DELIVERING OPTOMETRIC CARE IN THE UK

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Optometrists play an important part in delivering eye care in the United Kingdom; however opportunities for practitioners to extend their role through co-management of patients with ophthalmologists vary across the country. Devolution in Scotland and Wales has led to greater emphasis on community based care in these regions. This thesis reviews the current situation and, by examining ophthalmic outpatient clinic data, discusses further opportunities to reduce demands on secondary care and the cost savings that can be made.

To assess whether the profession is currently in a position to adopt an extended clinical role, changes in the availability of optometric instrumentation are assessed over a two year period. An increased prevalence of fundus cameras and contact tonometers places optometrists in a good position to take on further responsibilities in glaucoma management, however future investment could be impacted by the current economic climate as value for money became increasingly important to practitioners looking to purchase equipment.

Methods of training optometrists in the necessary skills to utilise new technology to extend their role are evaluated in terms of both learning and cost effectiveness. Interactive distance learning is proposed as a convenient and effective method to deliver continuing professional development.

Any changes to optometric practice must take account of the need for a sustainable business and the importance of attracting and retaining patients. The views of patients are assessed through a validated service quality questionnaire, SERVQUAL. The questionnaire is found to be valid for use in an optometry setting. Patients have a generally positive view of the service quality they receive from their optical practice and consider the intangible aspects, in particular responsiveness and empathy, most important.

Optometrists are well placed to increase their role in patient management; however a viable business model must exist to enable investment in instrumentation and training.

Keywords: UK optometry
Service Quality
Optometric Instrumentation
Co-management
Training Methods

DEDICATION

To my wonderful family-Mum, Dad, Michael, and Suzi. Thanks for always being so supportive. And to my husband Neil-thanks for the wedding and change of name stress! But most of all for believing in me.

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CHAPTER 1

Introduction

1.1: Overview

The role of optometrists in the United Kingdom (UK) is governed by the General Optical Council (GOC) which was created by an Act of Parliament, The Opticians Act 1958 (followed by the Opticians Act 1989), with the function of "…*promoting high standards of professional education and professional conduct among opticians…*" (Opticians Act, 1989). The GOC defines the role of an optometrist as one who "…examines eyes, tests sight and prescribes spectacles or contact lenses for those who need them. They also fit spectacles or contact lenses, give advice on visual problems and detect any ocular disease or abnormality, referring the patient to a medical practitioner if necessary. Optometrists may also share the care of patients who have chronic ophthalmic conditions with a medical practitioner. Once qualified, optometrists can undertake further training to specialise in certain eye treatment by therapeutic drugs". (GOC, 2010a). Optometrists in the UK who are registered with their local Primary Care Trust (PCT) can provide National Health Service (NHS) funded eye examinations to those eligible under General Ophthalmic Services (GOS).

Blach (2001) stated that existing UK ophthalmology resources of around 800 consultants and 1400 more junior ophthalmologists and trainees were not sufficient to provide total ophthalmic care in the community and required assistance from optometrists and orthoptists. The extent to which optometrists share the care of patients with medical practitioners varies across the country. Optometrists in certain Primary Care Trusts (PCTs) have the opportunity to participate in National Health Service (NHS) schemes such as cataract co-management and diabetic screening for which they are paid a fee. Other schemes that exist outside the NHS include Driver and Vehicle Licensing Agency (DVLA) field screening, and some laser clinics have co-management arrangements with optometrists who are paid a fee for referrals and follow-up appointments. These schemes are managed and defined by the local partners.

1.1.1: Co-management schemes

Co-management of patients with glaucoma, diabetes and cataract by optometrists and ophthalmologists are the most commonly found community management schemes in optometry, although schemes also exist for the management of low vision (Margrain *et al*, 2005) and paediatric optometry (Karas *et al*, 1999). Protocol for such schemes and their benefits are discussed here.

1.1.1.1: Glaucoma co-management

Alwitry (2008) in his book *"Shared Care Glaucoma"* notes that the number of glaucoma patients in the Hospital Eye Service (HES) is increasing rapidly due to the ageing population and a rise in glaucoma detection. The Bristol shared care glaucoma study reports that between 10 and 25% of ophthalmologists' outpatient appointments are with glaucoma patients (Gray *et al*, 1997). This increasing workload for ophthalmologists leads to longer waiting times for patients and takes up appointments which could be made available for emergency cases. The benefit to the patient is convenience as they are able to visit one of a number of participating optometrists with, generally, a wider range of appointment times. Patient satisfaction has been shown to be higher amongst those in shared-care schemes than with patients only receiving hospital-based care (Gray *et al*, 1997; Reidy *et al*, 1998). The optometrist receives financial remuneration, for example in the Bristol shared care glaucoma study an £18 fee per visit was paid (Gray *et al*, 1997), however this amount, equivalent to £24.16 in 2010[1], is not significantly greater than the fee received for an NHS eye examination (£20.70 from 1st April 2010 (Association of Optometrists, 2010a)). Optometrists also benefit from training provided such as in the Bristol study where those participating received 15 hours of lectures and 10 hours of practical training (Gray *et al*, 2000).

Glaucoma is a chronic eye condition needing lifelong monitoring. This makes it particularly suitable for co-management schemes due to the high frequency of follow-up visits needed. The prevalence of glaucoma in the UK is around 2% of the population aged over 40 (Azuara-Blanco *et al*, 2007). Additionally, those with ocular hypertension are included in these schemes (Association of Optometrists, 2009a) and this condition affects 4-5% of the adult population (Azuara-Blanco *et al*, 2007).

Optometrists routinely carry out the tests performed at glaucoma follow-up appointments, in particular visual fields, intra-ocular pressure (IOP) and optic disc assessment. Therefore they are in a good position to expand their role into glaucoma management. Through the College of Optometrists, practitioners can complete a postgraduate certificate in glaucoma. After the introduction of a second certificate in 2004, optometrists completing both parts are recognised with a diploma in glaucoma (Edgar & Rudnicka, 2007).

The Association of Optometrists (AOP) offers advice on its website on the standards of accreditation needed for optometrists to be included in a glaucoma co-management scheme. It states that any or all of the following criteria may be used (Association of Optometrists, 2009a):

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[1] based on inflation rates from http://www.statistics.gov.uk/StatBase/expodata/files/3974638511.csv

- minimum 10 Continuing Education and Training (CET) credits per annum (preferably including areas relevant to glaucoma and its management)
- attendance on regular courses as approved by the Local Optical Committee (LOC) and/or Health Authority/Trust/PCT
- attendance at ophthalmology clinics
- minimum standard in an assessment of knowledge and skills
- possession of and competence with specified equipment

Patient criteria

The AOP website contains protocol on which patients are suitable for glaucoma co-management schemes (Association of Optometrists, 2009a). These are:

- those with ocular hypertension
- those with suspicious discs and/or fields but no definite diagnosis of glaucoma
- narrow angle glaucoma patients with patent laser iridotomies/ peripheral iridectomies
- those with stable glaucoma

Stable glaucoma is defined by the Royal College of Ophthalmologists as patients fitting the following criteria (Association of Optometrists, 2009a):

- no change in the management of the patient's glaucoma for two years
- no new symptoms for two years which could be attributable to progressive visual deterioration, such as a drop in acuity or subjective change of a paracentral visual field defect
- an intraocular pressure remaining below a level satisfactory for the individual patient for two years

- no change in the optic disc appearance for two years. This should preferably be based on good quality optic disc photography undertaken in the HES at baseline
- no significant change in visual field over two years

Patients fitting these criteria are monitored by the community optometrist at intervals agreed on a local level. The patient is re-referred to their ophthalmologist if the above criteria are not met or if there are medication related issues such as non-compliance or suspected side-effects.

Glaucoma management has been a subject of controversy in the optical press recently after National Institute for Clinical Excellence (NICE) guidelines (April 2008) suggested that ocular hypertension should be defined as those patients with IOP readings of over 21mmHg. The guidelines required optometrists to refer these patients to an ophthalmologist.

1.1.1.2: Co-management of cataract

Cataract is the most common cause of visual impairment in the elderly (Reidy *et al*, 1998) and is the largest sub-speciality within ophthalmology (Sharp *et al*, 2003). Typically the referral pathway for cataract consisted of 8 stages (Figure 1.1) (Association of Optometrists, 2009b).

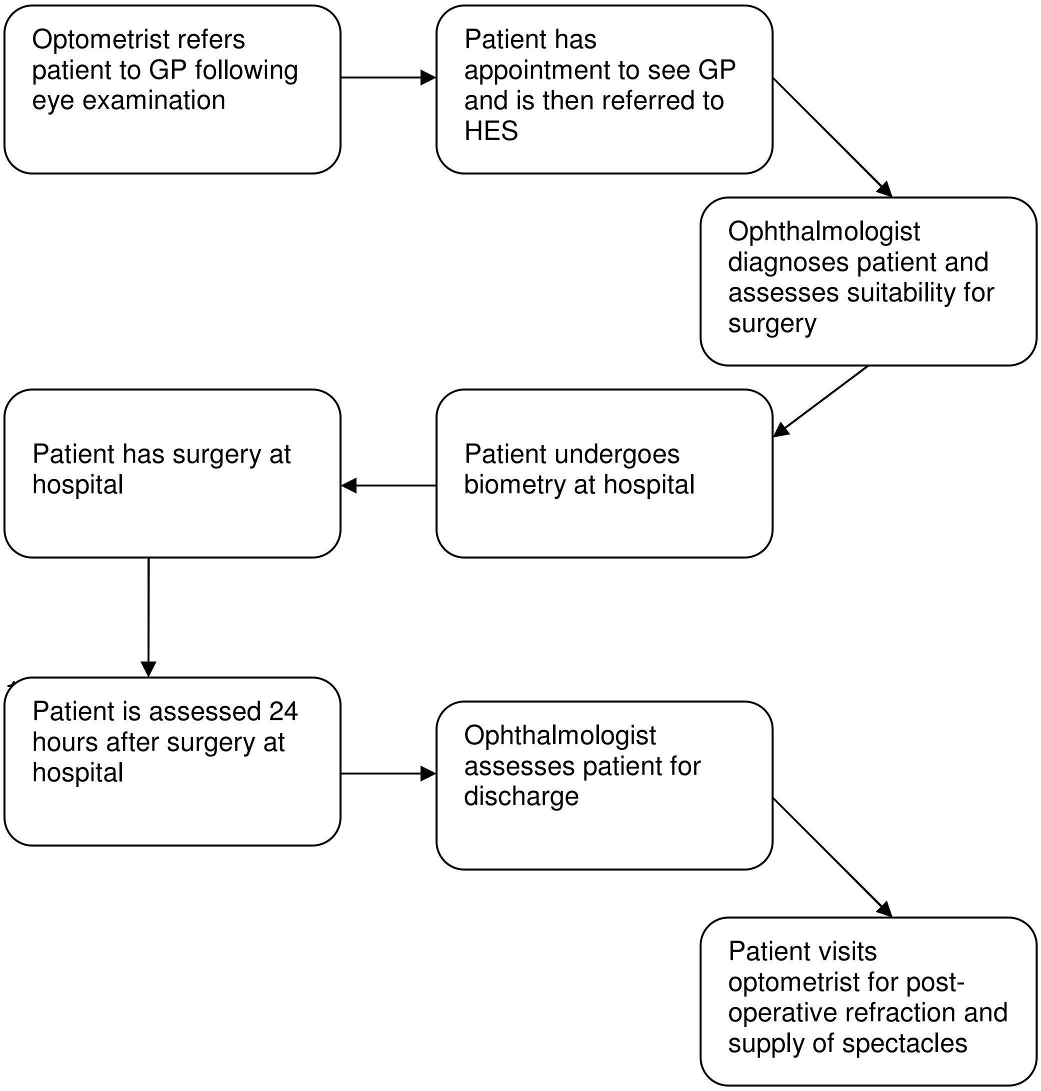

Figure 1.1: Typical cataract referral and treatment pathway

This leads to quite a protracted process for the patient and what may be a significant period of time before they are supplied with suitable spectacles for their post-op refraction. Co-management schemes reduce the number of steps in the process and may be as follows:

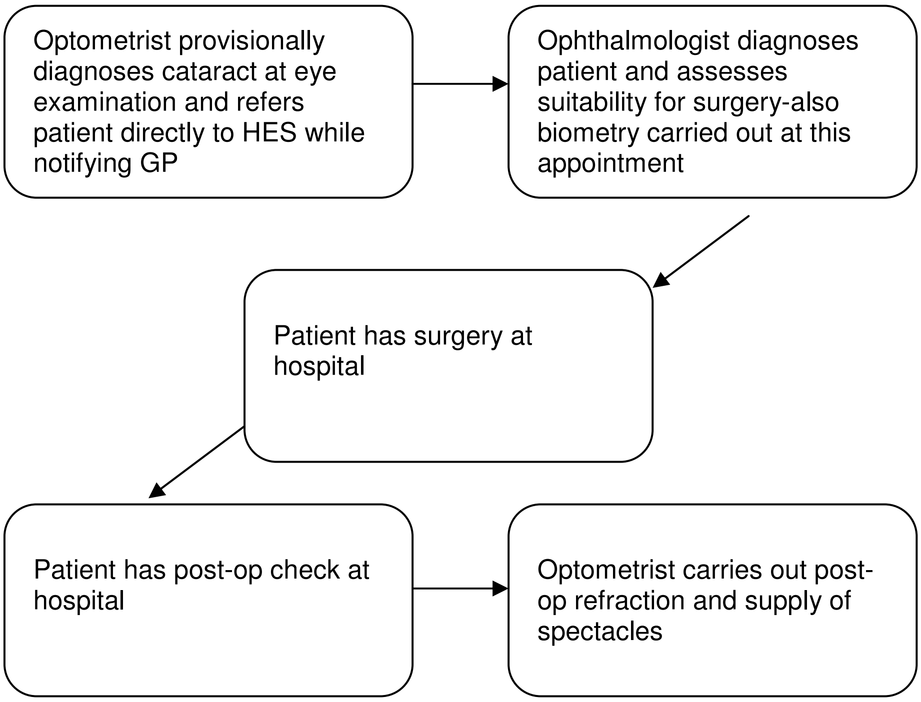

Figure 1.2: Co-management scheme with reduced pathway

Cutting out the excess steps in the patient journey reduces the number of appointments needed at the hospital and therefore the waiting list time for surgery. A scheme in Stockport followed this pathway and optometrists played a greater role in the patient's management both pre and post-operatively (Sharp *et al*, 2003; Warburton, 2000). Optometrists had to be accredited to take part in the scheme by agreeing to take part in audit and attending training sessions. Those accredited received £40 per assessment (Sharp *et al*, 2003) (the fee was not based on the number of referrals in order to reduce unnecessary referrals). In this scheme, patients who were interested in cataract referral made an appointment with an accredited optometrist and completed a self-administered questionnaire on their medical history to bring to the appointment. As well as a detailed ocular examination, the optometrist would discuss the advantages and disadvantages of surgery with the patient before deciding whether to refer.

Patient criteria

The key criteria for referral were (Sharp *et al*, 2003):

- Visual impairment primarily caused by cataract
- Reduced visual acuity, glare or other visual problems in the affected eye or eyes
- Visual problems impacting on normal activities
- Patient is willing to undergo surgery

Exclusion criteria for cataract surgery are (Bezan *et al*, 1992):

- Improvement in visual function is unlikely after surgery due to existing poor ocular health
- Patient does not want surgery or is happy with current visual ability
- Patient has very poor general health

The Stockport study found that 98% of patients referred to the HES through the scheme were listed for cataract surgery compared to only 62% previously (Sharp *et al*, 2003). This was largely due to patients having the opportunity to discuss surgery before their referral.

Post-operatively, optometrists in Stockport completed refraction and clinical examination after the patient has received their 1-week post-op check at the hospital. Previously, the patient would have to return to the hospital after refraction for a 4-week post-op check. Optometrists were given a clinical assessment form to complete which highlighted instances when the patient would require re-referral such as poor acuity, pain, redness or anterior chamber flare. The optometrist would also include the patient’s refraction in feedback to the ophthalmologist allowing them to monitor their surgical results (Warburton, 2000).

A survey of patient satisfaction was conducted and results showed that, while patients were satisfied with both hospital and optometrist post-op appointments, more patients were very satisfied with optometrist appointments (Warburton, 2000).

The main benefits for patients of cataract co-management are shorter waiting times, the opportunity to discuss surgery before referral, more convenient post-operative care and fewer appointments to attend.

1.1.1.3: Diabetes co-management

Diabetes affects over 4% of the UK population (Diabetes UK, 2011). At diagnosis, 37% of type II diabetics have diabetic retinopathy (NHS, 2008). In 2003 the Department of Health set out a 10-year plan for diabetic health care which included a target for 100% of diabetics to be offered screening for diabetic retinopathy by the end of 2007. However, due to the equivalent of 2000 new diagnoses of diabetes per week since 2003, this led to a massive surge in demand for the service. By April 2008, 89.4% of diabetics had been offered screening in the previous 12 months (Thakrar, 2008).

From January 2007, PCTs introduced a retinal camera based scheme for diabetic retinopathy screening (Harvey, 2008). These schemes may or may not involve optometrists. In areas where optometrists are not directly involved, the optometrist is only responsible for advising the patient to attend this screening regularly (Association of Optometrists, 2007). In these areas the screening is carried out at hospitals or specialist mobile screening units and is conducted by medical photographers and ophthalmologists.

Optometrists must be accredited in order to participate in such schemes and from 2008 this has included completion of at least some modules of the City & Guilds

Certificate in Diabetic Retinopathy Screening (Association of Optometrists, 2007). A minimum of six modules must be passed in order to complete the certificate; however optometrists are exempt from three of these due to their previous learning needed for GOC registration (Blakeney & Broadbent, 2007). The training takes place in the form of lectures, practical work, private study and work based activities.

