the self employed less strongly. They concluded that the time and travel costs of clinic based screening was substantial and may effect the overall cost effectiveness of the screening programme and deter potential subjects from visiting.[101]

A dental study was undertaken in Sweden which looked at direct and indirect costs of dental trauma. This was a 2-year prospective study of children and adolescents. They studied total costs which included direct costs (health care service, loss of personal property, medicine and transport) as well as indirect costs (loss of production and leisure) of dental trauma to children and adolescents.

They looked at a random sample of 192 children and adolescents with dental trauma. They concluded that dental traumas result in both direct and indirect costs. However, there was a pre-dominance of direct costs. The degree of severity had an impact on the direct costs. The indirect costs were mostly due to compromised access to health care services.[102] This was in contrast to our findings which were mainly due to accompanying person's costs.

All of these studies show how important it is to consider health economics in medicine from a cost perspective and also to consider the hidden costs to patients especially when planning schemes in healthcare.

5.3 Clinic costs

Our study showed that it was more costly to run the community based glaucoma clinics compared to hospital based clinics. This was the same outcome as the Bristol scheme which was the other main study to investigate hospital and community glaucoma clinics.[42] The reason for the cost escalation in the community between the two schemes was however different.

The main reasons for higher community costs in our study was the large overhead cost for running the glaucoma scheme in the optometric practices along with fewer patients being seen in the community compared to the hospital clinics. In the Bristol scheme the main reason was that there was a difference in the patient recall interval between the community and the hospital. The community clinic in the Bristol scheme had an average follow-up of 6 months compared to a hospital average follow-up of 10 months. The 6-month follow-up for the community was actually due to the protocol set for the scheme, hence it was down to study design.

The second reason for the escalated costs in the community for the Bristol scheme relates to the re-referral of patients back from the community clinics to the hospital clinics. The average re-referral rate in the Bristol scheme was 22% (range 19-27%) over the two year study period. [42] The proportion in Bristol relates directly to the strict protocol for community reviews within the scheme. A change in this protocol could possibly reduce this proportion.

The re-referral rate in our study was 9%, this was substantially lower than the Bristol scheme. In our scheme the community optometrists discussed cases when they next met the consultant. This may help to explain the lower re-referral percentage. It was interesting to note that removal of the costs of these re-referrals in the sensitivity analysis did not have a profound effect on our clinic cost per attendance. Even if we model re-referral at 22%, the cost per clinic attendance in the community rises to £157.24 which represents a smaller proportionate contribution of re-referral to costs in our scheme.

One of the reasons for the higher costs in the community compared to the hospital setting in our scheme was that fewer patients were seen in the community. This was primarily down to restrictions put down by the community optometrists on the number of patients they felt comfortable examining per session in their practices.

There was the additional issue of the logistics involved in transferring elderly patients from the hospital into the community. According to the sensitivity analysis (Table 4.7), the community optometric clinics would have to see an average of 25 (12/13 per session) patients per day in order to make the costs comparable between the two settings. In our scheme all glaucoma clinic patients who had a 6 month or greater follow up review were suitable to be seen in the community. If a more selected case mix of patients were to be used, then an increased throughput might safely be achievable.

The primary reason for the large cost differential between the two settings in our scheme was the high opportunity cost for the community setting. The sight test fee (including fees from private and NHS sight tests) represents a declining proportion of practice revenue and there has been a cross-subsidization of the sight test fees with the sale of optical appliances. There has been an increased dependence on retail sales in the optometric business models. In response to this, optometric practices have had to adopt prime high street locations to maintain a commercial advantage but this has had the impact of substantially increasing rental costs.

Another interesting outcome from conducting this project in relation to the optometrists was the conflict they faced regarding the financial pressure of lost practice revenue against the desire to participate in the project. This was particularly evident among the Ealing optometrists during the data collection phase.

In our scheme it was shown that lost revenue from retail sales resulted in the substantial increase in the opportunity cost for the community setting. The sensitivity analysis modelling showed that the average cost per attendance could be reduced considerably by increasing the throughput of patients on a single overhead cost. These numbers are not feasible with a single optometrist. However, a large optometric practice with multiple consulting rooms may achieve such numbers.

It is unclear, at this stage, how many optometrists would be willing to undertake the additional training and take on this extended clinical role. The recruitment issues that came to light may highlight the possibility that the number of optometrists needed with a single overhead cost to improve cost effectivity is just not realistic.

5.4 Optometrist recruitment

The recruitment for community optometrists for this project was very difficult. At the start of this project multiple optometric practices were contacted regarding possible participation in the research however there was a significant proportion of optometrists that were unable to take part. The main reason for this was the impact of the community optometrist leaving the practice and the loss of revenue.

At Ealing the four community optometrists that did take part in the project had worked with the consultant previously which helped with the recruitment process for Ealing. The reliance on established relationships between consultants and community optometrists is not the solution and does not reflect the reality of how difficult it was to recruit community optometrists into our scheme.

An interesting outcome from conducting this project in relation to the optometrists who did participate was the conflict they faced regarding the financial pressure of lost practice revenue against the desire to participate in the project. This was particularly evident among the Ealing optometrists during the data collection phase.

5.5 Optometrist accreditation

The training and accreditation structure in our model had a competency base and a clinic base. The main aim of the training was to manage glaucoma and detect change. The competency base training structure was developed to include lectures, practicals and was assessed using written papers, multiple choice questions and objective structured clinical examinations.

The clinical base involved a clinic placement and the completion of a portfolio. The examination format for the clinical section of the training included a final exit viva and assessment of unseen clinical cases. This training format has been subsequently used to develop the College of Optometrists Professional Higher Certificate in glaucoma.

5.6 Training

The training programme used to accredit the community optometrists in our model has been the platform in the development of the Moorfields-UCL Higher Professional Certificate in glaucoma.[103]

This qualification specifically prepares optometrists to work in community and hospital-based schemes involving the diagnosis of OHT and preliminary diagnosis of COAG, when not working alongside a consultant ophthalmologist. The course also develops the optometrist's skills in detecting change in the clinical status and decision making in patients at risk of developing glaucoma.

The common themes between our training structure and the higher certificate are the two-day face to face training days which consists of lectures, tutorials and case discussions. The hospital clinical placement section and the completion of a portfolio with a final viva based assessment was another similarity between the two training schemes.[104]

The main difference with the Moorfields higher certificate is the online component. This offers more flexibility to the optometrists and allows them to tailor their training to their individual needs and schedule.