Accredited optometrists may take part in screening in one of 4 ways (Association of Optometrists, 2007):

- Screening combined with sight test - with/without grading
- Screening without sight test – grading completed at the same time
- Screening without sight test – grading completed later (screening may be completed by a trained optical assistant)
- Grading is performed after screening has taken place elsewhere

Fundus images captured by retinal camera are graded based on the following six categories (Harvey, 2008):

- Level 0 / R0: no retinopathy. Patients are advised to continue with routine screening appointments
- Level 1 / R1: background retinopathy. Microaneurysms, intra-retinal haemorrhages and/or exudates seen, but no maculopathy present (see M1). Advice to patient is the same as for level 0.
- Level 2 / R2: pre-proliferative retinopathy. Venous beading, loops or duplication, intra-retinal microvascular abnormalities (IRMA), multiple haemorrhages, and/or cotton wool spots. A minimum of 70% of these patients should be seen by an ophthalmologist within 13 weeks, with a target of 95%.
- Level 3 / R3: proliferative. New vessels on the disc or elsewhere (including rubeosis iridis), pre-retinal haemorrhage and/or pre-retinal fibrosis. A

minimum of 70% of these patients should be seen by an ophthalmologist within 1 week, with a target of 95%.

- Maculopathy (M1): Exudates, retinal thickening and microaneurysms or haemorrhages (if visual acuity is 6/12 or less) within one disc diameter of the fovea. A minimum of 70% of these patients should be seen by an ophthalmologist within 13 weeks, with a target of 95%.
- Urgent referral: includes sudden loss of vision (e.g. from pre-retinal haemorrhage), retinal detachment or angle closure glaucoma from rubeosis.

The National Screening Programme for Diabetic Retinopathy now monitors 2.1 million diabetic patients annually compared to 1.5 million in 2004 (NHS, 2008). In order to cope with the increasing burden on ophthalmology hospital departments of age-related eye conditions it is clear that screening programmes and co-management schemes, such as those discussed, will need to utilise the community optometrist. It is also apparent that patients prefer the convenience of a community based service to a purely hospital based system (Alwitry, 2008; Reidy *et al*, 1998).

Optometrists must have an approved fundus camera in order to participate in diabetic screening schemes. The National Screening Committee set recommendations for the minimum standards of fundus cameras that can be approved for use. They must have a minimum pixel resolution of 20 pixels per degree and a minimum field of view of 45° horizontally and 40° vertically (Wolffsohn, 2008). The committee approves camera systems based on the image quality as it is presented on the display, rather than the number of megapixels of the camera (Taylor *et al*, 2009). There are currently six camera systems which are approved by the committee (NHS, 2009).

1.1.2: Referrals

Under the GOC rules and regulations, optometrists must refer any patient suffering from an injury or disease of the eye to a registered medical practitioner. An injury or disease is defined as "any abnormality of the eye of an anatomical, pathological and physiological nature" (GOC, 1999). An exception is made for optometrists with the supplementary prescriber speciality (see section 1.1.6). An optometrist carrying out eye examinations under the NHS is subject to the terms of the GOS regulations which additionally state that referral must be made if a patient does not obtain a satisfactory level of corrected vision, and that following the test of any patient diagnosed with diabetes or glaucoma, the patient's doctor must be informed of the results (Department of Health, 1986).

To ensure the optometrist is fulfilling his/her duties in terms of referral and to clarify where the responsibility for the patient lies, co-management schemes must have clear referral guidelines agreed by optometrists and ophthalmologists. Schemes must aim to maximise the number of cases of a condition that are detected (sensitivity) whilst minimizing the number of false cases referred (specificity). Sensitivity is calculated by dividing the number of patients diagnosed as having the disease by the total number of cases in the population. The estimated prevalence of the disease is usually used in this calculation as the number of cases not detected remains unknown. Specificity is calculated by dividing the number of true negative referrals by the number of the population who are disease free. This is, in other words, the probability that a healthy member of the population won't be referred (Gilchrist, 2000).

These measures influence referral criteria as if the criteria are set lower (e.g. IOP of 20mmHg or over in glaucoma screening) more cases will be detected (higher sensitivity) but conversely more false positives will be referred (lower specificity). If the referral criteria is set higher (e.g. IOP of 30mmHg or over) this will result in a lower sensitivity but a higher specificity. A lower sensitivity means incidences of disease are missed or are not detected until a later stage in the disease. In the case of glaucoma, late diagnosis is a risk factor in resultant blindness (Fraser *et al*, 1999) so early detection is essential. However, lowering referral criteria results in an increase in the number of referrals, that may have other negative consequences. Larger patient numbers mean increased costs for appointments and administration, waiting lists are lengthened therefore patients must wait longer for appointments during which time the disease may progress (Azuara-Blanco *et al*, 2007), and more false positive referrals occur resulting in unnecessary distress and wasted time for these patients.

In the example of glaucoma screening, Gilchrist (2000) suggested that referral accuracy could be increased by improved modes of screening and by targeting at risk groups (such as the elderly) to ensure that the proportion of patients referred matched or exceeded the prevalence of the disease in that section of the population. In Scotland, the introduction of the new GOS contract with changes to the method of screening for glaucoma resulted in an increase in true-positive referrals and a decrease in false-positives thereby increasing both the sensitivity and specificity of referrals (Ang *et al*, 2009).

1.1.3: Role of the optometrist within the Hospital Eye Service

The role of the optometrist within a hospital is slightly different to that of the high street optometrist. In this setting the ophthalmologist has overall responsibility for diagnosis and management of the patient and is supported by the optometrist (Oster *et al*, 1999). Research has shown how optometrists could be used to triage patients in an Accident and Emergency (A&E) department and how optometrists felt that some patients could be seen by hospital optometrists only (Hau *et al*, 2007).

This study showed that optometrists and ophthalmologists agreed with a patient's diagnosis in 89.3% of cases, and with their management outcome in 90.7% of cases. Optometrists suggested that 59.7% of cases they saw were suitable for optometrist-only consultation and management (compared to 45.5% in the opinion of the ophthalmologist). Conditions which fell into this category included posterior vitreous detachment, contact lens related problems, conjunctival disorders, blepharitis and corneal abrasions.

Co-management between optometrists and ophthalmologists can also take place in hospitals. This may be termed "parallel care" (Spry, 1997) when the optometrist works alongside the ophthalmologist, and a survey of ophthalmologists revealed that they prefer schemes to take place in a hospital environment rather than community-based schemes (Hitchings, 1995) perhaps because the legal responsibility for patient care was clearer. Oster (1999) described a scheme where the optometrist carried out initial investigations such as history and symptoms, slit lamp examination of the external eye, Goldmann tonometry and, where appropriate, further examinations such as visual field examination, tear film testing and Amsler chart test. In cases such as blepharitis, the optometrist could manage the patient with advice on lid hygiene, whilst in cases such as retinal conditions the ophthalmologist would diagnose and manage the patient. This reduces the burden on the ophthalmologist and allows them to spend more time on the more serious and difficult to manage conditions. Oster concluded that optometrists might be best placed to manage conditions with which they are already familiar such as cataract, glaucoma and diabetic retinopathy, and in particular those with chronic conditions requiring long term follow-up such as diabetic and hypertensive patients.

Banes *et al* (2000) reviewed the co-management of glaucoma in a hospital setting. Here optometrists examined all patients except recent post-op patients and carried out tests which would be outside the normal scope of a community-based optometrist such as checking blebs with the Seidel test, and gonioscopy. If no change in current therapeutic management was recommended they could write the prescription (although this then needed to be signed by an ophthalmologist). Banes *et al* concluded that these optometrists could support colleagues in the community and perhaps have their own prescribing rights for stable glaucoma patients.

1.1.4: Role of the optometrist in Scotland

The Scottish parliament re-introduced the free eye examination for all in April 2006 along with a revised fee structure. Scottish optometrists now receive £36 for an eye examination and £21 for supplementary tests. The new NHS eye examination now includes binocular indirect ophthalmoscopy, contact applanation tonometry and full threshold visual field examination. In order to ensure that optometrists had the necessary skills and equipment to carry out these tests, the Scottish Committee of Optometrists and Optometry Scotland arranged training and competency events for all optometrists and an £8000 equipment grant was available to every practice carrying out General Ophthalmic Services (College of Optometrists, 2009).

The four basic competencies that each optometrist had to be accredited for were applanation tonometry, slit lamp biomicroscopy, threshold visual field examination and Volk lens indirect ophthalmoscopy (Ang *et al*, 2009). The equipment grant was to cover a fundus camera, pachymeter and gonioscopy lens. Pachymetry and gonioscopy are classed as supplementary tests for which the optometrist receives a fee. Ang *et al* (2009) found that the new system produced greater accuracy and reduced the overall number of glaucoma referrals.

1.1.5: Role of the optometrist in Wales

In 2003 the Welsh Assembly introduced the Welsh Eye Health Examination (WEHE) followed by the Primary Eyecare Acute Referral Scheme (PEARS) (Sheen *et al*, 2009). The WEHE scheme was designed to screen at risk individuals for ocular disease, whilst the PEARS scheme aimed to manage minor eye conditions within the community through the optometrist rather than their general practitioner (GP). Patients with the following conditions are entitled to a WEHE (Sheen *et al*, 2008):

- Uni-ocular patients (as the better eye must be closely monitored);
- Patients who are profoundly hearing impaired (as sight is vital for lip-reading);
- Patients with retinitis pigmentosa or siblings of patients with inherited eye disease;
- Patients whose family origins are Black African, Black Caribbean, Indian, Pakistani or Bangladeshi;
- Patients at risk of eye disease by reason of race or family history.

The aim of the PEARS scheme was to avoid unnecessary referrals to the HES by providing an acute eye service in the community. Patients needing urgent attention for an eye condition could self-refer or be referred by their GP. Evaluation of the scheme's results over an eight month period found that two-thirds (66%) of patients were managed by the optometrist rather than referred for secondary care or to their GP. Telephone interviews ascertained that 94.8% of patients were "very satisfied" with their PEARS or WEHE examination.

1.1.6: Current training and career development

In order to practise optometry in the United Kingdom (UK), an optometrist must be registered with the GOC. For those training in the UK, this involves five steps (GOC, 2011):

1) Complete an undergraduate degree in optometry at one of the nine GOC-approved universities (currently Anglia Ruskin, Aston, Bradford, Cardiff, City, Glasgow Caledonian, Plymouth, Manchester and Ulster Universities);

2) Graduate with a 2:2 honours degree or higher;

3) Achieve the Stage 1 competencies required for entry to the pre-registration period (or complete the GOC's optometry progression scheme);

4) Successfully complete the pre-registration period under the supervision of an optometrist member of the College of Optometrists, or a supervisor approved by the University of Manchester. This includes work-based assessment and a final assessment on the Stage 2 core competencies for optometry;

5) Register with the GOC.

The method of assessing the ability of pre-registration trainees at the end of their pre-registration period has undergone several changes in recent years from a final multi-part examination which was in use until 2005. The assessment is now based on achieving the GOC's 82 core competencies (Constantine-Smith, 2011) through a combination of work-based assessment and final assessment under examination conditions. This final assessment now takes the form of an Objective Structured Clinical Examination (OSCE), which is also used extensively in other health professions such as medicine and dentistry, assessing the candidate's ability to perform a range of short clinical tasks (Lawrenson and Mullin, 2008). After qualification, optometrists are required to maintain their registration through obtaining Continuing Education and Training (CET) points.

Optometrists are among a number of health care professionals, including nurses and physiotherapists, who are now able to prescribe medicines related to their area of expertise. There are three diplomas offered by the College of Optometrists which allow practitioners to prescribe additional medications (Needle *et al*, 2008). They are:

- Independent prescribing;
- Supplementary prescribing;
- Additional supply.

Optometrists have been able to train in supplementary prescribing since June 2005 and as independent prescribers since June 2008 (College of Optometrists, 2011a). Independent prescribing allows optometrists to diagnose and manage patients including prescribing any medications for the eye and surrounding area within their area of expertise. Supplementary prescribing requires that a diagnosis is made by an independent prescriber, usually an ophthalmologist or GP, and a management plan is agreed between the independent prescriber, the supplementary prescriber (optometrist) and the patient. The supplementary prescriber can prescribe the medicine or medicines on the management plan, and refers back to the independent prescriber should a change to the management plan or surgery be required. In 2005 a number of medications were made available to optometrists who undertake additional training, these are known as 'additional supply' medications. The medications are used to treat non-sight threatening eye conditions such as infective and allergic conjunctivitis, blepharitis, dry eye and superficial injuries (Lawrenson *et al*, 2007). These include nedocromil sodium, azelastine hydrochloride and acetyl cysteine (Needle *et al*, 2008).

Around 70 optometrists currently have an independent or supplementary prescribing qualification (Courtenay *et al*, 2011). Surveys of optometrists have found that those who are qualified prescribers or currently undergoing training are predominantly from the hospital or independent sector (Figure 1.3) (Needle *et al*, 2008; College of Optometrists, 2011a).

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Figure 1.3: Percentage of optometrists currently in or considering training for an extended prescribing role. Additional supply (AS) or supplementary prescriber (SP) by practice type (Data from Needle et al, 2008)

Hospital optometrists are more likely to have the working relationships with ophthalmologists needed for supplementary prescribing and will come across larger numbers of suitable patients than high street practitioners. Remuneration remains a barrier to widespread adoption of therapeutic prescribing as England currently has no arrangements to reimburse practitioners in addition to the standard GOS eye examination fee (Mason & Mason, 2002).

In addition to specialist qualifications in therapeutics, the College of Optometrists offers a series of higher diplomas in several areas of expertise: glaucoma, low vision, contact lenses, orthoptics and diabetes. Low uptake of these diplomas has recently led to a review of how the diplomas are delivered (College of Optometrists, 2011b). A new Higher Qualifications Framework was created, with qualifications at three levels; Postgraduate Certificate, Postgraduate Higher Certificate and Postgraduate Diploma. Glaucoma is the first of these areas for which a competency framework has been developed (Myint *et al*, 2010) as NICE guidelines require that healthcare professionals who monitor and treat ocular hypertension and chronic open angle glaucoma (COAG) have a specialist qualification and relevant experience (NICE, 2009). Universities and other organisations will now provide qualifications which will be accredited by the College of Optometrists.

1.2: A sustainable business model for the optometrist?

The optical market in the UK is facing a period of change due to economic conditions affecting even the large companies. In 2009 the merger of two of the biggest providers, Boots Opticians and Dolland & Aitchison (D&A), took place. These two companies together with Vision Express, Specsavers and Optical Express had a 55% share of the overall market in 2009 with the rest being composed of independents, smaller chains and the supermarkets (Figure 1.4) (Mintel, 2010).

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Figure 1.4: Share of sales in optical goods, 2009 (Mintel, 2010). The five largest multiple retailers together had a 55% share of the market

This has shown a small increase over the last 10 years when the larger multiples held just under 48% (Hirji, 1999). From 2005-2007 growth in the industry was 9.2% (6.4% above inflation) resulting in a market worth £2,656m in 2007 (Mintel, 2008). Threats to the traditional high street optometry practices include the supermarkets Asda and Tesco, and internet retailers such as Glasses Direct and Postoptics, all of whom can benefit from low overheads and economies of scale to undercut prices on the high street.

Traditionally, high street optometry has used profit from spectacle and contact lens sales to subsidise the true cost of professional fees, such as eye examinations (Calver, 2010). The deregulation of the supply of spectacles in 1984 followed by the withdrawal of the NHS sight test for all in 1989 meant that opticians no longer relied on NHS funding but on their own marketing and pricing policies. CIBA Vision (in their Professional Fee Template) estimate the true cost as being “from around £50 for a 20-minute appointment in a busy practice, to £150 or more for a 30-minute appointment in a part time practice" (Russ, 2008). Based on these figures, the NHS sight test fee, currently £20.70, and the average private sight test fee of £21.30 (FODO, 2011) do not cover the cost of the optometrist's clinical time and the practice overheads. The majority of optometrists are dissatisfied (41%) or very dissatisfied (44%) with the current methods of reimbursement for GOS and other co-management schemes (Mason & Mason, 2002). Companies such as the Eyecare Fee Consultancy are now encouraging practices to charge more realistic fees for their private patients, enabling them to offer more competitive prices on spectacles and contact lenses (up to 25-35% lower than average) (Llewellyn, 2009). Tesco's recent strategy of introducing a free eye examination for all has drawn criticism that it "devalues their practice and the customer service it offers" (Optician, 2010a).

Research among the older population identified that, even though they are entitled to a free eye examination, fear of costs may prevent them from attending for regular eye tests (Smeeth, 1998). Other barriers can include lack of knowledge about eye health, poor understanding of the optometrist's role and affordability of spectacles (Jessa *et al*, 2007), and addressing these perceptions is vital to the future of the profession.

Customer service is an essential part of the success of an optometrist's business. Optometry combines service and retail industries; the service element being the eye examination and dispensing of spectacles, and the product spectacles or contact lenses. While large multiples can benefit from economies of scale to reduce the cost of glasses and contact lenses, independent practices must differentiate themselves to compete, and providing excellent customer service is one way of achieving this. Irrespective of the size of business, if a customer is satisfied with their experience of a practice they will remain loyal (Boulding *et al*, 1993). Retail aspects of a business can be monitored easily (by analysing performance indicators such as profit, conversion rate, and average spend per customer). Conversely, customer service is a more abstract concept that can depend on a customer's personal opinion and what aspects of service are particularly important to them (Parasuramen *et al,* 1988).

A practice looking to differentiate itself on the basis of good quality customer service must be able to measure its success. Various techniques may be employed such as customer feedback forms and mystery shopper reports, however, a number of validated questionnaires exist to measure service quality that have been used in a wide variety of settings but not previously in optometry. Chapter 6 will look at whether their use is valid in the optical industry and whether they could be a useful tool for practices in the future.

1.3 The future of eye care in the UK

The population of the UK is ageing and this will have a large impact on the ophthalmic population over the next 20 to 30 years. The percentage of the population aged over 65 has increased from 15% in 1985 to 17% in 2010, and is predicted to be 23% by 2035 (ONS, 2012). The percentage of the population aged over 85 is predicted to be 5% by 2035. This will greatly increase the number of patients requiring ophthalmic management for conditions where older age is a risk factor such as cataracts, diabetic retinopathy, glaucoma and age-related macular degeneration (AMD). Bron and Caird (1997) reported that 30% of those over 85 years old risked losing their vision from AMD, and whilst recent treatment developments may help to reduce this number, these patients will require long term ophthalmic care. The number of diabetics is expected to increase from 2.6 million in 2010 to 4.2 million in 2025 (Diabetes UK), placing further demands on the retinopathy screening service and on the HES. The increased proportion of the population over the age of 65 will also put greater economic pressure on the NHS in general as the budget is strained due to a smaller proportion of the population who are of working age and able to contribute through income tax.

The demand for ophthalmology services has increased over the past two decades from 400,000 finished consultant episodes in 1998 to almost 600,000 in 2008. The Centre for Workforce Intelligence (CfWI) (2010) estimated that 985 full time equivalent (FTE) specialists were required in England in 2010, whilst only 854 FTE specialists were employed in September 2009, leading to a shortfall. A shortfall in appropriately qualified specialists along with insufficient funding has led the Royal College of Ophthalmologists to review the future delivery of AMD services (Amoaku, 2009). Their proposals include training technicians and nurses to administer intra-vitreal injections and introducing follow-up clinics manned by optometrists. The increasing demand on secondary care presents an opportunity for optometrists to develop their role in disease management in order to support ophthalmology.

Advances in technology have led to the refraction aspect of the eye examination becoming increasingly automated. Auto-refractors can be linked to automated phoropters, reducing the need for retinoscopy and requiring the optometrist only to check the end point and binocular aspects of the refraction. The Association of British Dispensing Opticians (ABDO) has recently raised the possibility that Dispensing Opticians could be registered to carry out refractions (Optician, 2012). Though this proposal is not close to implementation and questions have been raised regarding the health aspects of the eye examination, it does further support the case for a change in the role of optometrists towards specialisation in disease detection and management rather than refraction. Advanced imaging from fundus cameras, optical coherence tomography (OCT) and digital slit lamp cameras creates an opportunity for screening and review in the community with support from ophthalmology specialists where further opinion is required.

The current business model adopted by many optical practices, discussed in section 1.2, may be under threat not just from the current economic climate and the increasing presence of internet retailers, but also from advancing technology. Refractive surgery has become well established in the UK over the past two decades with 147 clinics in 2010 compared to 47 in 2001 (Ewbank, 2010). The main growth area for this market is in presbyopic treatments, and at present no solution exists to restore vision to pre-presbyopic levels (Buckhurst *et al,* 2012). However, new treatment options such as intracorneal inlays and improvements in accommodating and multifocal intraocular lenses (IOLs) could, in the future, reduce the demand for varifocal spectacles and multifocal contact lenses as more of the population choose to undergo refractive surgery. This will, however, create a further need for optometrists to be trained in the post-operative management of these patients, further enhancing their clinical role.

1.4 Research aims

Blach (2001) stated that assistance from orthopists and optometrists is required to manage ophthalmic patients. With an ageing population and increasing prevalence of diseases such as diabetes, the strain on ophthalmology resources will only increase. In order to identify where optometrists may be of assistance, current waiting lists and outpatient clinics can be analysed. Conditions which optometrists currently manage or co-manage are discussed in section 1.1.1, however the aim of this research is to investigate whether there are further areas placing a strain on HES resources where optometrists could play a role in patient management. This research will also identify whether the role of optometrists in managing eye conditions where co-management schemes already exist could be further extended. In order to develop sustainable programmes for managing ophthalmic patients, any schemes implemented must be cost-effective for both the NHS and the optometrist, therefore cost analyses will be carried out. Previously audits have taken place to assess the cost-effectiveness of schemes for a specific condition such as glaucoma (LOCSU, 2011), however this research aims to look at possible cost-savings that could be achieved through management of a number of conditions.

In order to provide services outside their existing role, optometrists may need to invest in new instrumentation. This research will survey what equipment optometrists currently have available to them in practice, where they are looking to invest and what factors influence which instrumentation they buy. Additionally, optometrists may need to acquire new skills or refresh their knowledge to carry out diagnostic tests or procedures. This research aims to assess the effectiveness of different types of training to discuss how this training might be delivered and the relevant cost implications.

As discussed in section 1.2, optometrists and optical practices must have a sustainable business and attracting and retaining patients is crucial to this. Those that chose to participate in more clinical services may justify higher fees through a perceived higher level of patient care and better customer service. Service quality has been assessed across a large variety of businesses but not previously in optometry. Understanding how a customer forms their opinion of good or bad customer service is essential to practices in how they position the practice and whether changes such as new instrumentation have a significant effect on patient views.

CHAPTER 2

Analysis of new referrals to an ophthalmic outpatient clinic

2.1: Introduction

In order to identify areas in which optometrists could expand their services there must be an existing demand. When local services are oversubscribed patients are placed onto waiting lists which indicate an imbalance between supply and demand (Gravelle *et al*, 2003). In the 1980s and 1990s, waiting times for procedures such as cataract surgery could be 30-40 months (Thomas & Darvell, 1991) leading the government to introduce waiting time targets. Inpatient waiting time targets were reduced from 18 months in March 2000 to 6 months in 2008, whilst a maximum period of 18 weeks from GP referral to attending an outpatient appointment and undergoing any necessary treatment was the target for the end of 2008 (Dimakou *et al*, 2009). In a rural area of Northern Ireland, a waiting list initiative was introduced after the government announced that "*no patient identified and on a day case waiting list for a cataract or other eye operation, should be waiting more than six months*" (Department of Health, 2005). The Northern Ireland Assembly was restored in May 2007 after five years of suspension allowing the territory, along with Scotland and Wales, to decide on their own health policy (Maslin-Prothero *et al*, 2008). Under the standard NHS provision, this area had only 1 day of ophthalmology cover (half a day of outpatient appointments and half a day of surgery) per week, resulting in long waiting lists. The scheme used independent providers to carry out outpatient appointments and surgery at two hospitals. The independent providers supplied ophthalmologists and nurses who used the hospital facilities at weekends when they would not otherwise have been utilized.

A study carried out in 1988 surveyed referrals to an ophthalmic outpatient department and concluded that community based optometrists were well placed to conduct screening for glaucoma and diabetic retinopathy (Harrison *et al*, 1988). Glaucoma referral refinement and co-management schemes now exist in some areas of the UK with a recent survey finding that 19% of optometrists took part in NHS funded referral-refinement schemes (Medix UK, 2008). Diabetic retinopathy screening is primarily carried out in the community now with optometrists involved in around 30-50% of the UK (Warburton, 2004). More recent studies have compared referrals from general practitioners and optometrists (Pierscionek *et al*, 2009; Davey *et al*, 2011). These studies looked at the diagnosis of patients and the accuracy of referrals but did not look at the outcomes of these appointments. By looking at the management of patients referred to an ophthalmology department, it can be determined whether the patient's referral could have been managed in an alternative way and whether their ongoing management would require input from ophthalmologists, optometrists or both.

Schemes already exist in some parts of the United Kingdom to involve optometrists in a wider range of eye care services. Wales introduced the PEARS and the WEHE in 2003 with the aim to provide eye care services with good patient access and value for money (Sheen *et al*, 2009). These schemes enable optometrists in the community to provide primary eye care to patients who otherwise would have consulted their GP about ocular conditions. The PEARS was introduced for the early assessment of acute ocular conditions and WEHE as a screening service for patients at risk of ocular disease such as those with family history of eye disease. A major aim of the introduction of the new GOS contract in Scotland was to reduce the number of inappropriate referrals to the HES. Optometrists are able to carry out supplementary examinations such as contact tonometry and threshold automated perimetry (Ang *et al*, 2009).

By looking at the Northern Ireland waiting list initiative, it will be possible to identify patients who are not being catered for under the current HES provision. Schemes that exist in other parts of the United Kingdom involve optometrists in enhanced ophthalmic services, however the involvement of optometrists need not be limited to existing schemes, and this study aims to identify new areas of extended services for optometrists.

The aim of this study is to identify common referrals to the hospital eye service and suggest alternative ways of managing these patients in order to reduce the burden on hospital resources, both in terms of time and money, and increase patient satisfaction. It also aims to evaluate the financial implications of introducing alternative management schemes.

2.2 Method

Data from a hospital waiting list initiative was used to identify common referrals to the hospital eye service. The private company contracted to carry out the waiting list initiative collected the data for their own internal audit purposes, therefore initially ethics approval was not sought. When the company approached Aston University Ophthalmic Research Group to carry out a more detailed analysis the Audiology and Optometry Research Ethics Committee at Aston University was approached but they were unable to give retrospective approval; however they accepted that informed consent was obtained and the tenets of the Declaration of Helsinki were followed at data collection so the analysis was conducted at Aston University. Two hospitals were used: Tyrone County Hospital, Omagh is a larger hospital where outpatient appointments and surgery took place, whereas Erne Hospital, Enniskillen is a smaller community hospital and was only used for outpatient’s appointments.

Data was collected regarding all patients attending outpatient clinics between August 2007 and June 2009. Although the waiting list initiative continued until July 2010, no new patient clinics took place at these hospitals after June 2009, only review and surgery clinics. Patients had been referred to the HES by their GP or optometrist for secondary eye care. Patient data was collected for audit purposes by the clinic staff and information was available in the form of clinic lists, outcome lists and letter to GP or onward referral letter. This included reason for appointment (e.g. new patient, follow-up), outcome and recall period (if necessary). Only data from those patients classed as new patients was used in order to ensure patients did not appear multiple times in the data analysis. Patients were referred to by their hospital reference number therefore remaining anonymous.

Patient data was analysed by demographics of age and gender, diagnosed ocular condition, any secondary ocular condition, outcome and suggested recall time (if appropriate). The patient's age was calculated using their date of birth and the appointment date, therefore their age was accurate for the date on which they were first seen as a new patient. The distances patients had travelled were calculated by inputting their postcode into an internet maps application (Google Maps) and calculating the distance of the suggested route from their home to the hospital they attended. The distance was rounded to the nearest mile.

Diagnosis was classified according to the World Health Organisation (WHO) International Classification of Disease (ICD) coding (WHO, 2007). This classifies eye disorders by their location as shown in table 2.1. This method of classification was used as it allows comparison with other studies and grouping of a large number of conditions into twelve broad groups. However the specific diagnosis (e.g. pre-proliferative diabetic retinopathy) was also recorded to enable more detailed analysis of results.

WHO ICD coding	Disorders
1	Disorders of the eyelid, lacrimal system & orbit
2	Disorders of the conjunctiva
3	Disorders of the sclera & cornea
4	Disorders of the iris & ciliary body
5	Disorders of the lens
6	Disorders of the choroid & retina
7	Glaucoma
8	Disorders of the vitreous body & globe
9	Disorders of the optic nerve & visual pathways
10	Disorders of ocular muscles, binocular movement, accommodation & refraction
11	Visual disturbances & blindness
12	Other disorders of the eye & adnexa

Table 2.1: World Health Organisation classification of eye disorders (WHO, 2007)

2.3 Results

Data from 3051 patient visits was obtained. From this 1449 patients were classed as new patients and therefore were included in the results analysis. The mean age of patients was 61.4 (±19.8) years and 57.0% were female. Patients' ages ranged from 5 months to 99 years. These demographics are consistent with another study of the ophthalmic outpatient population (Churchill *et al,* 2003), where the mean age was 70 years (range 1-94) in Bristol and 64 years (range 1-93) in Leeds, with a bias towards women in both hospitals. Figure 2.1 shows the distribution of patients' ages.

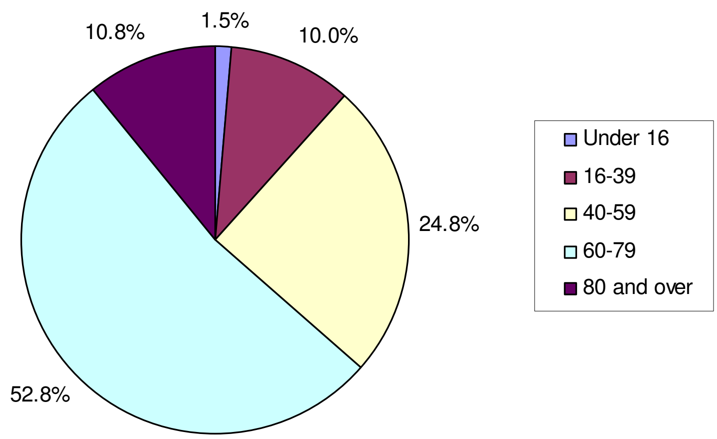

Figure 2.1: Ages of waiting list initiative patients. Almost two-thirds were over 60 years old.

The hospitals received patients from a large geographical area, this was particularly the case at Tyrone County Hospital (which carried out surgery as well as outpatients appointments) where the mean distance travelled by patients was 19.4 (±12.6) miles and the maximum distance travelled was 53 miles. The mean distance travelled by patients to Erne Hospital was 10.9 (±7.6) miles. The distances travelled by patients are shown in figure 2.2.

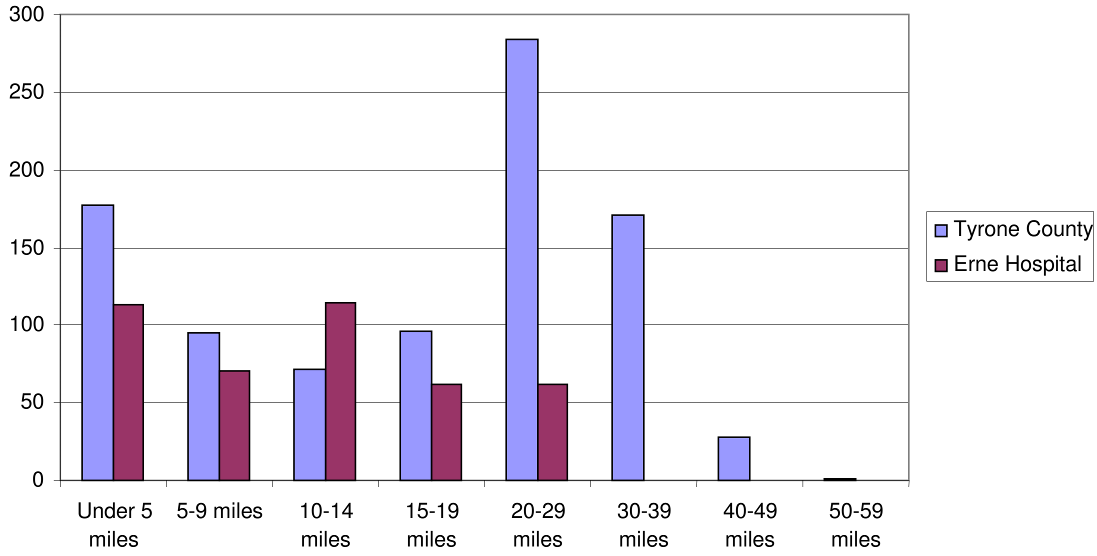

Figure 2.2: Distances between patients' homes and hospital visited. Patients travelled further to attend the larger district hospital, Tyrone County.

Patients were analysed by their presenting ocular condition and the breakdown of these is shown in figures 2.3, 2.4 and 2.5. A number of patients had unrelated co-existing ocular conditions (such as a cataract patient additionally with ocular hypertension), these patients were classified under their primary diagnosis stated by the consultant or the condition for which they were to first undergo treatment for. The WHO classification was used to group disorders by their location; additionally 23 patients had no apparent eye disorder therefore a 13th group was added to classify these patients. The results show that the most common presenting conditions were lens and eyelid, lacrimal system and orbit abnormalities.