The Professional Higher Certificate in glaucoma offers a standardised training structure for optometrists working in glaucoma schemes in hospital-based and community-based settings. Additionally the course has been accredited by the College of Optometrists and approved for continuing education training (CET) points for the participating optometrists.[105]

5.7 Time to consultation

The time to consultation for the hospital was more than three times longer than that in the community. This was the same for both Ealing and Upney. The hospital to hospital and community to community comparison for the two locations showed similar time to consultation values.

It was interesting to note the patient satisfaction survey that when the patients were asked if there was anything in particular they liked about the community visit, only 17% mentioned short waiting time. The convenience of travel to the optometric practice (29%) and friendliness of staff (23%) was more important.

5.8 Patient capacity

The number of patients seen by the optometrists in the hospital setting was approximately 45% greater than that in the community. This pattern was the same for both Ealing and Upney locations. This equates to quite a productivity difference between the two settings.

An important point to take into consideration was that the community optometrists placed a cap on the number of patients that could be seen in the community setting per session. There was no such cap whilst working in the hospital settings. It was agreed as a part of the study that the optometrists would solely examine the Moorfields glaucoma patients in the session.

The reasons behind this restriction on patient numbers could have been that the optometrists were examining Moorfields patients in isolation for the first time without the clinical support of the consultant. The community optometrists were running the Moorfields clinics on a 1/2 day basis. There may also have been pressure to complete the Moorfields clinic on time so that there would not be an impact on the normal clinic that was resuming for the remainder of the day.

The patient capacity within other reported shared care schemes was variable, the Peterborough scheme had nine specialist optometrists in glaucoma with a 12-month mean number of 8.0 new and 4.0 follow-up assessments. It is not clear whether these numbers are per session as the literature does not state this.[19]

It is important to note that our scheme had only follow up patients in the community setting. The results from the East Devon scheme showed that on average over an 18-month period the 6 community optometrists with a special interest in glaucoma undertook 8.3 assessments per month. In comparison the 2 optometrists with specialist interest in the Waltham Forest scheme saw 10.3 new patients per month. Again the literature for these studies did not elaborate on the patient numbers seen per session. The Waltham Forest scheme had on going administrative issues with processing referrals and data collection regarding follow-up patients.[19]

The data from these schemes makes it difficult to reach a comparative conclusion regarding patient capacity as each scheme used a different number of optometrists and the data were recorded for different periods of time. The literature does not elaborate the number of sessions over which some of the patients were seen.

In general, however it appears that the optometrists in our scheme seem to see more than the East Devon and the Waltham Forest scheme but less than the Peterborough scheme.

The results from our scheme clearly highlighted the importance of patient capacity on the cost effectivity of the scheme. It was shown that the community optometrists had to see at least 25 patients per day to make the costs comparable. This figure is impossible using a single optometrist per session. In a normal high street optometric clinic, it would be difficult for an optometrist to examine 25 patients. This would be even more unlikely if the optometrist had to see 25 Moorfields glaucoma patients with more challenging clinical demands.

There are more important issues to consider when considering increasing patient volumes. High volume clinics can present serious safety issues in relation to optimum clinical care and management of the patient.
These issues, coupled with the difficulty in optometrist recruitment and commercial pressures which was clearly evident from our study, makes this model very difficult to sustain.

The possibility of having multiple community optometrists within one practice thereby restricting space and overhead costings is an option. This option is likely to come up against opposition due to the impact this model would have on the financial performance of the practice.

There is still the issue of optometrist recruitment and coordinating multiple optometrists to work together at the same time in the day in a Moorfields glaucoma clinical session. There is also the issue that, even though having a single overhead with multiple optometrists in theory may help improve cost effectivity, that single overhead site may have to be a larger unit which may have a negative impact on costs.

5.9 Completeness of clinical records

There was excellent documentation of drop history, intraocular pressure and optic discs in both the hospital and community setting. This was not surprising as these are key assessments of glaucoma patients during an ophthalmological examination.

A far greater proportion of patients had their general health documented in the community compared to the hospital setting. It is feasible that the hospital clinicians did ask about general health but failed to document their finding. Alternatively, an assumption could have been made by the hospital clinicians that the patients would volunteer any general health changes themselves. There is also the possibility that clinicians in the hospital may have been focused on the glaucoma investigation and management and overlooked the patient’s general health.

It is possible that the optometrists in the community were being over cautious as they were running Moorfields glaucoma clinics in their practices in isolation. The impact of the recent accreditation process could also have made the community optometrists more sensitive to documenting general health.

The data also highlighted the fact that a far greater proportion of the patients were asked about the side effects to the ocular therapy by the community optometrists in the optometry practices compared to the hospital clinicians in the hospital eye clinics.

The reasons behind this could be the same as with the documentation of general health. These include failure to document the side effects even though the question was asked. The hospital clinicians were expecting the patients to volunteer any side effects experienced from the medical therapy.

There is also the possibility that the hospital clinicians were focused on investigating and managing the glaucoma that they forgot to ask about the side effects. The impact of the recent training and accreditation could again have made the community optometrists more cautious and influenced them to ask about ocular therapy side effects, especially as they were working in isolation.

The proportion with documentation of enquiry about general medical history was higher in Ealing hospital than in Upney. An analysis of the glaucoma proforma used at the two hospital settings did not explain this difference.

Intraocular pressure and optic disc were recorded well in both settings. It was interesting to note that optic disc recording was performed 100% of the times in both hospital settings and in the Ealing community site. It was only in the Upney community site that the optic disc was not assessed for 3 of the patient. The main reasons for this were that 2 out of the 3 patients were being called back from previous recent appointments where optic nerve assessment had already been performed. There was also the fact that one of the three patients had dense cataract and therefore optic nerve assessment was not possible.

5.10 Change in Intraocular pressure

Of the 200 patients seen in the hospital clinics, 20 had an increase in IOP of greater than 5 mmHg documented compared to their previous visit. Of these 13 (65%) had a comment recorded. In the community 26 patients out of the 200 sampled had a change in their IOP documented. Of these 12 (46%) had a comment documented by the optometrist.

These results show that the efficiency of the clinician to document comments when a change in IOP was detected was similar between the hospital and community settings.

It seems that in both settings the comment when there was a change in IOP is surprisingly low when you take into consideration they are managing glaucoma patients. The possible reasons to explain this could be that the clinicians were placing more emphasis on the overall target IOPs set for the patient or the optic nerve assessment and visual field status. It could be that the clinicians were aiming to repeat the IOPs on the next visit before making a definite comment. A repeat analysis of record keeping needs to be performed to investigate this issue in more detail.