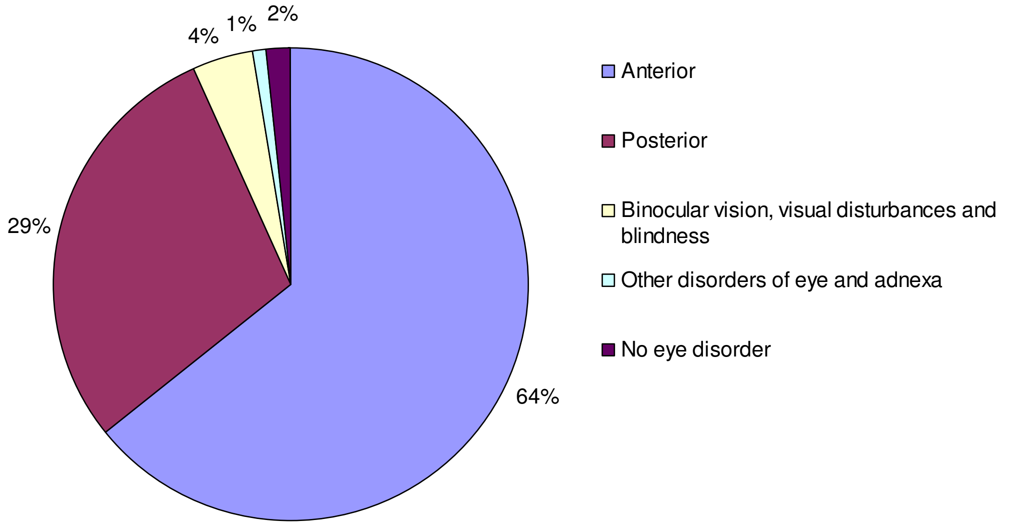

Figure 2.3: General classification of presenting primary ocular condition

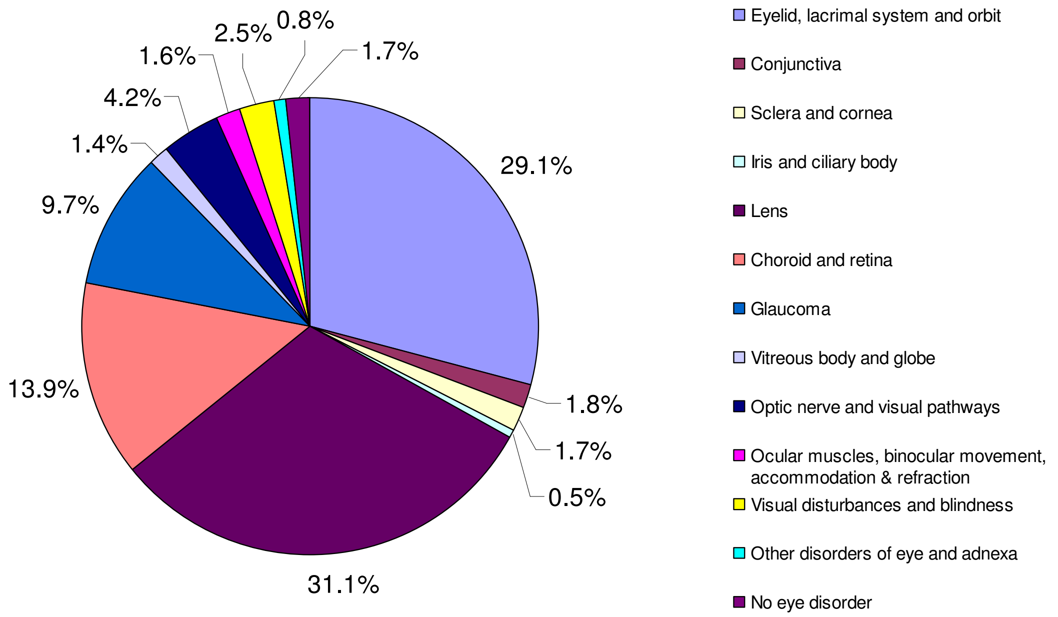

Figure 2.4: Presenting primary ocular condition of patients by WHO classification

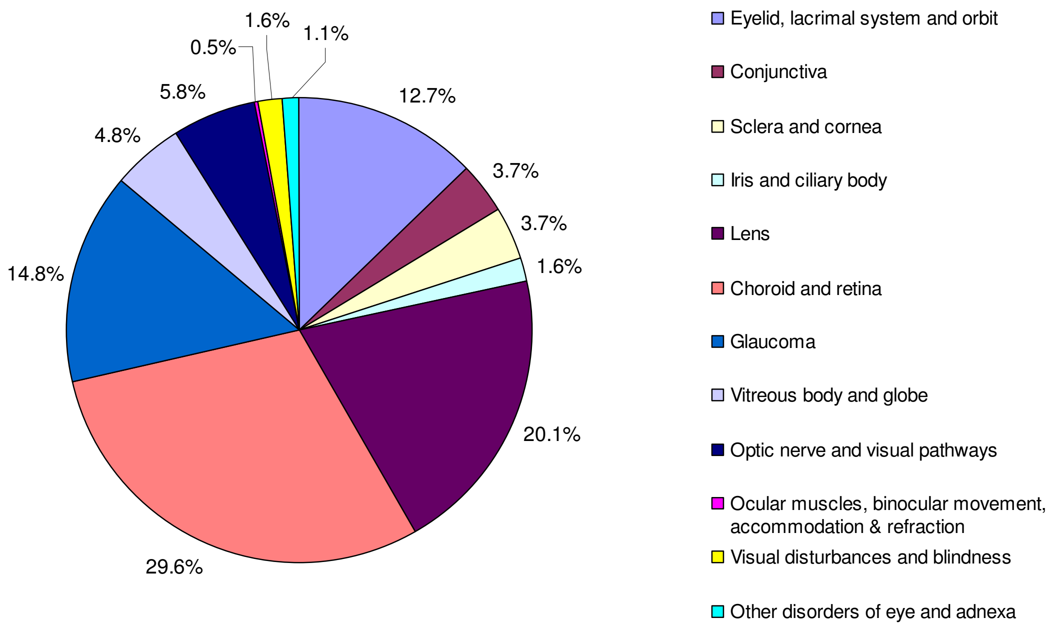

Figure 2.5: Secondary ocular conditions of patients by WHO classification

Thirteen percent of patients additionally presented with a secondary eye condition with the distribution shown in figure 2.5. Almost half of secondary conditions were choroidal and retinal or lenticular. Lenticular conditions were almost entirely early cataracts, whilst the most common choroidal and retinal conditions were dry AMD and pre-proliferative diabetic retinopathy.

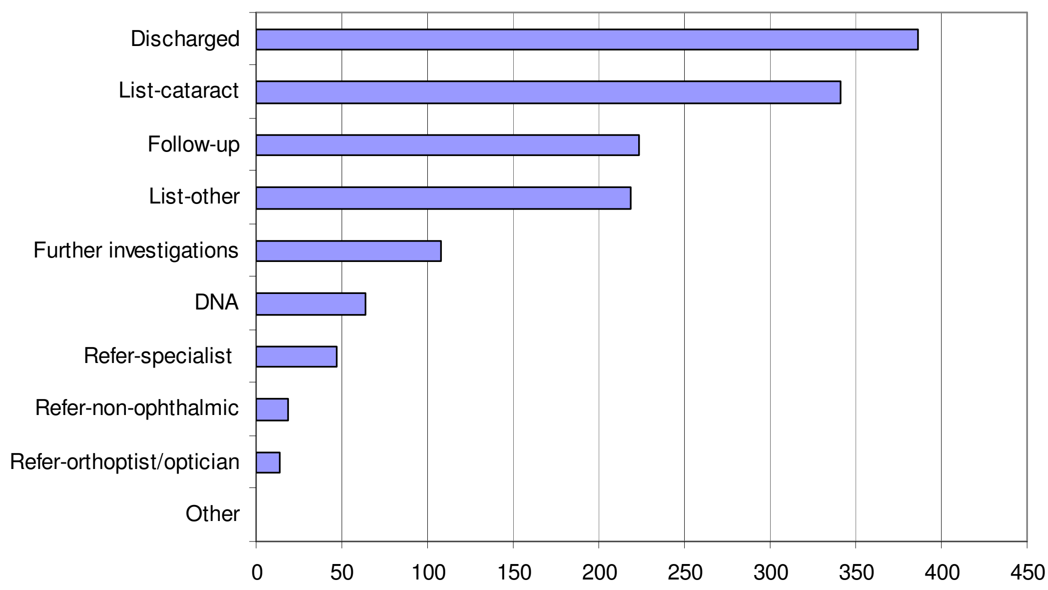

Figure 2.6: Management of new patients (DNA indicates patients who did not attend their appointment; 1 patient under 'other' required consultation with the patient's GP before management was agreed)

Figure 2.6 shows the outcomes of appointments; 3.9% of patients had more than one outcome therefore were included under all that applied. Thirty-nine per cent of patients were listed for day case surgery to be performed by the consulting ophthalmologist at a later date. This included phaco-emulsification, lid lesion excision/incision, YAG (yttrium aluminium garnet) iridotomy and YAG for posterior capsular opacification. Fifteen per cent of patients were recalled for follow-up outpatient appointment, the mean recall time was 3.5 (±3.2) months.

Further referrals consisted of 44 patients referred to specialist eye clinics (retinal, low vision or corneal), 19 patients were referred to hospital non-ophthalmic services (earth, nose and throat (ENT), neurology or for blood tests), 107 were referred for further investigations (optical coherence tomography (OCT), visual field examination, fluorescein angiography or fundus photo) and 14 patients were referred to other eye care professionals (orthoptists and optometrists). Twentyseven per cent of patients were discharged back to the care of their optometrist and 4.4 per cent of patients did not attend their appointment.

Outcomes of the four most common conditions; glaucoma, lens conditions, lid conditions and retinal/choroidal conditions; are shown in figure 2.7.

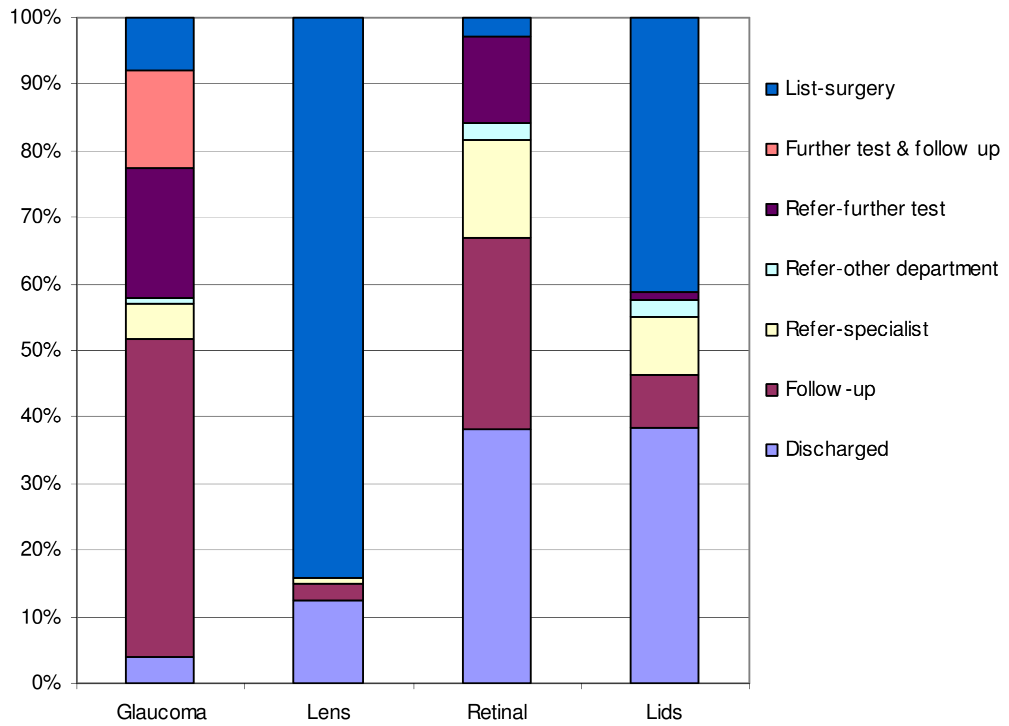

Figure 2.7: Outcomes of appointments for patients with the most common eye disorders

2.4 Discussion

The distribution of ocular conditions in this study shows agreement with a previous study looking at referrals from optometrists and GPs into the hospital eye service. Pierscionek *et al* (2009) found that the most common reason for referral from optometrists was cataract and from GPs it was lid/tear duct/conjunctival conditions;

whilst this study found that lid, lacrimal system and orbit patients made up 29% of referrals, and those with lens disorders made up 30% of referrals.

A survey of patient views from a glaucoma clinic showed that distance travelled was seen as the most important factor in provision for follow-up care and those who travelled the furthest were most likely to consider a 'one-stop shop' to be an important factor (Bhargava *et al*, 2008). The glaucoma study took place around Nottingham and the mean distance travelled by patients was only 6.9 (±6.2) miles compared to the much larger distances in this study of rural Northern Ireland; therefore one would assume that it is even more important for these patients that the number of visits is kept to a minimum. Reducing the distance that the patient needs to travel is particularly important in the ophthalmic population as they are required not to drive to appointments so that dilated fundus examination may be carried out. This means relying on lifts from relatives and friends, public transport, or using hospital ambulance services at considerable cost to the NHS. This study covered a rural area which presents its own challenges, public transport is often limited and (as above) patients travelled up to 53 miles on mostly minor roads to reach the hospital. Evaluation of the PEARS and WEHE schemes in Wales found that 87.4% travelled less than 5 miles to an optometrist (this ranged from 97.6% in South Wales to 78.6% in the more rural area of Mid and West Wales) (Sheen *et al*, 2009). In comparison, only 21.6% of patients in this study travelled less than 5 miles to attend their hospital appointment.

Despite the large distances involved, the rate of non-attendance (4.4%) compared favourably with previous studies showing non-attendance rates in ophthalmology clinics of 9.9% (Potamitis *et al*, 1994) and 12.6% (King *et al*, 1995). King *et al* found that new patients were more likely to attend their appointment than follow-up patients and that inability to get time off work was an important factor in non-attendance. As the patients in this study were all new patients and the appointments were at weekends the non-attendance rate may have been lower than would normally be seen in an outpatient clinic. Even in the retired population, weekend appointments may be desirable as they rely on family or friends of working age to transport them to their appointment.

The results highlight a number of areas which could be managed in a more effective way by involving optometrists who are located closer to the patients' home, can offer flexible appointments and increasingly have access to advanced technology. Patients attending the clinics in this study have waited a number of months for an appointment and better management of these patients would reduce patient waiting time, reduce the financial burden on the hospital and increase patient satisfaction. Some possible solutions for reducing the waiting list and improving patient management are discussed below:

2.4.1 Visual field examination

Eighty-six patients (5.9%) were referred for visual field examination. These were predominantly suspected glaucoma patients. These patients would have to attend for a specific visual fields appointment followed by another appointment to review the results with the consultant. This pathway could be reduced by their local optometrist carrying out the field screening and emailing the results to the ophthalmologist for review. The consultant could review the results and notes to establish whether a follow-up appointment was necessary.

Ten per cent of the patients in this study were glaucoma suspects, corresponding with the figure of 10-15% of new patient referrals found in previous studies (Willis *et al*, 2000). Additionally, 62.5% of glaucoma patients required a follow-up appointment, at which visual field examination would typically be carried out.

Management of glaucoma patients in a hospital ophthalmology department would typically involve perimetry, pachymetry, disc photography and may include nerve imaging such as OCT, Heidelberg retinal tomography (HRT) or scanning laser polarimetry (GDx) (Gordon-Bennett *et al*, 2008). Optometrists could additionally take part in the ongoing monitoring of glaucoma patients with investment or funding to ensure they had the necessary equipment and training to ensure they could interpret the results of nerve imaging in particular. This is a good example of an area where optometric services could be expanded with investment in equipment.

2.4.2 Imaging (OCT and fundus photography)

Four patients were referred for an appointment for further imaging, two for OCT and two for fundus photography. Given that these instruments are becoming more widespread in high street optometry practices (see Chapter 4), it would seem to be more convenient for the patient to attend their local practice for this appointment than to return to the hospital. As both patients referred for fundus photography were diagnosed with naevi, it would be most convenient for the patient to combine this with their routine (annual or bi-annual) eye examination.

Patients requiring OCT examination could be seen at a local practice rather than returning to the hospital for this appointment. Generally the conditions involved would require the opinion of a retinal specialist, however the examination could be emailed to the retinal department for diagnosis to establish if further follow-up was necessary. Such a scheme has been trialled in Canada where a third of diabetics were not receiving annual dilated fundus examinations due to large distances involved (Ng *et al*, 2009). This programme involved stereoscopic digital images being encrypted and sent to reviewers for grading. Another option would be involve optometrists with OCTs in additional training to enable them to diagnose common retinal conditions. One patient in this study had a macular hole and the other macular drusen, conditions which could be diagnosed and managed by the optometrist with additional training.

2.4.3 Cataract referral and management

The largest group of patients were those with cataracts (28%). Of these patients, 81.8% were listed for cataract surgery and 12.4% were discharged. 29 patients were discharged as they opted not to have surgery whilst in other cases there was co-existing pathology (such as AMD or diabetic retinopathy) affecting the patient's vision or the cataracts were judged too mild to warrant intervention. While a consultant must make the final decision on whether to operate, previous schemes have used optometrists to ensure that a patient is motivated to have surgery before referral (Sharp *et al*, 2003). Patients were also given cataract information leaflets to enable them to make an informed decision. This reduced the burden on the hospital eye department of those who were not interested in undergoing surgery and gave additional information to those who were keen to undergo surgery.

The cataract referral process in the hospitals from this study consisted of 6 steps:

1) patient is referred from the optometrist or GP;

2) patient is seen at a new patient appointment with the consultant (the appointments included in this study);

3) attend hospital again for a biometry appointment;

4) return to hospital for surgery;

5) consultant review 2 weeks post-op;

6) visit optometrist for refraction.

Two of these steps could easily be cut out under the current cataract co-management guidance issued by the AOP (AOP, 2009b). Biometry can be completed at the first hospital appointment where the decision to list is made and post-op care can be delegated to the optometrist. This involves the patient visiting a participating, trained optometrist 7-14 days after surgery where the optometrist identifies those who have had successful surgery and those who, following a protocol drawn up by the consultant ophthalmologist, must be seen again at the hospital. Removing these two steps would significantly improve convenience for the patient: one of the patients listed for cataract surgery in this study had travelled 46 miles, therefore removing these two appointments would save this patient 184 miles in total!

Further training of optometrists could even allow biometry to be completed at the optometrist. Optical biometry is usually performed by ophthalmic nurses in a hospital environment and could easily be operated by an optometrist with basic training. Equipment could be loaned by the hospital to participating optometrists removing the need for an investment of around £20,000 by the optometrist.

2.4.4 Lid conditions

There are 3 aspects to the management of these conditions. Firstly, some conditions could be managed by their optometrist without the need for hospital involvement. Secondly, there are conditions which be co-managed by an optometrist working in conjunction with an ophthalmologist. Thirdly, a future role could involve advanced training for optometrists to specialise in this area.

Sixty-two (4%) of those referred had blepharitis. Of these 34 patients had co-existing conditions, and of the remaining 28 patients, 82.1% were discharged with advice on lid hygiene or antibiotics prescribed. These patients could have been managed by their optometrist in conjunction with their GP where necessary.

Optometrists often carry out minor procedures such as removal of ingrowing eyelashes in their routine practice. With further specialist training in this area they may be able to carry out minor lid operations, such as chalazion excision, under the supervision of an ophthalmologist. This would be an ideal specialism as general anaesthetics are not generally used, the procedure is straightforward (often performed by junior doctors) and complications are rare and easily managed (Procope & Kidwell, 1994). At least one UK hospital is already involving optometrists in carrying out these procedures. Less invasive treatments of chalazion involve inter-lesion steroidal injections or botulinum toxin injections. Both have been shown to have good success rates, however the patient commonly needs a second injection (Watson & Austin, 1984; Knezevic *et al*, 2009). An optometrist could be trained to administer the injections and record the recovery with digital slit lamp imaging. In this study 5.3% of all patients were listed for chalazion excision and 3 patients were listed for intra-lesional steroid injections.

One study in India showed how technology could be used in the diagnosis and management of adnexal and orbital diseases by an optometrist sending slit-lamp images by satellite link to a consultant ophthalmologist (Verna *et al*, 2009). The consultant ophthalmologist studied the photos along with clinical data in order to recommend further investigation or diagnosis.

2.4.5 Optometrist triage (within hospitals)

Another option would be to further utilise optometrists within the hospital environment. This would enable them to take some workload off the ophthalmologist whilst having the ability to ask for a second opinion where necessary. For example the role could involve:

- assessing a patient's suitability for cataract surgery and carry out biometry;

- assessing lid conditions, refer to the consultant where necessary and assess the patient's motivation for surgery;
- advising patients with mild to moderate blepharitis and dry eye on treatment without the need for them to see the consultant;
- carrying out procedures such as punctal plugging and eyelash removal;
- reviewing visual field examinations to determine management in conjunction with the ophthalmologist if necessary;
- carrying out refraction where reduction in vision is not clear (2 patients in this study were referred back to their optometrist for refraction);
- working in conjunction with the medical photographer to analyse fundus photos and OCT examinations, for example those with naevi, macular holes and PVD.

All these are within the normal scope of practice of an optometrist and would not require further training. Whilst an orthoptist or specialist nurse may be able to carry out some of these functions, the amount of training and supervision required to become competent in all these areas is costly and not always possible due to time pressures in a busy hospital environment.

2.5: Economics

The hospital waiting list initiative was run by a private external company, as per the conditions of the waiting list initiative. The company employed consultants on a per patient fee and nurses to support them. Consultants came from the mainland UK so costs included flights, car rental, accommodation and meals. Additionally administrative support was needed to complete paperwork such as appointment letters and reports to GPs. The government paid the private company £65 per patient consultation to cover all these costs, but how would the cost of involving optometrists in the management of these patients compare? Average costs paid by the NHS for existing schemes are shown in table 2.2.

Table 2.2: Average fees paid for enhanced optometry services around the UK (Association of Optometrists, 2008)

2.5.1: Model 1: Optometrist triage within hospitals

The numbers of patients which fall into the categories discussed in section 2.4.5 are shown below. Patients are only included if this is their primary condition as those who have multiple ocular conditions may still need to be managed by a consultant ophthalmologist. In total there are 720 patients with these conditions or approximately half of all patients seen by the waiting list initiative.

Condition	**Number of patients**
Cataract (assessment and biometry)	397
Lid lumps and bumps	148
Dry eye and blepharitis	28 blepharitis, 55 dry eye
Review of visual fields	86
Refraction	2
Review of fundus photo/OCT	4
Total	720

Table 2.3: Number of patients with ocular conditions which could be managed by optometrist triage

These patients were seen over a period of eleven months in addition to those attending for appointments during the week at the regular clinics. This calculates at an average of 15.2 patients per week, therefore (based on 20 minutes per patient) the optometrist would be needed for 1.3 four hour sessions per week. Banes *et al* (2000) reported sessional rates for optometrists of between £54.27 and £65.21. This was including London allowance, although a similar premium for working in a rural area can be assumed.

The waiting list initiative consisted of 27 ophthalmologist days of outpatient appointments over 11 months, averaging 0.6 days of cover per week. If it is assumed that a similar profile of patients is also found in the half day per week of existing ophthalmologist cover, this would result in another 632 patients falling into the categories described in table 2.3. This would result in the need for 9.5 hours of optometrist cover per week. The waiting list consisted of a back log of patients that had built up over a number of years so the numbers of patients would drop slightly after this had cleared, therefore 8 hours or 1 full day of optometrist cover per week would be sufficient.

2.5.2: Model 2: Community based management

Community based management could take two forms: based from the practitioners own practice (independent or multiple) or based from a local Health Centre/GP's surgery. The first option has the benefits of an existing patient base, existing equipment (though some additional instrumentation may be required) and existing administration and support staff. The second option may benefit from attracting patients who would normally consult their general practitioner about eye conditions. When booking patients in for appointments, receptionists could book those with ocular conditions in with the optometrist rather than the GP. Sixty-three percent of patients in this study were over 60 years old. Many of these, and younger patients with conditions such as diabetes, will visit their local surgery regularly for routine checks and prescriptions. If these patients were able to combine, for example a regular blood pressure or cholesterol check-up with an appointment to review their blepharitis, the patient would save time and money on travel. Many surgeries will have a pharmacy on site where the patient can obtain antibiotics or other prescribed medicines.

Using the Association of Optometrists' average payments for schemes that currently exist, costs have been calculated to compare management of these patients by a community based optometrist compared to the current costs under the waiting list initiative (Table 2.4).

Enhanced service	**Average payment**	**Number of patients**	**Cost of community based scheme**	**Cost of waiting list initiative**
Triage	£45	231	£10,395	£15,015
Glaucoma monitoring	£45	128	£5760	£8320
Low vision	£50	9	£450	£585
Cataract pre-op assessment	£40	397	£15,880	£25,805
Cataract post-op assessment	£20	337	£6740	£21,905
Total		1102	£39,225	£71,630
Saving				£32,405

Table 2.4: Costs of community based management compared to waiting list initiative. Triage patients included are those with lid lumps and bumps, dry eye and blepharitis.

Thirteen percent of patients had secondary ocular conditions such as early cataract, dry AMD, glaucoma and diabetic retinopathy. Some of these patients may already be under the management of secondary care, therefore good communication links between community schemes and local hospitals can further reduce the number of avoidable referrals by allowing straightforward access to hospital records (Steele *et al,* 2006).

2.6: Conclusion

Hospital waiting list initiatives have previously been used to reduce average waiting times to meet government targets. As in this case, they may take place in the lead up to a general election as the government wishes to provide evidence that it has met manifesto promises on waiting times. This is, however, a costly exercise and optometrist involvement can lead to sustainable cost savings as shown in table 2.4. To improve outpatient efficiency for ophthalmic patients, optometrists could be used in two ways. Either they are employed at the hospital or a co-management scheme with optometrists in the community is utilised, of course a combination of both could be utilised too.

Employing an optometrist is cheaper than a medical assistant; as Banes *et al* (2000) reported costs of between £54.27 and £65.21 per session for an optometrist compared to £71.66 and £72.04 for a medical assistant (costs at 1998 levels, including London allowance). The difference compared to a consultant ophthalmologist will be even greater, therefore any patients that can be seen by an optometrist rather than an ophthalmologist have a significant cost-saving. If the optometrist can run a clinic in parallel with the ophthalmologist there are further cost savings as facilities and support staff can be shared. A factor which is not considered in this study is the costs of training which are considerably greater for an ophthalmologist than for an optometrist due to the longer duration and scope of training.

Community based schemes which reduce the number of patients being referred to secondary care providers have been shown to reduce costs. A recent audit of Wales' Cwm Taff glaucoma pathway showed a saving of £28,418 over 6 months as only 39% of patients seen required referral to secondary care (LOCSU, 2011).

Analysis of patients in this study who could be managed in the community shows that a significant saving of £32,405 could be made. Part of this saving could be used in the form of grants to allow optometrists involved in this scheme to invest in advanced instrumentation. In Scotland, optometrists received an £8000 equipment grant to help fund instrumentation such as Goldmann tonometers, pachymeters perimeters and fundus cameras. The cost saving from these patients would allow four optometrists to be allocated a grant at this level in the first year. As discussed in section 1.2, current reimbursement for GOS is not enough to cover practice overheads and a more realistic figure would be £50 for a 20-minute appointment in a busy practice. When negotiating fees for community based management it is important to create a sustainable model, and negotiating a fee of £50 per patient rather than the AOP average payments used in table 2.4 would still represent a saving to the NHS of £16,530 for these patients compared to the waiting list initiative, whilst not disadvantaging the practice from lost dispensing income. This is an important obstacle to overcome when looking to gain participation from large multiple practices where dispensing cross-subsidy often funds discounted or free eye examinations.

Community based schemes have cost savings not only for the HES but also for the patients. This study shows an average journey of nearly 20 miles to Tyrone County Hospital which will cost the patient not only petrol or public transport costs, but also costs in terms of time off work (or of relatives who accompany them). If patients can be seen in the community where they live or work, appointments can be fitted in around working hours and travel costs are greatly reduced. Studies of community based co-management schemes have also shown increased patient satisfaction when compared to hospital-only based management (Gray *et al*, 1997; Reidy *et al*, 1998).

When planning to introduce new initiatives, it is important to take account of the impact of changing demographics as the provision for eye care must change to reflect this. The aging population will have a large effect on the prevalence of age-related eye disease, for example the population of the UK with neovascular (wet) AMD is estimated to increase from 414,561 in 2010 to 515,509 in 2020 (Minassian & Reidy, 2009). York Hospital introduced a mobile eye clinic for those with wet AMD to attend for check-ups and Lucentis injections (York Teaching Hospital NHS Foundation Trust, 2011). This eye unit covered a geographic area similar in size to that found in this study with many patients travelling 40 miles each way to attend appointments in York. With the projected increases in the AMD population and the regularity of the appointments, this may be an area in which optometrists can undergo further training and perhaps even administer the Lucentis injections in areas where access to specialist eye departments is limited. These patients may eventually become low vision patients. This study looked at new referrals of which 9 patients were referred for low vision consultations; however this relatively small group of patients will require long term care. Culham *et al* (2002) found that low vision services are clustered in areas of high population density when elderly patients are more likely to be found in coastal and rural areas such as the area covered in this study. With the ageing population, optometrists would be ideally placed to manage the increasing number of low vision patients within the community.

A limitation of this study is that the demographics of patients and the prevalence of eye conditions found in this study cannot be assumed to be equal across other areas of the United Kingdom. For example, ethnically 99.15% of the population of Northern Ireland are White Caucasian (NISRA, 2002) in comparison to only 29% of the population of London (ONS, 2002). This will influence the occurrence of eye conditions such as open-angle glaucoma which has a higher prevalence amongst people of African and African-Caribbean descent (Leske *et al*, 2007). The average age of patients in this study, 61.4 (±19.8) years, may create bias towards an increased prevalence of age-related eye conditions; it would be useful to audit data from hospitals in other regions, particularly in inner city areas, to gain a full picture of the ophthalmic population.

The aim of the hospital waiting list initiative is to reduce waiting times for the patients and this was done by bringing in private companies to increase the ophthalmic services provided, however, with more involvement from optometrists it is possible to save money, save patients money and improve patient satisfaction. By extending the services provided by optometrists, waiting lists for appointments with ophthalmologists are reduced, enabling the most complicated or sight-threatening cases to be seen more promptly in secondary care.

CHAPTER 3

Analysis of surgical and review appointments at an ophthalmology outpatient clinic

3.1: Introduction

In Chapter 2, new referrals to an ophthalmology outpatient clinic were analysed. Previous studies have also focussed on new referrals to ophthalmology departments (Pierscionek *et al,* 2009; Harrison *et al,* 1988), as this data is important to identify patients for whom referral to secondary care could be avoided. Chapter 2 found that 26.6% of new patients were discharged after their initial appointment, whilst 38.6% were listed for surgery and 15.5% required follow-up appointments (figure 2.6). The most common ocular conditions requiring follow-up appointments were glaucoma and retinal conditions (figure 3.1), whilst the most common conditions requiring surgery were cataract and eyelid conditions.

Chronic conditions such as diabetic retinopathy and glaucoma require long-term review after diagnosis as few symptoms are apparent to the patient until permanent damage has already been caused (Reardon *et al*, 2011). Data on follow-up appointments is sparse and usually focussed on specific conditions. For example, Spry *et al* (1999) found that 23% of all ophthalmic outpatient appointments were for glaucoma follow-up. Harrison *et al* (1988) estimated that a community based glaucoma management scheme could save 100 new patient appointments, and as many as 1000 follow-up appointments per year in the population they investigated.

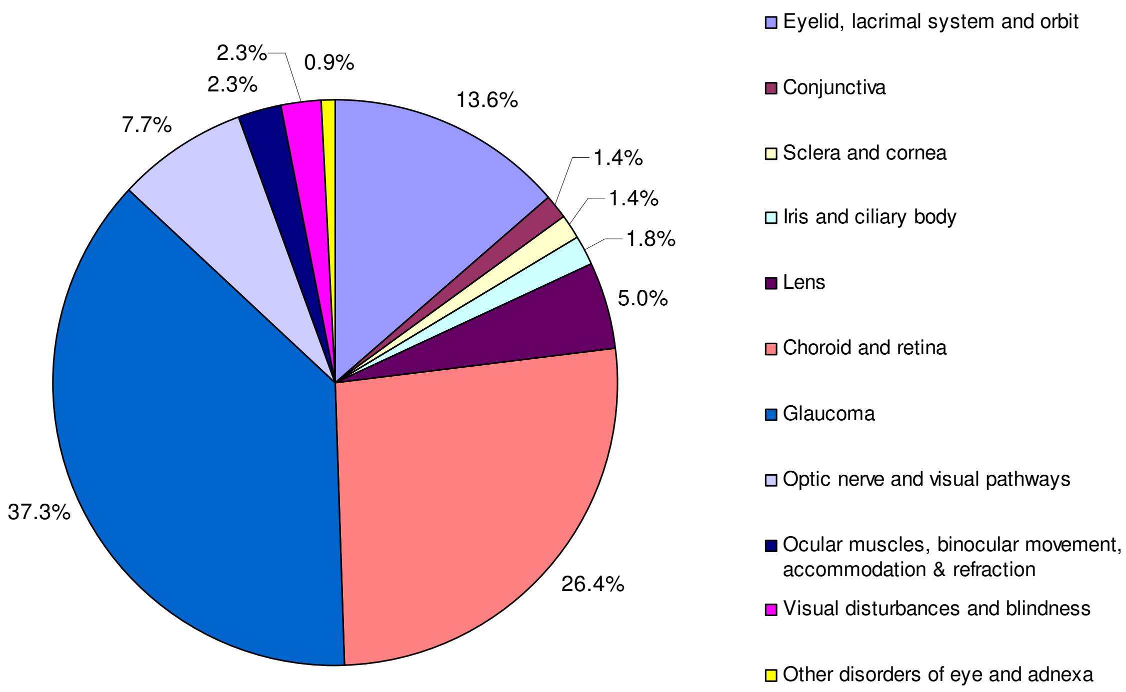

Figure 3.1: Ocular conditions of patients requiring follow-up appointments after initial ophthalmic consultation. Over 60% of patients requiring follow-up were those with glaucoma or choroidal and retinal conditions.

Surgery appointments and their outcomes were analysed in this chapter to identify whether the model described in section 2.4.3 for cataract co-management was suitable for these patients or whether some would require hospital-based rather than community-based follow-up. Surgery appointments for other ocular conditions was analysed in order to ascertain whether a community-based eye scheme could be suitable for management of any of these conditions.

Potential cost savings for new patient appointments have been analysed in Chapter 2 (table 2.4), however follow-up appointments are generally less costly to the hospital (£48) compared to new patient appointments (£106) (AOP, 2008). Patient convenience is a crucial aspect of review appointments, as glaucoma and diabetic patients may be required to attend as regularly as every six months, relying on family and friends or hospital transport to travel to their appointments.

The aim of this chapter was to analyse surgery and review appointments in order to identify those that may be managed in a community setting, providing greater convenience for patients requiring long term follow-up.

3.2: Method

Data from review and day surgery appointments, which took place between June 2008 and August 2009 were analysed. Prior to June 2008, only four review clinics took place as most appointments were for new referrals, therefore these clinics were not included as it would not give an accurate indication of the numbers of patients over a specific time period. The waiting list initiative continued until July 2010, however between August 2009 and July 2010, clinics were arranged as needed rather than on a regular basis, making long term numbers difficult to predict. Therefore the data from these patients was not analysed as part of this study. This data was collected by the clinic staff as part of their audit process, and patients were referred to by their hospital identification number therefore remaining anonymous. As in chapter 2, data from two hospitals was used. Review appointments and surgery took place at Tyrone County Hospital, whilst only review appointments took place at the smaller community hospital, Erne Hospital. All data for surgery and review appointments was included, therefore some patients appeared multiple times in the analysis as the aim was to review the number of appointments required rather than the number of patients.

Data on patient demographics, ocular condition, outcome and recall period (if required) were obtained from clinic lists, outcome records and GP notification or further referral letters. Ocular conditions were analysed by the WHO International Classification of Disease system (table 2.1). The specific diagnosis was also noted to enable analysis of particular conditions within each category. Where patients had more than one presenting ocular condition, the primary and secondary conditions were both recorded. For example, if a glaucoma patient attended for cataract surgery, the primary condition would be cataract (as the appointment is specifically for management of this condition) and the secondary condition glaucoma. Patient age was calculated from their date of birth and the date of the appointment, whilst distance travelled was found from inputting the postcode into an internet maps application (Google Maps) and calculating the distance of the suggested route to Tyrone County or Erne Hospital (dependant on where the appointment took place). The distance was rounded to the nearest mile.

3.3: Results

Data from 1099 follow-up and day surgery appointments was analysed. The mean age of patients was 70.0 (±14.8) with a range of 2 to 97 years, 60.6% were female and 39.4% male. The patients attending for review appointments had a mean age of 69.6 (±14.5) years, whilst those attending for surgery had a similar age profile with a mean age of 70.6 (±15.1) years.

Two-thirds of appointments were for patients whose primary ocular condition was cataract or another lens disorder. Eyelid, lacrimal system and orbit conditions were the primary disorder in 17% of patients and 11% were glaucoma patients (figure 3.2). Lens disorders, glaucoma and retinal/choroidal conditions were the most prevalent secondary eye conditions (figure 3.3).