5.11 Change in Optic disc

Of the 200 patients seen in the hospital clinics 8 patients had an increase in their cup to disc ratio of greater than 0.2 documented. In all of these patient's cases the clinician recorded a comment. In the community 2 patients of the 200 sampled had a change in their optic discs documented. Of these two patients, 1 had a comment recorded by the optometrist and 1 patient did not.

It is difficult to draw any definitive conclusions from these results as the sample size of patients who had a change in cup to disc ratio and where a comment was recorded, was very small. There needs to be a larger sample of clinical records to enable analysis.

The record card data has shown areas which were well documented and other areas that were not so well documented by the clinicians. The implementation of electronic patient records (EPR) maybe a solution to poor record keeping. There are many eye departments in the UK that have already starting using programmes such as medisoft. Auditing ophthalmology units who are on EPR to assess clinical documentation would be very useful.

5.12 Patient feedback

Our study investigated patient feedback in attending the community clinics. The Bristol shared care glaucoma study also included a patient satisfaction survey. Their results supported our findings. The Bristol patients were significantly more satisfied with several aspects of care provided by the community optometrists, particularly relating to waiting times, compared to the hospital.[106]

The patient feedback results from our study also showed waiting times to be a positive aspect of the community clinics along with convenience of location and nice staff.

It seems possible that there is scope to evolve this model however the research shows that that is likely to be difficult due to optometrist recruitment and high volumes of patients that will be need to be seen to make the model cost effective.

The development of an alternative model needs some thought on whether we pursue a complete community based model in which case a mobile unit such as a Moorfields van could be considered. There would have to be detailed analysis of costs but this unit could be utilized in various locations.

Our research has highlighted the difficulties in optometrist recruitment so if the mobile unit option was to be explored then we would have to consider other work force options such as ophthalmic nurses, general practitioners with special interest and ophthalmic technicians. The ophthalmic nurses and ophthalmic technicians would have to be allocated by Moorfields. Again we would have to investigate the cost effectivity of such a model.

Instead if we were to investigate an alternative model within the hospital setting itself, we could then follow the Bristol model. This includes using hospital optometrists and ophthalmic nurses working in a shared care department within the hospital. Additionally, the advantage of using hospital optometrists working in the hospital glaucoma clinics would be that they would already have a good level of training and glaucoma clinical skills.

6.0 Conclusion

The flow diagram below illustrates step by step what was achieved as a part of this work.

Aim: The aim of this project was to investigate the cost-effectiveness, efficiency, safety and capacity of running a Moorfields glaucoma clinic in community optometric practices.

↓

Community optometrists were recruited to participate in the project

↓

The community optometrists were trained and accredited to examine glaucoma patients

↓

Data collection tools were developed to capture data on the various aspects under investigation in the project

Hospital data was collected on cost effectiveness, efficiency, safety and capacity

Moorfields glaucoma clinics were started in the approved community optometric practices

Once the community glaucoma clinics had been running for a period of time, community data collection was initiated

Cost effectiveness, efficiency, safety, capacity and patient feedback data were collected from the community sites

Hospital micro-costing was undertaken and consensus meetings were held with community optometrists for establishing community fees

Hospital and community data were analysed and compared. The findings were reported

↓

Conclusions were made on whether it was feasible to operate Moorfields glaucoma clinics in community optometric practices using accredited optometrists

Figure 3.1: Overall project design

There were many positive outcomes from our research. The community optometrists who were involved our scheme were in general found to be competent and safe when managing Moorfields glaucoma patients in their community optometric practices. This reflected positively on our training and accreditation process for the community optometrists.

The clinical record data showed that the optometrists were of a comparable level to the hospital when recording the clinical outcomes for the glaucoma examinations. The patient satisfaction questionnaire showed that the patient experiences were very positive with a large majority of the patients happy to be seen in the community again.

The patient based costs in travelling to the community clinics were found to be similar compared to the hospital setting. These outcomes were however representative of inner city areas of London. Further research would have to be done in other areas within the UK to see the general trend.

Additionally, a further positive outcome was that the times to consultation in the community clinics were shorter compared to the hospital. It was interesting to note that a relatively small proportion of the patients surveyed in the patient questionnaire mentioned this.

6.1 Training

The training programme developed in order to accredit the community optometrists in our study has been successfully used as a platform to develop the Moorfields-UCL Higher Professional Certificate in Glaucoma. The first event started on the 21st of September 2016.[104] Moorfields Eye Hospital aim to use the Higher Professional Certificate as a step towards obtaining a Diploma in Glaucoma.[103]

Our integrated glaucoma model was however shown to be more costly to run compared to the hospital based clinics. The Bristol shared care glaucoma scheme is the only other study to look at cost effectivity of community and hospital based glaucoma schemes. They also found their community scheme not to be cost effective.

Interestingly the reasons for the cost escalation between the two schemes was however different. The main reasons for higher costs in our study was the large overhead costs for running the glaucoma scheme in the optometric practices along with fewer patients being seen in the community compared to the hospital clinics.

In the Bristol scheme there were two main reasons for the increased costs. The first was the difference in the patient recall interval between the two settings. According to the study design the community clinics in the Bristol scheme had an average follow-up of 6 months. In comparison the hospital setting had a follow-up of 10 months.

The second reason for the cost escalation in the Bristol scheme relates to the re-referral of patients back from the community clinics to the hospital clinics. The average re-referral rate in the Bristol scheme was 22% over the two-year study period. This high re-referral figure was again as a result of the strict protocol set for the scheme, a change of which could reduce this proportion. It was interesting to note that as well as our scheme having a lower re-referral rate of 9%, through sensitivity analysis it was shown that there was a smaller proportionate contribution of re-referral to costs in our scheme.

In our model it was shown through sensitivity analysis that increasing the number of patients seen in the community per day made the costs more comparable between the hospital and community setting.

The community optometrists placed restrictions on the numbers of patients they were willing to see in the community per session therefore this further impacted on the community costings.

It is important to highlight that two community sites were active in this project therefore the generalizability of these findings needs to be established by analysing more community sites and conducting further research at locations outside London.

7.0 Future work

One of the possible recommendations to evolve the model could have been to utilize multiple optometrists in a single overhead cost unit. However, our research suggests that this will be difficult to achieve due to optometrist recruitment and the level of patient volume that would have to be seen to make the model cost effective.

A more viable model could be to run the shared care scheme within the hospital setting to avoid the high rental costs of the optometric practices. This model is being successfully run at Bristol hospital where there is a complete shared care department involving optometrists. This type of model could utilize the hospital optometrists but more interestingly accredited community optometrists could attend the hospital and participate in such schemes. It remains to be seen how many community optometrists would be willing to participate in such a model given the ever present financial pressure from community practice.

An advantage of such a model is that it may allow better clinical governance to be established along with an expansion of the case mix within the scheme as a result of the close ophthalmology support available within a hospital setting. It would also be interesting to see if the hospital shared care model had any impact on capacity within the shared care clinics. Further research is needed to investigate these aspects before any conclusions can be reached.

A second option could be to run these shared care clinics in hospital satellite settings or mobile units. An example of the mobile model is

Newmedica. One of the aspects of this company is to have mobile glaucoma units that are located outside the main hospital. Glaucoma patients are then examined in these units utilizing community optometrists and clinical assistants. Mount Vernon and Kingston hospitals are locations where mobile units are currently examining glaucoma patients. There is a clear requirement for cost effectiveness analysis of such schemes along with a rigorous assessment of efficiency, safety, capacity and patient acceptance.

ABBREVIATIONS

AMD	Age Related Macular Degeneration
AOP	Association of Optometrists
C/D	Cup to Disc Ratio
CET	Continuing Education and Training
CHANGES	Community and Hospital Allied Network Glaucoma Evaluation Scheme
CMG	Clinical Management Guidelines
COSI	Community Optometrist with Special Interest
CPD	Continuing Professional Development
EPR	Electronic Patient Record
GOS	General Ophthalmic Services
HES	Hospital Eye Service
HRT	Heidelberg Retinal Tomography
IGA	International Glaucoma Association
IOP	Intraocular Pressure

LOC	Local Optical Committee
LOCSU	Local Optical Committee Support Unit
MCEC	Moorfields Community Eye Clinic
MCOptom	Member of the College of Optometrists
MEH	Moorfields Eye Hospital
NCT	Non - Contact Tonometry
NDESP	NHS Diabetic Eye Screening Programme
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NTG	Normal Tension Glaucoma
OCT	Optical Coherence Tomography
OHT	Ocular Hypertension
OSCE	Objective Structured Clinical Examination
PAC	Primary Angle Closure
PACG	Primary Angle Closure Glaucoma
PCT	Primary Care Trust

QiO	Quality in Optometry
RNIB	Royal National Institute of Blind People
WEEU	West of England Eye Unit
WHO	World Health Organisation
VEGF	Vascular Endothelial Growth Factor

BIBLIOGRAPHY

Reference List

1. The College of Optometrists. What is an optometrist? [Internet]. 2016. [Accessed 18 February 2016]; Available from: http://www.college-optometrists.org/en/qualifying-as-an-optometrist/a-career-in-optometry/index.cfm

2. Optician. Top 10 Optical chains in the UK. [Internet]. 6 May 2015. [Accessed 17 August 2016]; Available from: https://www.opticianonline.net/features/top-10-optical-chains-uk

3. Boots Opticians. About Boots Opticians. [Internet]. 2016. [Accessed 17 August 2016]; Available from: http://www.boots.com/en/Boots-Opticians-About-Us_1116270/

4. Specsavers. The Specsavers Partnership. [Internet]. 2016. [Accessed 16 August 2016]; Available from: http://www.specsavers.co.uk/news-and-information/history/.

5. Optician. Boots Opticians announces merger with D&A.[Internet]. 29 January 2009 [Accessed 19 August 2016]; Available from: https://www.opticianonline.net/news/boots-opticians-announces-merger-with-da

6. Vision Express. About Vision Express. [Internet]. 2016. [Accessed 17 August 2016]; Available from: http://www.visionexpress.com/news/009.

7. Tesco Opticians. Collecting Clubcard points with Tesco Opticians. [Internet]. 2016. [Accessed 17 August 2016]; Available from: https://www.tescoopticians.com/collectingclubcardpoints/

8. The College of Optometrists. The routine eye examination. [Internet]. 2016. [Accessed 17 February 2016]; Available from: www.guidance.college-optometrists.org

9. Public Health England. Diabetic eye screening: programme overview. [Internet]. 1 January 2014. [Accessed 18 February 2016]; Available from: https://www.gov.uk/guidance/diabetic-eye-screening-programme-overview

10. NHS Screening Programmes. City & Guilds Qualifications. [Internet]. 2016. [Accessed 30 January 2016]; Available from: www.cpd.screening.nhs.uk

11. Scanlon PH. The English national screening programme for sight-threatening diabetic retinopathy. *J.Med.Screen.* 2008;**15**:1-4.

12. Pointer JS, Baranyovits P, O'Malley BP. The Kettering Diabetic Monitoring Programme: twelve months experience of an optometric practice-based scheme. *Ophthalmic Physiol Opt.* 1998;**18**:401-7.

13. Hulme SA, Tin U, Hardy KJ *et al*. Evaluation of a district-wide screening programme for diabetic retinopathy utilizing trained optometrists using slit-lamp and Volk lenses. *Diabet.Med.* 2002;**19**:741-5.

14. Okoli U, Mackay K. An evaluation of diabetic retinopathy screening models. *J.Public Health Med.* 2002;**24**:190-5.

15. Warburton TJ, Hale PJ, Dewhurst JA. Evaluation of a local optometric diabetic retinopathy screening service. *Diabet.Med.* 2004;**21**:632-5.

16. Dorset HealthCare, University NHS Foundation Trust. Dorset Diabetic Eye Screening Programme. [Internet]. 2016. [Accessed 18 February 2016]; Available from: www.dorsethealthcare.nhs.uk

17. Park JC, Ross AH, Tole DM *et al*. Evaluation of a new cataract surgery referral pathway. *Eye (Lond)* 2009;**23**:309-13.

18. Sharp J, Moriarty A, Warburton T, and Dixon J. Cataract assessment and direct referral: Stockport optometrists take the initiative. *Optometry Today*, 2003;**25**: 16-17.

19. Mcleod H, Dickinson H, Williams I, Robinson S, and Coast J. Evaluation of the chronic eye care services programme: final report. [Internet]. December 2006. [Accessed 12 April 2016]; Available from: http://www.eyecare.nhs.uk/uploads/ChronicEyecareServicesProgramme.doc

20. Gaskell A, McLaughlin A, Young E *et al*. Direct optometrist referral of cataract patients into a pilot 'one-stop' cataract surgery facility. *J.R.Coll.Surg.Edinb.* 2001;**46**:133-7.

21. Newsom, W., Gibbons H, Flanagan D, and Hingorani, M. Direct referrals for cataracts in Huntingdon. *Optometry Today* 2005;**45**:21-24.

22. Baker H RGHREDLJ. Effectiveness of UK optometric enhanced eye care services: a realist review of the literature. *Ophthalmic & Physiological Optics* 2016;545-57.