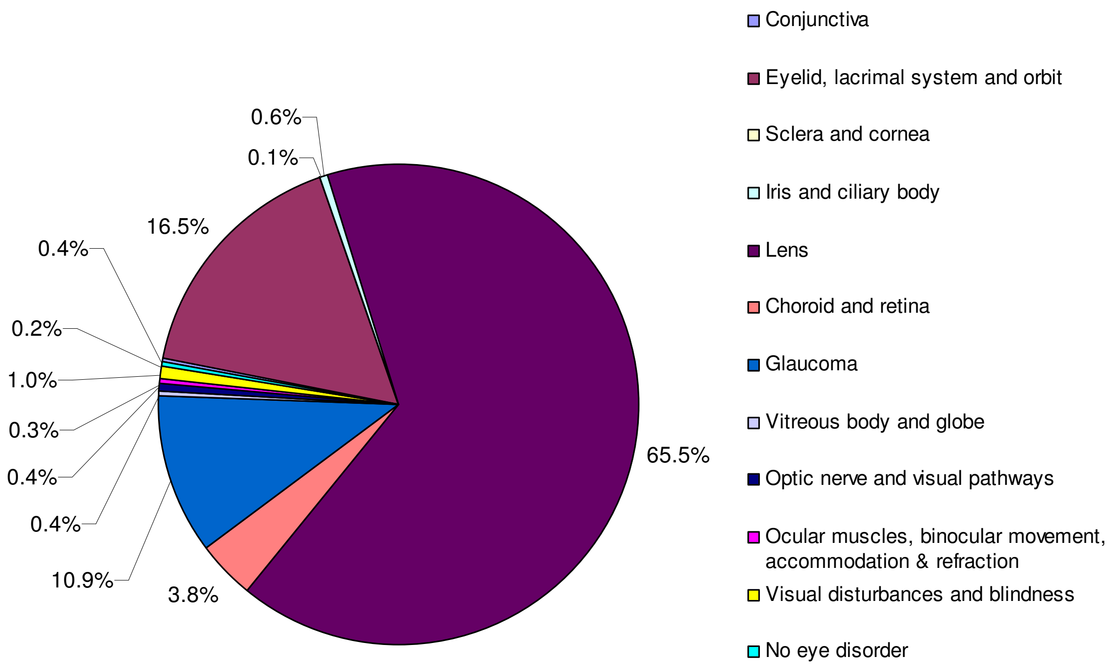

Figure 3.2: Primary ocular condition of patients attending for review and surgery appointments by WHO classification. Cataract surgery and follow-up appointments comprised almost two-thirds of the total number.

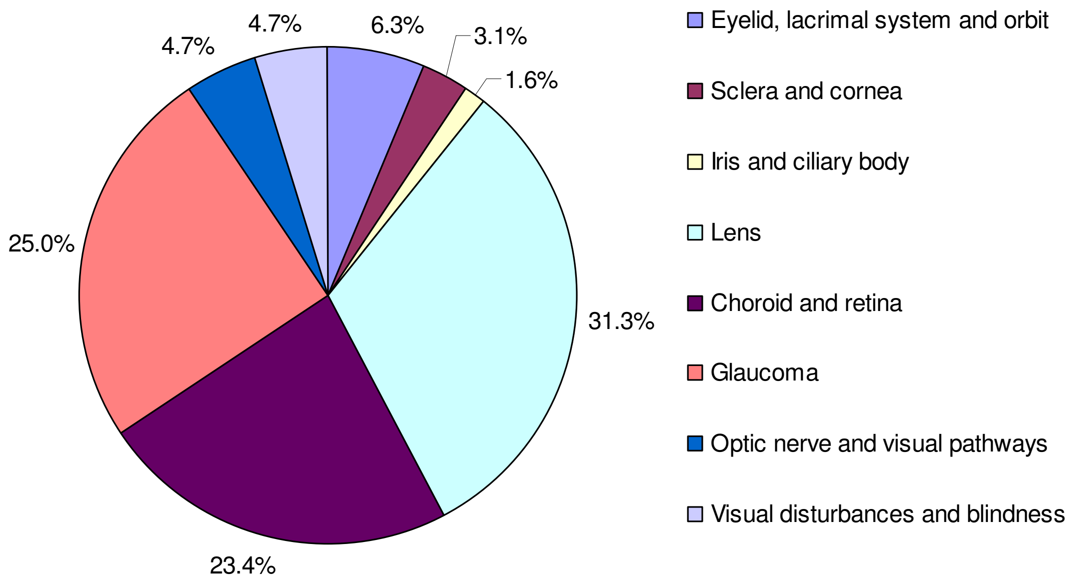

Figure 3.3: Secondary ocular condition of patients attending for review and surgery appointments by WHO classification. Six per cent of patients had a secondary ocular condition

When further analysed by appointment type, three-quarters of surgery appointments were for cataract patients with the remaining quarter for eyelid and lacrimal system surgery (figure 3.5). Patients requiring other surgery, such as for glaucoma or retinal detachment, were not treated under the hospital waiting list initiative but instead referred to a specialist department. Approximately 70% of follow-up appointments were post-operative or review appointments for lens and eyelid conditions (figure 3.4). Other significant groups attending for follow-up appointments were those with glaucoma (18.4%) and choroidal and retinal conditions (6.4%).

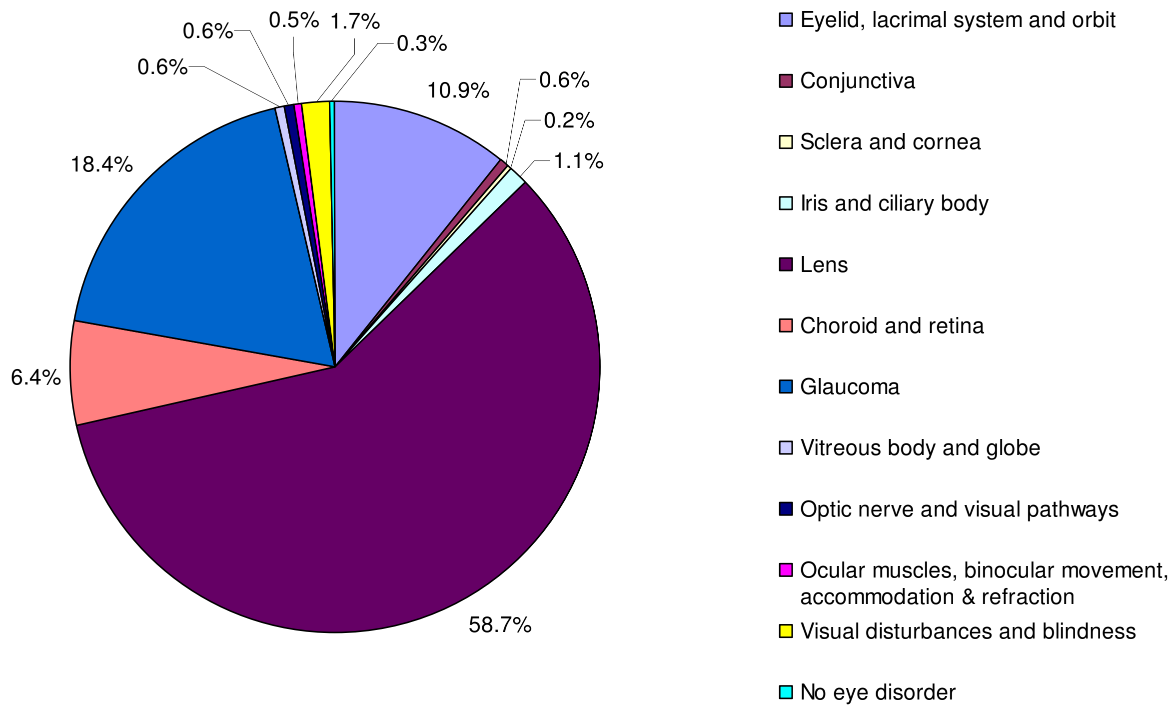

Figure 3.4: Primary ocular conditions of patients attending for review appointments by WHO classification. The largest group had cataract or other disorders of the lens.

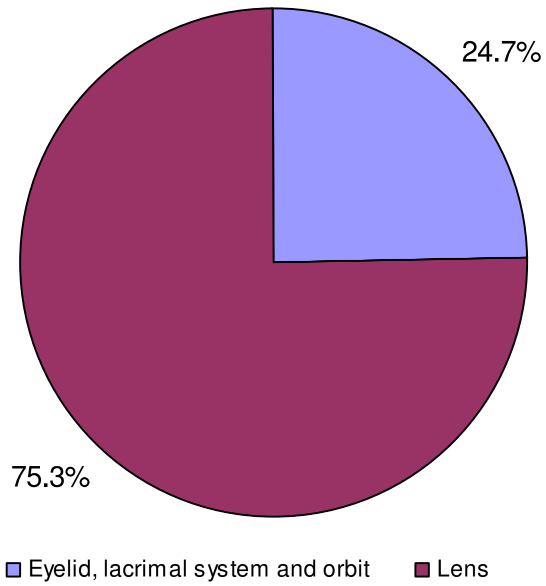

Figure 3.5: Primary ocular conditions of patients attending for surgery appointments by WHO classification, three quarters attended for cataract surgery (all other conditions were 0%)

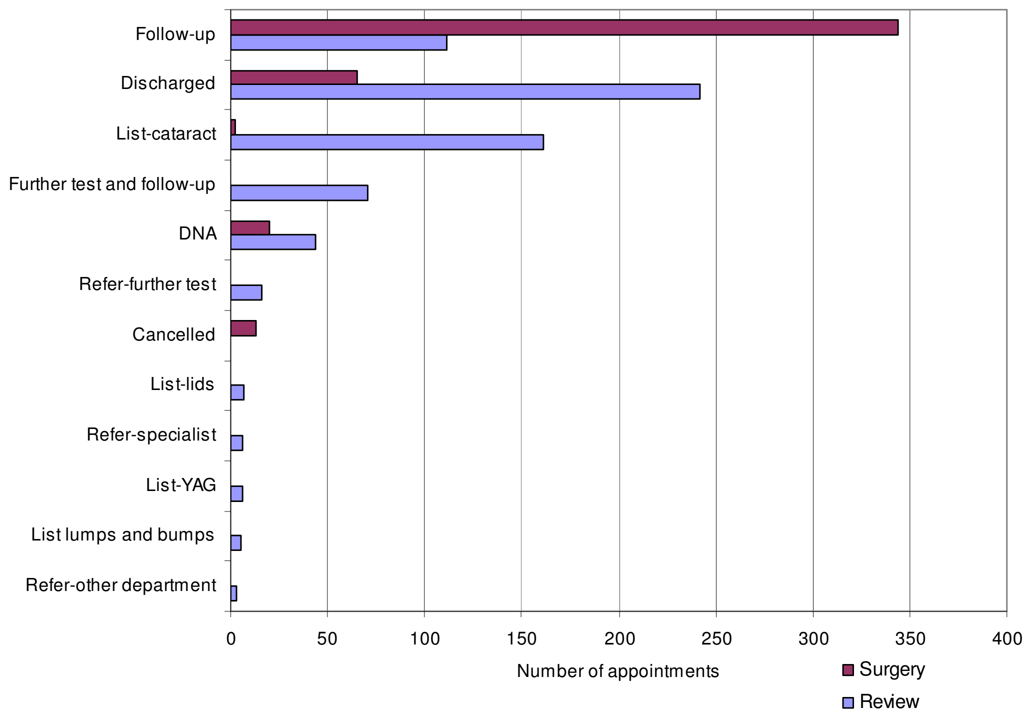

Figure 3.6: Management of patients attending for follow-up and surgery appointments. Over three-quarters of surgery patients required follow-up, while 36% of review patients were discharged.

Appointment outcomes are shown in figure 3.6. Non-attendance rates were 4.5% for surgery appointments and 6.5% for review appointments. The higher rate of non-attendance for review appointments than for new patients (4.4%, see Chapter 2) is in line with previous research (King *et al*, 1995). The majority, 77.1%, of surgery patients required follow-up appointments within the HES, whilst 14.6% of surgery patients and 35.9% of follow-up appointments were discharged.

The mean distance travelled by patients to their appointments was 22.8 (±11.3) miles, with a range from 0 to 50 miles. The majority of appointments were carried out at Tyrone County as surgery was only carried out at this location.

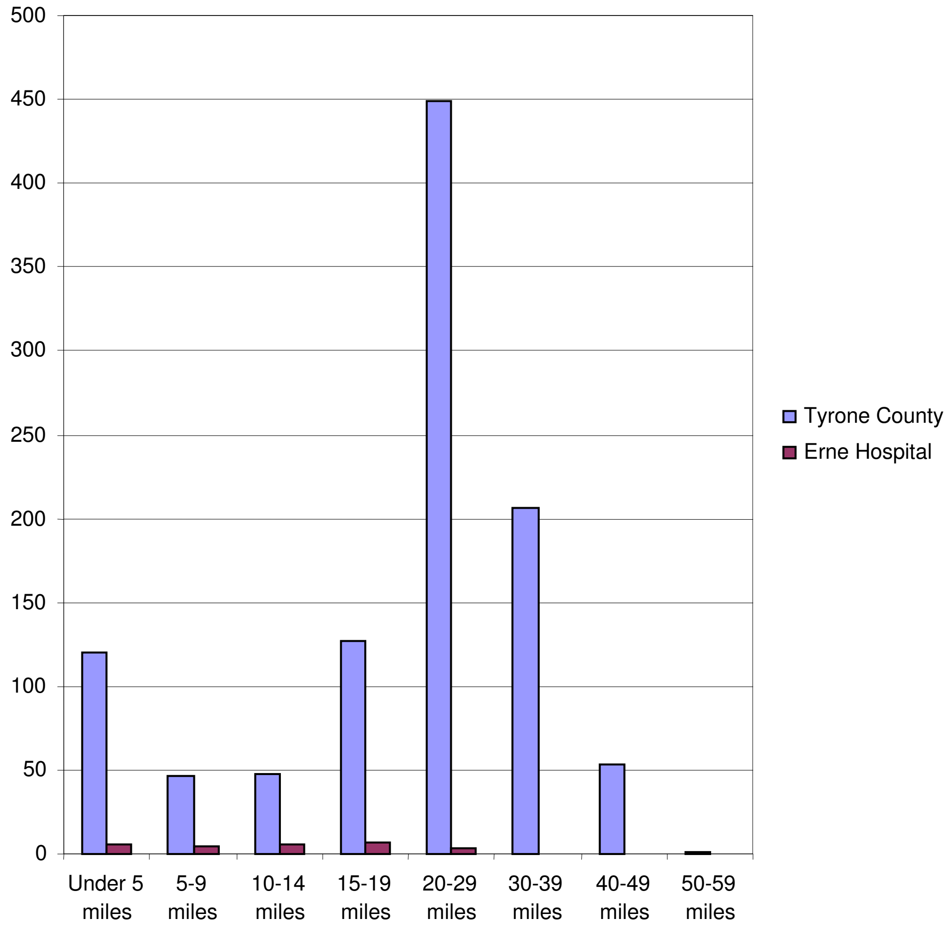

Figure 3.7: Distances travelled by patients for surgery and follow-up appointments at Tyrone County and Erne Hospitals. Few patients attended Erne Hospital as all surgery was carried out at Tyrone County.

Although surgery was only carried out at Tyrone County Hospital, the mean distance travelled for each type of appointment were similar at 23.3 (±11.4) miles for surgery and 22.5 (±11.3) miles for reviews.

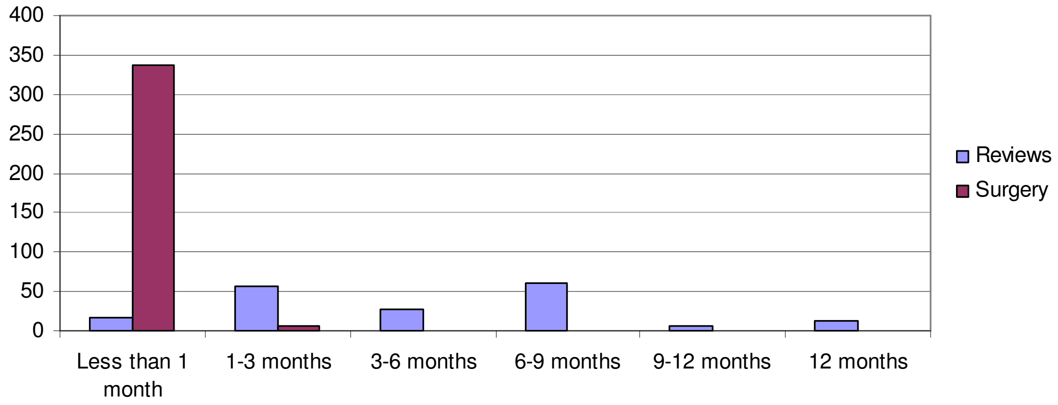

Figure 3.8: Recall period for review and surgery patients requiring follow-up appointments. The largest group of review patients were recalled in 6-9 months with a mean recall period of 4.4 months. Ninety-eight percent of surgery patients requiring follow-up were recalled within 1 month.

Almost all (98.0%) patients requiring review after surgery were recalled within a month for follow-up. The mean recall period for review appointments was 4.4 months as these patients were more likely to have chronic conditions such as glaucoma (figure 3.8).

3.4: Discussion

Appointments carried out as part of the waiting list initiative in this study took place at weekends. Churchill *et al* (2003) found that only 4% of clinic patients and 1% of surgery patients would opt for evening or weekend appointments, and proposed that unpopular appointment times would lead to higher rates of non-attendance. This does not appear to be the case in this study as the non-attendance rates of 4.5% for surgery and 6.5% for review appointments are lower than that found in previous studies (Koshy *et al*, 2008; Potamitis *et al*, 1994). Community optometrists will usually provide an option of weekend appointments which are often preferable to those of working age and those who rely on transport from family and friends of working age.

Cataract and lid conditions accounted for all the surgical appointments in this study and post-operative reviews of these patients formed a large proportion of review appointments. Glaucoma and retinal conditions accounted for 24% of review appointments. These four conditions together formed 98% of the surgical and review appointments analysed in this study. Opportunities to reduce the burden of these on the HES by increasing community-based management are discussed below.

3.4.1: Management of cataract patients

Three-hundred and thirty-five cataract operations were carried out during a 15 months period. Of these, nineteen patients had an intra-operative or post-operative complication. This equates to a rate of 5.7%, which is slightly lower than in previous studies with rates of around 7% at the same stage of follow-up (Haynes *et al*, 2001; Rogers *et al*, 2009), although figures on long term complications such as posterior capsular opacification (PCO) were not available due to the duration of the study. The most common complication was uveitis (anterior and posterior) with eight cases recorded, there were three cases of raised IOP, and other complications included a posterior vitreous detachment, a vitreous haemorrhage and conjunctivitis. Two patients required sutures during the cataract procedure, therefore their review appointments included removal of the sutures.