23. The Outside clinic. Home-visiting Optician. [Internet]. 2016. [Accessed 17 August 2016]; Available from: http://outsideclinic.co.uk/

24. World Health Organisation. Change the Definition of Blindness. [Internet]. 1972. [Accessed 19 February 2016]; Available from: www.who.int

25. RNIB. Supporting people with sight loss. [Internet].2016. [Accessed 17 August 2016]; Available from: http://www.rnib.org.uk/

26. The College of Optometrists. Independent Prescribing. [Internet]. 2016. [Accessed 19 February 2016]; Available from: http://www.college-optometrists.org/en/CPD/Therapeutics/independent-prescribing/

27. The College of Optometrists. Clinical Management Guidelines. [Internet]. 2016. [Accessed 25 April 2016]; Available from:http://www.college-optometrists.org/en/professional-standards/clinical_management_guidelines/

28. Hau S, Ehrlich D, Binstead K *et al*. An evaluation of optometrists' ability to correctly identify and manage patients with ocular disease in the accident and emergency department of an eye hospital. *Br.J.Ophthalmol.* 2007;**91**:437-40.

29. University Hospitals Bristol NHS foundation trust. Ophthalmology. [Internet]. 2016. [Accessed on 27 April 2016]; Available from: http://www.uhbristol.nhs.uk/for-clinicians/gp-handbook/ophthalmology/

30. Farrell S. Optometrist-led diabetic clinic audited. *Optometry Today* . 2012;**20**:52

31. Bedford Hospital NHS Trust. Ophthalmology-Moorfields:Clinics. [Internet]. 2016. [Accessed on 26 February 2016]; Available from: www.bedfordhospital.nhs.uk

32. York Teaching Hospital NHS Foundation Trust. Ophthalmology. [Internet]. 2016. [Accessed on 15 August 2016]; Available from: http://www.yorkhospitals.nhs.uk/our_services/az_of_services/ophthalmology/

33. The Royal College of Ophthalmologists. Maximising Capacity in AMD services. [Internet]. 2013. [Accessed on 18 August 2016]; Available from: https://www.rcophth.ac.uk/wp-content/uploads/2014/12/2013-SCI-302-Maximising-Capacity-in-AMD-Services-July-2013.pdf

34. Department of Health (1998). A first class service: quality in the new NHS. [Internet].1998. [Accessed on 24 March 2011]; Available from: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4006902

35. College of Optometrists (2011a). Code of ethics and guidelines for professional conduct. [Internet]. 2011. [Accessed on 24 March 2011]; Available from: http://www.college-optometrists.org/en/professional-standards/Ethics_Guidelines/index.cfm

36. National Health Service, England. General Ophthalmic Services (2008): Contract regulations. Statutory instrument 1185. [Internet]. 2008. [Accessed 24 March 2011]; Available from: www.legislation.gov.uk/uksi/2008/1185/pdfs/uksi_20081185_en.pdf

37. Quality in Optometry. Quality in Optometry England: Introduction. [Internet] 2016. [Accessed on 24 March 2016]; Available from: www.qualityinoptometry.co.uk

38. Department of Health (2000a). The NHS Plan: a plan for investment, a plan for reform. [Internet]. 2016. [Accessed on 24 March 2016]; Available from: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4002960

39. The College of Optometrists. Therapeutics. [Internet]. 2016. [Accessed on 4 March 2016]; Available from: www.college-optometrists.org

40. Local optical committee support unit. Supporting the development of local eye services. [Internet]. 2016. [Accessed on 16 August 2016]; Available from: http://www.locsu.co.uk/

41. The College of Optometrists. College of Optometrists (2011b) Code of ethics and guidelines for professional conduct. Clinical management guidelines. [Internet]. 2016. [Accessed on 24 March 2016]; Available from: http://www.college-optometrists.org/en/professional-standards/clinical_management_guidelines/index.cfm;

42. Coast J, Spencer IC, Smith L *et al*. Comparing costs of monitoring glaucoma patients: hospital ophthalmologists versus community optometrists. *J.Health Serv.Res.Policy* 1997;**2**:19-25.

43. Information Commissioner's Office (2011a). The Acts. [Internet]. 2016. [Accessed on 24 March 2016]; Available from: http://www.ico.gov.uk/for_the_public/the_acts.aspx

44. National Patient Safety Agency. What is a Patient Safety Incident? [Internet]. 2016. [Accessed on 15 August 2016]; Available from: http://www.npsa.nhs.uk/nrls/reporting/what-is-a-patient-safety-incident/

45. NHS Connecting for Health (2011). Spine factsheet. [Internet] 2011. [Accessed on 24 March 2011]; Available from: http://webarchive.nationalarchives.gov.uk/20130502102046/http://connectingforhealth.nhs.uk/resources

46. Foster PJ, Buhrmann R, Quigley HA *et al*. The definition and classification of glaucoma in prevalence surveys. *Br.J.Ophthalmol.* 2002;**86**:238-42.

47. Glaucoma Research Foundation. Normal-Tension Glaucoma. [Internet] 2014. [Accessed on 12 August 2016]; Available from: http://www.glaucoma.org/glaucoma/normal-tension-glaucoma.php

48. Sommer A. Intraocular pressure and glaucoma. *Am J Ophthalmol* 1989;**107**:186-8.

49. Congdon NG, Quigley HA, Hung PT *et al*. Screening techniques for angle-closure glaucoma in rural Taiwan. *Acta Ophthalmol.Scand.* 1996;**74**:113-9.

50. Foster PJ, Baasanhu J, Alsbirk PH *et al*. Glaucoma in Mongolia. A population-based survey in Hovsgol province, northern Mongolia. *Arch.Ophthalmol.* 1996;**114**:1235-41.

51. Foster PJ, Oen FT, Machin D *et al*. The prevalence of glaucoma in Chinese residents of Singapore: a cross-sectional population survey of the Tanjong Pagar district. *Arch.Ophthalmol.* 2000;**118**:1105-11.

52. Salmon JF, Mermoud A, Ivey A *et al*. The prevalence of primary angle closure glaucoma and open angle glaucoma in Mamre, western Cape, South Africa. *Arch.Ophthalmol.* 1993;**111**:1263-9.

53. International Glaucoma Association. About Glaucoma. [Internet] 2016. [Accessed on 11 March 2016]; Available from: www.glaucoma-association.com

54. American Academy of Ophthalmology. Who is at Risk for Glaucoma. [Internet] 1 March 2017. [Accessed on 10 July 2017]; Available from: https://www.aao.org/eye-health/diseases/glaucoma-risk

55. Leske MC, Connell AM, Wu SY *et al*. Incidence of open-angle glaucoma: the Barbados Eye Studies. The Barbados Eye Studies Group. *Arch.Ophthalmol* 2001;**119**:89-95.

56. Leske MC, Connell AM, Wu SY *et al*. Risk factors for open-angle glaucoma. The Barbados Eye Study. *Arch.Ophthalmol* 1995;**113**:918-24.

57. Leske MC, Wu SY, Hennis A *et al*. Risk factors for incident open-angle glaucoma: the Barbados Eye Studies. *Ophthalmology* 2008;**115**:85-93.

58. Tielsch JM, Katz J, Sommer A *et al*. Family history and risk of primary open angle glaucoma. The Baltimore Eye Survey. *Arch.Ophthalmol* 1994;**112**:69-73.

59. Bonovas S, Peponis V, Filioussi K. Diabetes mellitus as a risk factor for primary open-angle glaucoma: a meta-analysis. *Diabet.Med* 2004;**21**:609-14.

60. American Academy of Ophthalmology. Angle-Closure Glaucoma. [Internet] 18 December 2013. [Accessed on 10 July 2017]; Available from: https://www.aao.org/munnerlyn-laser-surgery-center/angleclosure-glaucoma-19

61. Office for National Statistics. Historic and Projected Data from the Period and Cohort Life Tables, 2012-based revised. [Internet] 2014. [Accessed on 27 March 2016]; Available from: http://webarchive.nationalarchives.gov.uk/20160105160709/http://ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-355125

62. Klein BE, Klein R, Sponsel WE *et al*. Prevalence of glaucoma. The Beaver Dam Eye Study. *Ophthalmology* 1992;**99**:1499-504.

63. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. *Br.J Ophthalmol* 2006;**90**:262-7.

64. World Health Organisation. Glaucoma is second leading cause of blindness globally. [Internet] 1 November 2004. [Accessed on 2 August 2017]; Available from: http://www.who.int/bulletin/volumes/82/11/feature1104/en/

65. Bosanquet n. Liberating the NHS - Eyecare: Making a reality of equity and excellence. [Internet] 2010. [Accessed on 1 April 2016]; Available from: http://www.locsu.co.uk/uploads/reports/liberating_nhs_by_prof_bosanquet_revised_text_march_2011.pdf

66. National Institute of clinical excellence guidelines (CG85). Glaucoma: diagnosis and management of chronic open angle glaucoma and ocular hypertension. [Internet] 22 April 2009. [Accessed on 4 April 2016]; Available from: https://www.nice.org.uk/guidance/CG85/chapter/1-Guidance

67. Local optical committee support unit. Advice on NICE glaucoma guidelines. [Internet] 11 February 2010. [Accessed on 4 April 2016]; Available from: http://www.locsu.co.uk/uploads/glaucoma_faqs_6th_revision_11-02-2010.pdf

68. College of Optometrists and College of Ophthalmologists. Joint Supplementary College Guidance on Supervision in relation to Glaucoma-related Care by Optometrists. [Internet] 21 December 2010. [Accessed on 8 May 2017]; Available from: https://www.college-optometrists.org/the-college/media-hub/news-listing/joint-group-nice-glaucoma-guideline-guidance.html

69. College of Optometrists and College of Ophthalmologists. Guidance on the referral of Glaucoma suspects by community optometrists. [Internet] 21 December 2010. [Accessed on 8 May 2017]; Available from: https://www.college-optometrists.org/the-college/media-hub/news-listing/joint-group-nice-glaucoma-guideline-guidance.html

70. Strong NP. How optometrists screen for glaucoma: a survey. *Ophthalmic Physiol Opt.* 1992;**12**:3-7.

71. Vernon SA. The changing pattern of glaucoma referrals by optometrists. *Eye (Lond)* 1998;**12 (Pt 5)**:854-7.

72. Myint J, Edgar DF, Kotecha A *et al*. A national survey of diagnostic tests reported by UK community optometrists for the detection of chronic open angle glaucoma. *Ophthalmic Physiol Opt.* 2011;**31**:353-9.

73. Shah S, Murdoch IE. NICE- impact on glaucoma case detection. *Ophthalmic Physiol Opt.* 2011;**31**:339-42.

74. El-Assal K, Foulds J, Dobson S *et al*. A comparative study of glaucoma referrals in Southeast Scotland:effect of the new general ophthalmic service contract, Eyecare integration pilot programme and NICE guidelines. *BMC Ophthalmology* 2015;**15**.

75. Lash SC. Assessment of information included on the GOS 18 referral form used by optometrists. *Ophthalmic Physiol Opt.* 2003;**23**:21-3.

76. Scully ND, Chu L, Siriwardena D *et al*. The quality of optometrists' referral letters for glaucoma. *Ophthalmic Physiol Opt.* 2009;**29**:26-31.

77. Henson DB, Spencer AF, Harper R *et al*. Community refinement of glaucoma referrals. *Eye (Lond)* 2003;**17**:21-6.

78. Devarajan N, Williams GS, Hopes M *et al*. The Carmarthenshire Glaucoma Referral Refinement Scheme, a safe and efficient screening service. *Eye (Lond)* 2011;**25**:43-9.

79. Bourne RR, French KA, Chang L *et al*. Can a community optometrist-based referral refinement scheme reduce false-positive glaucoma hospital referrals without compromising quality of care? The community and hospital allied network glaucoma evaluation scheme (CHANGES). *Eye (Lond)* 2010;**24**:881-7.

80. Vernon SA, Hillman JG, Macnab HK *et al*. Community optometrist referral of those aged 65 and over for raised IOP post-NICE: AOP guidance versus joint college guidance--an epidemiological model using BEAP. *Br.J.Ophthalmol.* 2011;**95**:1534-6.

81. Venerus K. Enhanced Service Case Study: IOP Refinement by Community Optometrists in Stockport. [Internet] 28 September 2010. [Accessed on 8 April 2016]; Available from: https://www.networks.nhs.uk/nhs-networks/healthcare-professionals-commissioning-network/knowledge-management-centre/best-practices-examples/Katrina%20-%20Case%20Study%20-%20Optometric%20Enhanced%20Services.pdf/at_download/file

82. Murdoch I, Theodossiades J. Is review of enriched populations the way forward for glaucoma case detection? *Eye (Lond)* 2003;**17**:5-6.

83. Parkins DJ, Edgar DF. Comparison of the effectiveness of two enhanced glaucoma referral schemes. *Ophthalmic Physiol Opt.* 2011;**31**:343-52.