From this data we can conclude that over 90% of patients underwent straightforward cataract surgery with no recorded short term complications. Optometrist involvement at the stage of the two week post operative appointment would be appropriate, particularly if training to identify the common post-operative complications was available. Patients requiring suture removal and those with intra-operative complications would still require review by a consultant ophthalmologist, however this study found that only around 1% of patients were in these categories. Based on a post-op fee of £20 (table 2.2) compared to a cost of £65 for the hospital appointment, management by optometrists at this stage would save £14,850.

Surgery was only carried out at Tyrone County Hospital, the larger regional hospital. A study in a rural area of Norfolk found that patients were significantly more satisfied with the treatment process and facilities at a smaller community hospital than at a larger district hospital (Haynes *et al*, 2001), therefore consideration may be given to the option of also conducting surgery at Erne Hospital.

3.4.2: Management of glaucoma patients

Gray (1997) found that between 10 and 25% of ophthalmology outpatients appointments are with glaucoma patients. The results from this research fell within this figure with glaucoma being the primary condition in 18% of review appointments. Additionally 16 patients attending for management of ocular conditions in other categories were also glaucoma patients. Within those classed as having glaucoma by the WHO classification; 46% had been diagnosed with glaucoma, 14% with ocular hypertension and 38% were glaucoma suspects. The management of these patients is shown in figure 3.9.

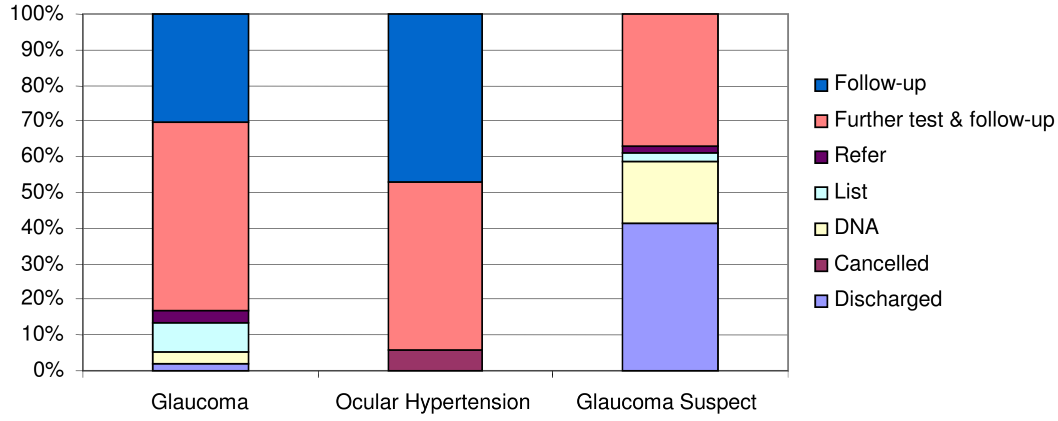

Figure 3.9: Management of patients with glaucoma, ocular hypertension and suspected glaucoma. Forty per cent of glaucoma suspects were discharged, whilst 17.4% did not attend their appointment.

All but one of those diagnosed with glaucoma and ocular hypertension required further review appointments or were listed for surgery (4 for cataract surgery, one for YAG laser treatment of PCO). It is interesting to note the high level of non-attendance amongst glaucoma suspects compared with those diagnosed with the condition (17.4% *versus* 3.4%). Research by Potamitis *et al* (1994), also found a high level of non-attendance in these patients. Non-attendance amongst these patients is concerning as early diagnosis and treatment will result in a better prognosis (Fraser *et al*, 2001), however these patients may not be suffering from any visual symptoms therefore they may be more likely to forget their appointment or not consider it to be important. Of these patients 39.6% were discharged back to their optometrist. Ophthalmological opinion is needed to confirm glaucoma diagnosis, however strict referral criteria, such as that used in Scotland, has been found to reduce the number of false positive referrals from optometrists.

3.4.3: Management of diabetic patients

Diabetic patients accounted for the largest proportion of patients with retinal conditions (31 patients). This group had a particularly high rate of non-attendance of 25.8%, which is comparable with a rate of 24% found in a US study (Leiner *et al*, 2009). As with glaucoma, the lack of symptoms in these patients may play a role in this. Although a national screening programme for diabetic retinopathy exists, figures from 2007 found that only 80.62% of the diabetic population had been offered screening compared to a target of 100% (Nagi *et al*, 2009). Of the diabetic patients who attended review appointments, 78.3% required further follow-up appointments with an average follow-up time of 5.5 months. Jones and Edwards (2010) discussed how cost-effectiveness in diabetic screening involves a balance of sensitivity, coverage and cost and proposed digital photography with telemedicine links as a solution for remote rural communities, such as the population covered by this study. Two-thirds of diabetic patients requiring further follow-up had a recall period of six months or more. These patients could be photographed in a community setting and their fundus photos reviewed by an ophthalmologist, thereby retaining those with more advanced retinopathy requiring urgent attention in the secondary care system and reducing the number of appointments required for those with early signs of disease that does not currently require treatment.

3.4.4: Management of eyelid lesions

A quarter of patients attending for surgical appointments underwent treatment for disorders of the eyelid, lacrimal system and orbit. The specific conditions are detailed in figure 3.10. Fitting of punctal plugs by optometrists is considered within the normal scope of practice (Barnard, 1996), however it is not commonplace in UK practice with only 5% of practitioners indicating that they carry out punctal occlusion (Medix UK, 2008). This may be due to the relatively small numbers of patients (only 2 patients in this study) and lack of NHS funding for this procedure, however if practitioners were able to carry out a greater variety of eyelid and lacrimal system procedures they could incorporate punctal plugging as a part of their service.

Over half (59.1%) of patients with eyelid, lacrimal system and orbit disorders were discharged immediately following surgery. Three-quarters of eyelid, lacrimal system and orbit patients attending for surgery had chalzion, cyst or papilloma procedures. Whilst lid repositioning generally requires follow-up and suture removal, lesion removal is predominantly a straight-forward procedure with minimal complications (Sendrowski & Mayer, 2000). Ophthalmic nurses have carried out these procedures in some UK hospitals with successful results (Jackson & Beun, 2000). Further training would be required for optometrists in diagnosing and treating lesions, and digital slit lamp cameras with internet links would be of benefit where assistance from ophthalmologists is required.

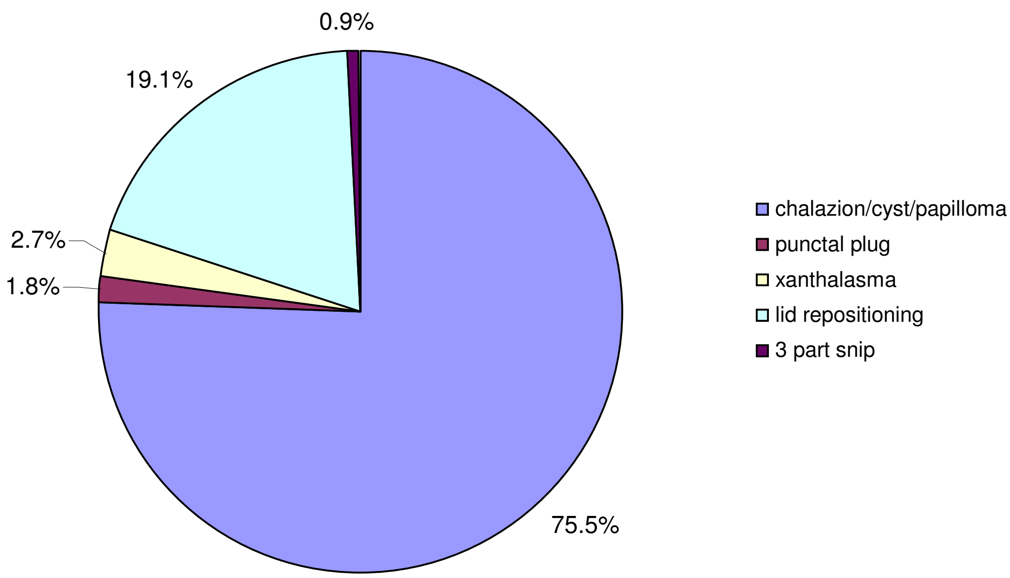

Figure 3.10: Eyelid, lacrimal system and orbit disorders of those attending for surgical appointments

3.5: Economics

In order to assess whether it is feasible to implement a scheme such as minor eyelid procedures where advanced training and instrumentation are required, a cost analysis must be conducted. In West Sussex, GPs with a specialist interest are paid £88.50 per procedure for surgical treatment of chalazian (NHS West Sussex, 2010). In this analysis, 83 patients underwent surgery for lid lesions. The cost model shown in table 3.1 proposes that the optometrist undertake training in the form of hands-on training with an ophthalmologist in a hospital ophthalmology outpatient clinic as this is commonly used in cataract co-management schemes, though future developments could include the introduction of a distance learning course. The cost of purchasing a digital slit lamp was spread over three years as, if purchasing on a finance scheme, the optometrist would expect to pay back the cost in this period. After this time the cost of maintenance would be a factor, though significantly less than £1666 per year, leading to an overall reduction in the optometrist's overheads.

		Cost
Training	8 hours of optometrists time @ £22.18 per hour	£177.44
Instrumentation	Digital slit lamp: £5000 over 3 years	£1666.67
Costs of consumables	£5.91 (Jackson & Beun, 2000)	£490.53
Total cost		£2334.64
Cost per patient		£28.13

Table 3.1: Costs of implementing optometrist surgical excision of lid lesions. Assuming a cost for the optometrist's time of £45, the total cost per patient would be £73.13

If a fee for the optometrist's time is paid in line with current schemes for glaucoma and cataract co-management schemes (table 2.2), at £45 per patient, the total cost per patient would be £73.13. This represents a saving of around £15 per patient compared to the West Sussex GP scheme. Jackson and Beun (2000) costed treatment by a Senior House Officer or Specialist Nurse in an ophthalmology department at £13.66 per patient, however this did not take into account overheads such as training and the cost of facilities and support staff. This also assumes that the clinic is operating at full capacity. A more realistic figure would be close to the average new patient cost of £106 (AOP, 2008).

As discussed previously, many of the cataract, glaucoma and diabetic patients reviewed in this study could be suitable for optometric management. The following cost analysis includes cataract post-op appointments where surgery was straightforward, as those with intra-operative complications would need further ophthalmological opinion. All glaucoma, ocular hypertension and glaucoma suspects were included, and diabetic patients requiring follow-up appointments in 6 months or more were included as their condition would not be immediately sight-threatening.

Enhanced service	Average payment to optometrist	Number of appointments	Cost of community based scheme	Cost of appointments in HES	Cost of waiting list initiative
Cataract post-op	£20	330	£6600	£15,840	£21,450
Glaucoma	£45	120	£5400	£5760	£7800
Diabetic review	£20	12	£240	£576	£780
Total		462	£12,240	£22,176	£30,030
Cost saving of community based scheme				£9936	£17,790

Table 3.2: cost analysis of review appointments for ocular conditions: comparison of hospital and community based schemes. This model assumes a standard per patient fee of £65 in the waiting list initiative and an average cost of £48 per patient for an HES outpatient appointment

Costs to the patient must also be considered, as Sharma *et al* (2010) calculated that they may account for a third of the total costs of attending an outpatient clinic. Sharma *et al* calculated mean costs per visit of between £12.90 and £16.20 for glaucoma patients at several London hospitals. This considered the cost of travel and loss of productivity time for both the patient and any companion attending with them. As information on employment status and whether the patient was accompanied was not available as part of this study, a full cost analysis is not possible. However, based on travel alone, the mean cost per patient attending for a follow-up appointment is £24.75 (based on a mean round trip of 45 miles and a cost of 55p per mile as per Sharma *et al*). When considering implementation of community-based schemes, remote communities may benefit from greater cost-savings than urban populations when patient costs are considered.

3.6: Conclusion

Glaucoma, diabetes and cataract were three of the four most common reasons for attending surgical and review appointments in this study. Schemes already exist across the UK for diabetic retinopathy screening which may or may not involve optometrists, further use could be made of these schemes for those patients where ophthalmological review is required but the condition is not at an advanced stage. Patients diagnosed with level 2 retinopathy (see section 1.1.1.3) who require monitoring rather than treatment may be suitable for this management if good communication exists between the optometrist, ophthalmologist and GP.

Glaucoma and cataract co-management schemes exist in some but not all regions across the UK. Further utilisation of these schemes would provide a cost-saving by reducing the number of referrals to secondary care in the case of glaucoma, and the number of separate appointments needed for cataract patients. Further expansion of the optometrist's role into management of eyelid, lacrimal system and orbit disorders could include blepharitis management as discussed in section 2.4.4, punctal occlusion and lesion removal procedures. Optometrists may currently offer their patients treatment for blepharitis and punctal occlusion, however most charge privately as NHS funding is not available. NHS funding for these procedures would reduce the number of outpatient appointments required costing £65 per appointment under the waiting list initiative, with a payment of around £40 (see table 3.2) to the optometrist representing a significant cost saving.

CHAPTER 4

Current use of Instrumentation in Optometric Practice

4.1: Introduction

Instrumentation to aid optometric practice has a long history, dating back to early instruments such as the optometer, introduced by William Porterfield in 1737 (Bennett & Rabbetts, 2007), and the ophthalmometer, discovered by Ramsden in the late eighteenth century (Mandell, 1960). Instruments that would be recognised by today's optometrists were introduced in the nineteenth century, with Cuignet's retinoscope in 1873 (Millidot, 1973) and Helmholtz's ophthalmoscope in 1850 (Ravin, 1999).

Figure 4.1: The Wesley-Jessen Photo-Electric Keratoscope (Left, image courtesy of Richard Pearson) and the Oculus Keratograph (Right, image courtesy of Craig Woods). Development of photokeratoscopy measurement to corneal topography: the principle of the Placido disc remains the same, however advancing computer technology has enabled the development of smaller instruments, greater automation and more detailed analysis of results.

More recently, computers have become commonplace in optometry practices and have led to many advances in instrumentation (Adams, 1993) such as automated perimetry and digital imaging. Figure 4.1 shows how the photokeratoscope developed from a specialist instrument to one that can be easily incorporated into high street optometric practices due to advances in computer technology. Gerber (2009) discusses the advantages of investing in new instrumentation which include:

- increasing staff morale;
- saving money on repairing old or unreliable equipment;
- increasing income and patient flow;
- reducing time demands on the optometrist;
- generating positive publicity for the practice;
- positively influencing the patient’s opinion of the practice.

Optometric practices have varying levels and types of instrumentation; this may depend on factors such as the resources of the company, specialist interests of the optometrist and which supplementary tests the company wishes to offer. Regulations do not dictate what instrumentation an optometrist must have in order to practice, however, in its Code of Ethics and Guidelines for Professional Conduct the College of Optometrists, has recommendations for the contents of a routine eye examination and the basic level of equipment required (College of Optometrists, 2011c). Its list of suggested and optional equipment is shown in table 4.1, together with a separate list of equipment for optometrists who fit contact lenses (table 4.2). In order to carry out GOS, a practice must conform to the minimum equipment requirements of the local PCT. This may vary between PCTs though an example of the equipment required is included in table 4.1. The PCT also stipulate that the equipment must be fit for purpose and in working order.

Recommended equipment	**Other appropriate equipment**
Test chart	Slit-lamp mounted camera
Near vision tests	Digital imaging system
Trial lenses, trial frame & accessories	Non-mydriatic camera
Retinoscope	Children's acuity charts
Direct Ophthalmoscope	Supplementary vision charts
Accommodation rule	Refractor head
Colour vision test	Auto refractor
Distance & near oculomotor balance tests	Binocular headset indirect ophthalmoscope
Test for stereopsis	Contrast sensitivity chart
Applanation tonometer*	Equipment for foreign body removal
Threshold controlled visual field equipment	Equipment for punctum plug insertion & tear duct syringing
Peripheral visual field equipment	
Amsler charts	
Slit-lamp biomicroscope	
Condensing lens for slit lamp indirect biomicroscopy	
Keratometer	
Pen torch	
Focimeter	

*non-contact tonometers are suitable for screening but contact tonometers are preferred when considering referral

Table 4.1: List of equipment for routine eye examination recommended by the College of Optometrists (College of Optometrists, 2011c). Minimum equipment required by Bedfordshire PCT is highlighted (courtesy of Bedfordshire PCT)

Aston University

Illustration removed for copyright restrictions

Table 4.2: List of equipment recommended by the College of Optometrists for practitioners involved in contact lens practice (College of Optometrists, 2011c)

A number of studies have investigated the type of instrumentation practitioners have available to them in optometric practices. The College of Optometrists carried out its Clinical Practice Survey in 2001 and 2007 (Medix UK, 2008), which measured the usage of certain instruments such as tonometers, methods of fundus viewing and photography, and test charts. It did not ask about other equipment such as corneal topographers, pachymeters and auto-refractors. The questionnaire also asked optometrists if they were involved in certain primary care activities and if they charged for supplementary tests such as fundus photography and orthoptic assessment. The survey found that the largest increase in instrumentation usage was in digital fundus photography, with 45% of optometrists using the equipment in 2007 compared to 11% in 2001. It also found that 42% of respondents charged for supplementary tests. This varied by practice type, with 56% of respondents from independents charging compared to 31% of respondents from joint venture or multiple practices. Other studies have looked at the prevalence of instrumentation related to a particular purpose, such as glaucoma screening (Willis *et al*, 2000) or involvement in specialities such as therapeutics (Needle *et al*, 2008).

Areas that have not been explored in these studies are:

- a comprehensive survey of all types of equipment is available in practice;
- future purchase intentions;
- specific equipment needs for different types of practice;
- what factors are most important when considering purchase of new instrumentation; and
- how much practices charge for supplementary tests conducted with additional instruments.