84. Ratnarajan G, Newsom W, French K *et al*. The impact of glaucoma referral refinement criteria on referral to, and first-visit discharge rates from, the hospital eye service: the Health Innovation & Education Cluster (HIEC) Glaucoma Pathways project. *Ophthalmic Physiol Opt.* 2013;**33**:183-9.

85. Gray SF, Spry PG, Brookes ST *et al*. The Bristol shared care glaucoma study: outcome at follow up at 2 years. *Br.J.Ophthalmol.* 2000;**84**:456-63.

86. Mandalos A, Bourne R, French K *et al*. Shared care of patients with ocular hypertension in the Community and Hospital Allied Network Glaucoma Evaluation Scheme (CHANGES). *Eye (Lond)* 2012;**26**:564-7.

87. Syam P, Rughani K, Vardy SJ *et al*. The Peterborough scheme for community specialist optometrists in glaucoma: a feasibility study. *Eye (Lond)* 2010;**24**:1156-64.

88. The College of Optometrists and The Royal College of Ophthalmologists. Commissioning better eye care: Glaucoma. [Internet] 14 February 2013. [Accessed on 3 April 2017]; Available from: http://www.locsu.co.uk/uploads/enhanced_pathways_2013/joint_colleges_glaucoma_guidance.pdf

89. Vernon SA, Adair A. Shared care in glaucoma: a national study of secondary care lead schemes in England. *Eye (Lond)* 2010;**24**:265-9.

90. Giavarina D. Understanding Bland Altman analysis. *Biochem.Med (Zagreb.)* 2015;**25**:141-51.

91. Wordsworth S and Thompson S. An annotated costs questionnaire for patients: results of piloting. Paper presented to the UK health economists study group meeting. [Internet]. March 2001. [Accessed on 1 March 2011]; Available from: https://www.abdn.ac.uk/heru/document/BP/HERU_Discussion_paper_03-01.pdf

92. Office for National Statistics. Standard occupational classification (SOC 2000) and NS-SEC on the labour force survey. [Internet] 2016. [Accessed on 21 August 2016]; Available from: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/methodologies/standardoccupationalclassificationsoc2000andnsseconthelabourforcesurvey

93. Centers for Disease Control and Prevention. Epi Info. [Internet] 2016. [Accessed on 21 August 2016]; Available from: https://www.cdc.gov/epiinfo/index.html

94. Stata. Stata: Data analysis and statistical software. [Internet] 2016. [Accessed on 14 August 2016]; Available from: http://www.stata.com/

95. Petrol running costs. [Internet] 2009. [Accessed on 1 April 2009]; Available from: ww.theaa.com/motoring_advice/running_costs/advice_rcosts_guide.html

96. Labour cost survey. [Internet] 2009. [Accessed on 1 August 2009]; Available from: www.ec.europa.eu/eurostat/web/labour-market/labour-costs

97. Frick K.D. Micro-costing quantity data collection methods. *Med Care* 2009;**47**:S76-S81.

98. Microsoft. Microsoft excel. [Internet] 2016. [Accessed on 22 August 2016]; Available from: https://www.office.com

99. Sharma A, Jofre-Bonet M, Panca M *et al*. Hospital-based glaucoma clinics: what are the costs to patients? *Eye (Lond)* 2010;**24**:999-1005.

100. Department for innovation, National Statistics Universities & Skills Statistical First Release. The level of highest qualification held by adults:England 2007 (Revised). [Internet] 19 June 2008. [Accessed on 19 June 2016]; Available from: http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000798/DIUSSFR05-2008.pdf

101. Frew E, Wolstenholme JL, Atkin W *et al*. Estimating time and travel costs incurred in clinic based screening: flexible sigmoidoscopy screening for colorectal cancer. *J.Med.Screen.* 1999;**6**:119-23.

102. Glendor U, Jonsson D, Halling A *et al*. Direct and indirect costs of dental trauma in Sweden: a 2-year prospective study of children and adolescents. *Community Dent.Oral Epidemiol.* 2001;**29**:150-60.

103. Moorfields Eye Hospital NHS Trust. Moorfields-UCL Higher Certificate in Glaucoma for Optometrists. [Internet] 2016. [Accessed on 4 August 2016]; Available from: http://www.moorfields.nhs.uk/sites/default/files/Leaflet%20HCG%20September%202016.pdf

104. University College London. Advanced Clinical Optometry - Glaucoma (Level 2) (Professional Higher Certificate in Glaucoma). [Internet] 2016. [Accessed on 12 August 2016]; Available from: https://www.ucl.ac.uk/ioo/study/cpd/optometryglaucoma

105. The College of Optometrists. Professional Higher Certificate in Glaucoma– Moorfields Eye Hospital in partnership with University College London. [Internet] 2016. [Accessed on 12 August 2016]; Available from: http://www.college-optometrists.org/en/CPD/hq/glaucoma-hq/phc-glauc-moorfields.cfm

106. Gray SF, Spencer IC, Spry PG *et al*. The Bristol Shared Care Glaucoma Study--validity of measurements and patient satisfaction. *J.Public Health Med.* 1997;**19**:431-6.

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The author has no commercial interest in any aspect of this thesis.

APPENDIX

APPENDIX A

PATIENT COST QUESTIONNAIRE

Site:

Patient Costs Questionnaire.

Subject ID										
Date of birth										
Todays date										

Sex?		1=Male, 2=Female
Ethnic category?		1=White, 2=Eastern Asian, 3=Indian, 4=British Indian, 5=Pakistani, 6=BritishPakistani, 7=African, 8=Caribbean, 9=Turkish, 10=other
Highest qualification attained by full time students and school children?		1=None,2=1+O level passes;1+CSE/GCSE any grades;NVQ level 1;Foundation GNVQ. 3=5+O level passes;5+CSEs(grade 1's);5+GCSEs(grades A-C);School Certificate; 1+ A levels/AS levels;NVQ level 2;Intermediate GNVQ. 4=2+ A levels;4+ AS levels;Higher School Certificate;NVQ level 3;Advanced GNVQ. 5=First degree; Higher degree; NVQ levels 4 and 5; HNC;HND;Qualified Teacher Status;Qualified medical doctor;Qualified Dentist; Qualified Nurse;Midwife; Health Visitor.6=Other.
Which activities are you currently involved in?		1=Paid work <=20 hrs per week, 2=Paid work > 20hrs per week, 3=Student part-time, 4=Student full-time, 5=Volunteer work <=20hrs per week, 6=Volunteer work > 20hrs per week, 7=Retired, 8=None, 9=Other, 10=Unemployed.
Employment type?		1=Managers and senior officials, 2=Professional occupations, 3=Associate professional and technical occupations, 4=Administrative and secretarial occupations, 5= Skilled trade occupations, 6=Personal service occupations, 7=Sales and customer service occupations, 8=Process;plant and machine operatives, 9=Elementary occupations, 10=Retired, 11=Unemployed
If retired, what was your past occupation?		1=Managers and senior officials, 2=Professional occupations, 3=Associate professional and technical occupations, 4=Administrative and secretarial occupations, 5=Skilled trades occupations, 6=Personal service occupations, 7=Sales and customer service occupations, 8= Process;plant and machine operatives, 9=Elementary occupations, 10=Not applicable
Which transport method did you use to arrive at the hospital?		1=Walk, 2=Bus, 3=Cab/Taxi, 4=Car, 5=Train, 6=Hospital transport, 7=More than one

If more than one method of transport was used, please specify combination:

____

Did you come alone?		1=Yes, 2=No
If no, what is the occupation of the person that came with you?		1=Managers and senior officials, 2=Professional occupations, 3=Associate professional and technical occupations, 4=Administrative and secretarial occupations, 5=Skilled trades occupations, 6=Personal service occupations, 7=Sales and customer service occupations, 8=Process; plant and machine operatives, 9=Elementary occupations, 10=Retired, 11=Unemployed, 12=Not applicable, 13=other.
What was the reason for the patient being accompanied by the other person?		1= Mobility reasons, 2=Translation reasons, 3=Moral support, 4=Disability reasons, 5=Not applicable.

Cost of travel? Bus Fare:_________,If free pass distance travelled:__________
Train Fare:_________,If free pass distance travelled:__________
Taxi Fare:________
Car: mileage:________ ,car park charges:______ ,congestion charge:_______
Hospital transport mileage:________

Cost of travel (One way to the hospital)?_______________

Travel time (One way to the hospital)?_________________

Are you going back the same way you came?		1= Yes, 2=No
If no, what is the transport method you will using for your return journey?		1= Walk, 2=Bus, 3=Cab/Taxi, 4=Car, 5=Train, 6=Hospital transport, 7=More than one 8=Not applicable.

If more than one method of transport was used, please specify combination:

____

Cost of return journey? Bus Fare:__________,If free pass distance travelled:__________
Train Fare:_________,If free pass distance travelled:__________
Taxi Fare:__________
Car: mileage:__________,congestion charge:__________
Hospital transport mileage:__________

Cost of return journey (One way from the hospital)? _____________

In summary the total cost incurred for the hospital visit (two way journey to and from the hospital) by the patient was:________________

Total cost agreed with patient [ ] 1=Yes 2=No

Was any time taken of work in order to attend the appointment?		1=Yes , 2=No
Who took the time off work?		1=Patient, 2=Person who accompanied patient, 3=Both, 4=Not applicable

In terms of other expenses incurred:

Was it taken as sick pay or loss of earnings?		1=Sick pay, 2=Loss of earnings, 3=Not applicable
Was it taken as a full day or half day?		1=Full day, 2=Half day, 3=Not applicable

If the patient took time off work:

How much money was lost, if there was loss of earnings for the patient?________________

If the person who accompanied the patient took time off work:

Was it taken as sick pay or loss of earnings?		1=Sick pay, 2=Loss of earnings, 3=Not applicable
Was it taken as a full day or half day?		1=Full day, 2=Half day, 3=Not applicable

How much money was lost, if there was loss of earnings for the accompanying person?________________

Were there any other reasons that expenses were incurred in order to attend the appointment?

☐ 1=Yes 2=No

If the answer is yes, what were these other expenses?
Eg: Nanny expenses, baby sitters, house sitters for other dependent relatives.

Reason:___________________________cost:___________

Reason:___________________________cost:___________

APPENDIX B

HOSPITAL - TIME TO CONSULTATION

Hospital - Time to Consultation

Site:
Patient ID:

1. What time did to you arrive at the clinic?	am/pm
2. What time was your appointment?	am/pm
3. What time did you see the fields technician?	am/pm
4. What time did you see the nurse?	am/pm
5. What time did you see the Doctor?	am/pm
6. What time did you leave the clinic	am/pm

APPENDIX C

COMMUNITY - TIME TO CONSULTATION

Community - Time to Consultation

Site:
Patient id:

1. What time did you arrive at the optician practice? am/pm
2. What time was your appointment? am/pm
3. What time did you see the optometrist? am/pm
4. What time did you leave the Optician practice? am/pm

APPENDIX D

RECORD COMPLETENESS PROFORMA

Record Completeness Proforma.

Date:
Site:
Clinician Grade:
Reference ID:

Field………………..	Y/N.	Comment…………………………...
Name	Y/N	
Date	Y/N	
ID	Y/N	
Drop History	Y/N	
Side effects	Y/N	
General health	Y/N	
Comparison with past	Y/N	
VA R	Y/N	
VA L	Y/N	
VA ph R	Y/N	
VA ph L	Y/N	
Change VA?	Y/N	
If change any comment/action?	Y/N	
IOP	Y/N	
Change?	Y/N	
If any change comment?	Y/N	
Disc	Y/N	
Change?	Y/N	
If any change comment?	Y/N	
Fields	Y/N	
Change?	Y/N	
If any change comment?	Y/N	
In the past if fields were requested, were they performed?	Y/N	
Next appointment	Y/N	
Diagnosis	Y/N	1=POAG, 2=OHT, 3=Glaucoma suspect, 4=Treated PACG, 5=ACG, 6=Optic Atrophy 7=NTG, 8=Congenital glaucoma, 9= Secondary glaucoma

APPENDIX E

COMMUNITY-PATIENT FEEDBACK QUESTIONNAIRE

PATIENT FEEDBACK QUESTIONNAIRE.

Anurag Sharma: Hello my name is Anurag Sharma, I am ringing from Moorfields Eye Hospital, Ealing. Thank you for attending the community clinic. I am ringing to ask you your thoughts on your visit in the community. Your responses are to help us understand the patient perspective and improve service. Would you have a few minutes to spare?

Site:
Patient ID:

Anurag Sharma: Overall what did you think of the experience?
Patient:

Anurag Sharma: Was there anything you particularly liked about your community visit?
Patient:

Anurag Sharma: Was there anything you particularly disliked about your community visit?
Patient:

Anurag Sharma: Is there anything we could do to improve your experience?
Patient:

Anurag Sharma: Would you be happy to be seen in the community again?
Patient:

APPENDIX F

PEER REVIEWED PUBLICATIONS ORIGINATING DIRECTLY FROM THIS THESIS

Please refer to Anurag Sharma publication files