These questions are important to consider when exploring how well equipped UK optometrists are to extend their role, how to promote new instrumentation to optometrists, and to look at how an optometrist can fund investment in new technology as part of a viable business plan.

Given the paucity of literature in these areas, this study aimed to discover the current availability of equipment to optometrists in the East and West Midlands regions. The study also looked at factors in equipment purchase decision making, specialities of optometrists, delegation of tasks to support staff, and what equipment practices are likely to buy in the near future. Respondents were asked about the size and modality of their practice in order to compare any significant differences in results.

4.2: Method

Rather than ask practitioners to list what equipment they had, which may have led to omissions and would be more time-consuming, a list of equipment was drawn up that would commonly be available to practitioners. A list of optometry equipment available from a distributor of ophthalmic equipment was used as a starting point. Information from other UK distributors' brochures and websites was used to ensure the list was comprehensive. Several optometrists were consulted to ensure that the list would apply to both high street and hospital practice and to ensure that the terminology (such as perimeter and focimeter) was well understood.

Respondents were asked to indicate the type of practice they worked in. The options were hospital, laser clinic, single independent, small chain (<5 stores), large chain (5-30 stores), franchise of large multiple, and large multiple (>30 stores). Other surveys have included practices with a small number of branches in the 'independent' bracket (Medix UK, 2008; Mintel, 2008). However, it was felt that including these practices as a separate category "small chains" would be beneficial as they may benefit from greater economies of scale than single independent practices. Question 4a asked decision makers to rank twelve factors in order of those they consider most important when purchasing new equipment. A list of twelve factors was drawn up in consultation with Birmingham Optical Group (a UK distributor of ophthalmic equipment). These were reasons commonly given by customers for buying an instrument or for choosing a competitor's instrument instead. Several optometrists were also consulted to ensure the list was comprehensive.

In July 2008, a self-administered questionnaire was sent out to 1,734 optometrists from the East and West Midlands whose details were obtained from the GOC register. All optometrists who listed their county as West Midlands, Staffordshire, Worcestershire, Warwickshire, Shropshire, Gloucestershire, Leicestershire, Nottinghamshire, Derbyshire or Herefordshire were selected. The database was then searched again by postcodes covering these areas to identify practitioners who had not listed their county. Postcodes included were those with the prefaces B, WV, WS, ST, DY, WR, CV, TF, SY, GL, LE, NG, DE and HR. These optometrists were targeted as the secondary aim of the questionnaire mailing was to recruit practices for a Midlands Clinical Research Network to take part in future research projects. The questionnaires were anonymous but a detachable form was included for practitioners to supply their details should they wish to be contacted about future research. In order to obtain a representative sample of this large population, the response rate needed to be as high as possible. Several methods were employed to maximise response rate. Etter *et al* (2002) showed that questionnaires printed on pink paper had an increased response rate compared to other colours, therefore pink paper was used. In order to encourage optometrists to participate, all respondents were entered into a draw to win a weekend break in London. The questionnaire was kept as short as possible and mostly required only ticked box answers in order that practitioners would be more likely to have time to respond.

The questionnaire was initially carried out after a period of steady growth in the sector, of 22% between 2002 and 2007, had led to a market worth £2,656m in 2007

(Mintel, 2008). The 2008 Mintel report predicted slower growth between 2007 and 2012. This was shown to be accurate as the optical goods market fell by 2.2% in 2009 compared to the previous year (Mintel, 2010). The economic downturn and 'credit crunch' led to a reduction in the availability of finance to small businesses (HM Treasury, 2009). The questionnaire was repeated in July 2010, in order to investigate any changes in the availability and use of instrumentation over the study period. Additional aims of the second study were to establish whether intended purchases had been negatively affected by wider economic problems, whether this had led to a change in which factors were most important in instrumentation purchase and whether the amount charged to the patient for supplementary tests had been affected.

The same database of optometrists as for the first study was used, however in the 2008 study some questionnaires had been returned as the practitioner was no longer practicing at that address or had retired; details of these practitioners were removed from the database which resulted in a smaller sample of 1443 optometrists. Pre-paid envelopes were used this time in order to increase the response rate as some respondents from the first study had suggested this as an improvement that could be made. The questionnaire was kept identical to the original so as to make the two studies comparable.

4.3: Results

The initial questionnaire received a response rate of 23.1%, with 400 responses received. This is comparable to the College of Optometrists' survey (Medix UK, 2008) which received a response of 30%. Based on this response rate there is 95% confidence that the results would be accurate to within ±4.3% of the results for the whole population of 1,734 optometrists in the East and West Midlands. The confidence interval is calculated using the formula:

$$d = \sqrt{\frac{t^2 * (p) * (1-p)}{n}}$$

where d = margin of error, t = value for selected alpha level (1.96 for 95% confidence level, p = proportion of one choice (0.5 used for sample size calculation), n = corrected sample size for a finite population ($n = \frac{ss}{1+(ss-1/population)}$)

(Bartlett *et al*, 2001).

Due to a low number of responses from hospital optometrists, further questionnaires were emailed to local hospital optometrists; this increased the total responses to 408. The follow-up questionnaire in 2010 received 423 responses (29.3% response rate). From this response rate we can be 95% confident that the results would be within ±4.01% of the results for the whole population. Respondents were asked to indicate the type of practice that they worked in. Approximately 1% of respondents indicated that they worked in different modalities of practice; therefore they were included under the practice at which they worked most frequently. The breakdown of respondents is shown in Figure 4.2, indicating a similar profile of respondents between the two surveys.

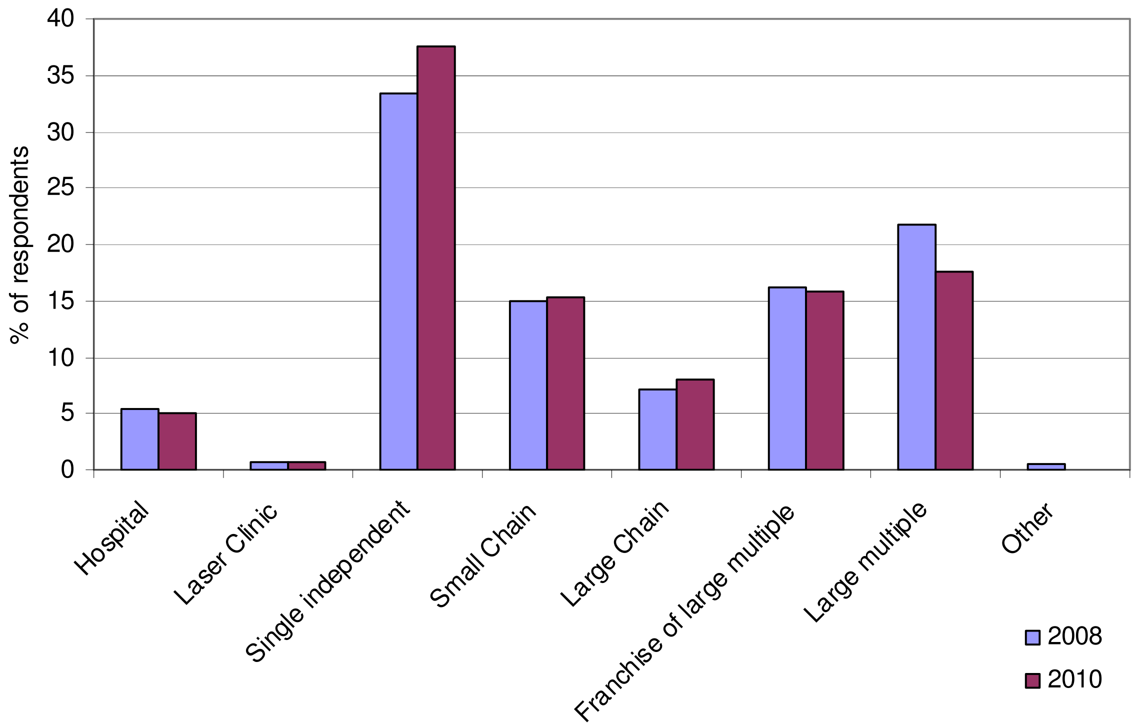

Figure 4.2: Type of practice of respondents: 2008 and 2010 surveys. In the 2008 survey, the 2 respondents in the category of 'other' were domiciliary practitioners. The 2010 survey received a slightly higher proportion of responses from single independent practices and a lower proportion from large multiples in comparison to the 2008 survey

Question 2 asked how many consulting rooms the practice has. The 2008 results show a mean (± standard deviation (SD)) of 2.5 (±1.5) testing rooms per practice compared to 2.4 (±1.4) rooms in 2010.

Question 3 asked the number of testing days that the practice operated per week; this counted one clinician testing for a full day as 1 testing day and 2 clinicians testing on the same day as 2 testing days. Therefore, one full time optometrist was equivalent to 5 testing days per week. The mean number of testing days per week in the 2008 survey was 8.4 (± 4.9) (using the mid-point of each group) and in the

2010 survey it was 7.8 (±4.6), a slight reduction but not at a statistically significant level ($p=0.214$).

Question 4 was about the decision-making process and who was involved. Some of the respondents ticked more than one box for this question to indicate that more than one person was involved. An optometrist practice manager/director was most likely to decide on purchases and there was little variation between the surveys (Figure 4.3).

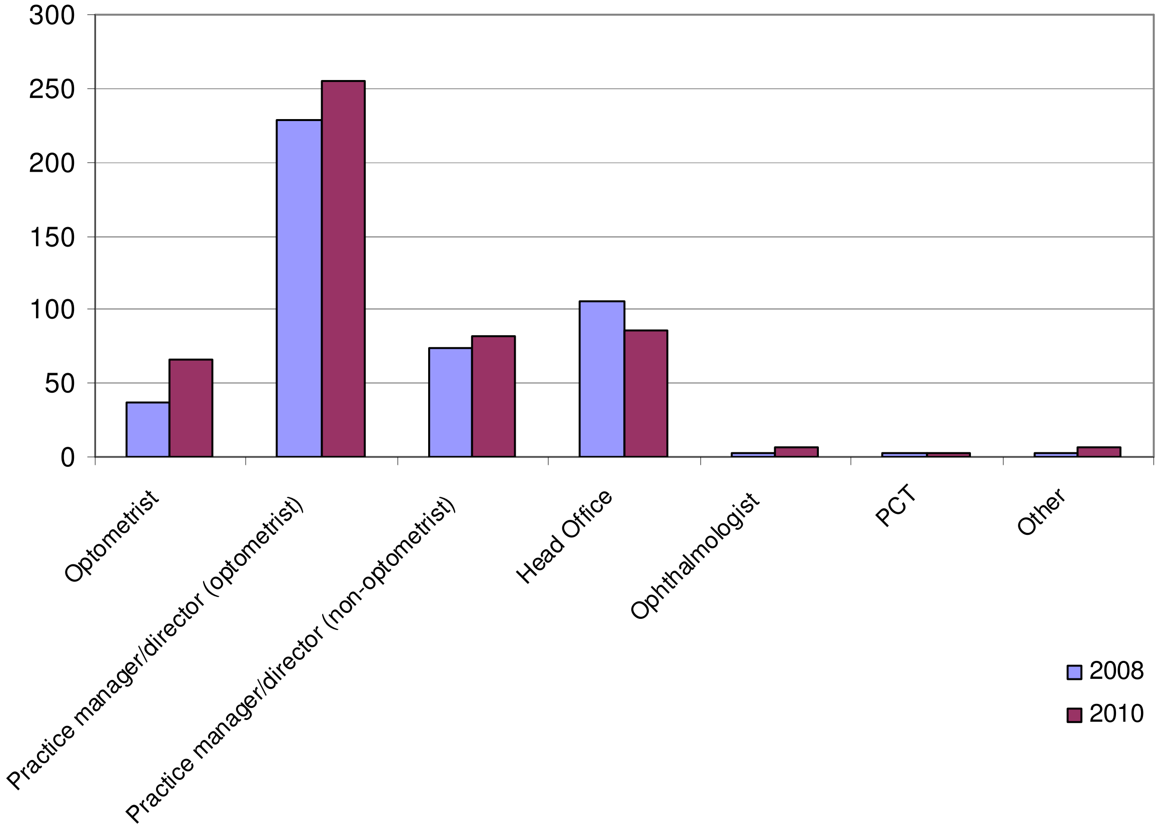

Figure 4.3: Decision-makers in instrumentation purchasing. The lower number of responses where 'head office' was the key decision maker in 2010 is consistent with fewer responses from non-franchised large multiple practices

For those who were involved in the decision-making process, question 4a asked which factors were taken into consideration when purchasing new equipment. The questionnaire gave 12 factors which the optometrist might consider and asked them to rank the factors in order from 1 to 12 with 1 being the most important and 12 the least. This was the only question that produced some confusion in the answers. When asked to number the options from 1 to 12, with 1 being the most important, some respondents ticked those that they considered to be most important while others awarded a score out of 12. These responses were disregarded for the analysis of this question. Figure 4.4 shows the mean ranking of each factor (a lower number meaning a more important factor). This question was answered by 223 respondents the 2008 survey and by 240 respondents in 2010. No data exists regarding the total number of optometrists across the East and West Midlands who are involved in instrumentation decision making; however for an infinite population these response rates give margins of error of ±6.6% and ±6.3% respectively. Shapiro-Wilk W tests showed abnormal distribution across all factors (p=0.000), therefore Mann-Whitney U tests were carried out between the 2008 and 2010 results for each factor. There were no significant differences (p=0.102 to 0.953)

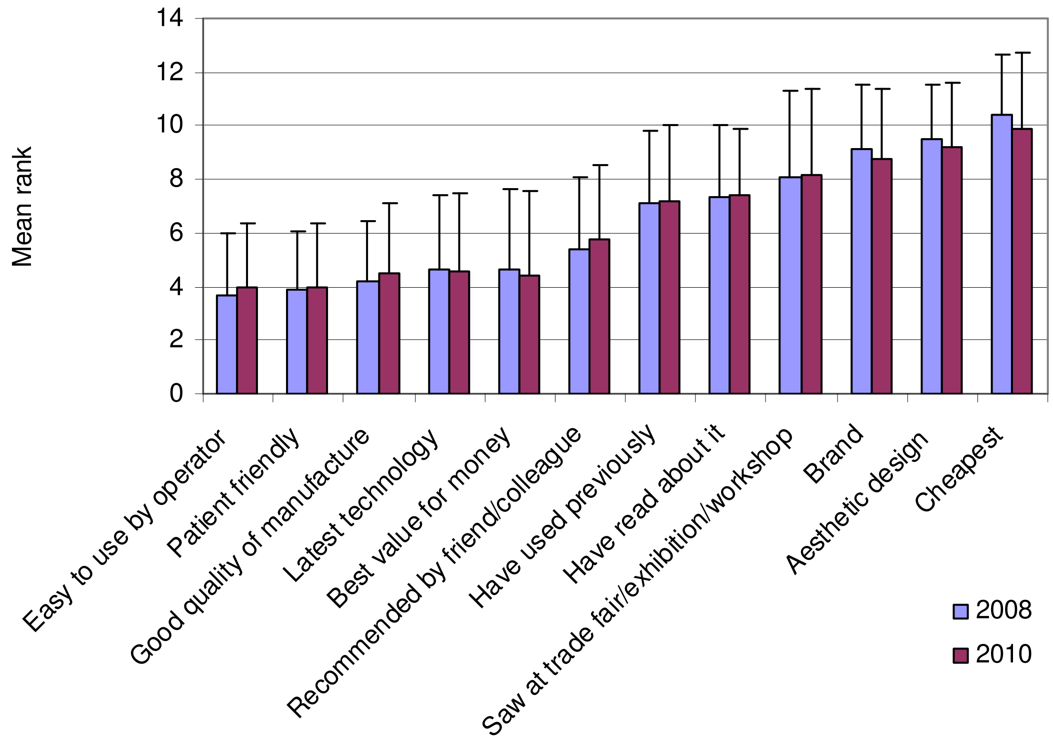

Figure 4.4: Mean rank (out of 12) of each factor in instrumentation purchase decision making. 'Easy to use by operator' was the most important factor in both the 2008 and 2010 surveys. 'Cheapest' showed a significant increase in importance between the two surveys.

Table 4.3 shows the responses given when asked about the range of instrumentation respondents currently had available to them in practice and that which they were looking to buy or upgrade in the 6 months following the survey. The results show that the largest increases between the two surveys were in fundus cameras, contact tonometers and LCD (Liquid Crystal Display) test charts.

Instrument	**% of practices (2008)**	**% of practices (2010)**	**Change (%)**	**Looking to buy/upgrade (2008)**	**Looking to buy/upgrade (2010)**	**Change (%)**
Tonometer (NCT)	84.80	83.69	-1.11	5.39	3.55	-1.84
Tonometer (contact)	69.12	77.78	+8.66	3.68	10.64	+6.96
Perimeter	80.88	86.29	+5.41	8.33	10.17	+1.84
Fundus camera	57.35	73.76	+16.41	14.71	9.93	-4.78
Focimeter	99.02	98.82	-0.20	2.94	3.31	+0.37
Slit-lamp	99.26	99.05	-0.21	3.92	5.20	+1.28
Keratometer	96.08	95.27	-0.81	3.92	1.42	-2.50
Auto-refractor	34.31	34.75	+0.44	3.92	1.42	-2.50
Test Chart (projector)	46.08	44.21	-1.87	3.19	0.95	-2.24
Test Chart (illuminated)	64.71	55.56	-9.15	3.19	2.36	-0.83
Test Chart (LCD)	23.77	29.55	+5.78	5.64	2.84	-2.80
Refractor Head	37.25	39.24	+1.99	2.21	2.60	+0.39
Retinoscope	98.03	96.45	-1.58	2.70	1.89	-0.81
Ophthalmoscope	98.53	97.40	-1.13	2.21	2.84	+0.63
Volk Lens	97.79	96.69	-1.1	2.45	1.65	-0.80
Pachymeter	9.80	12.53	+2.73	3.19	5.20	+2.01
Biometer	4.66	4.73	+0.07	0.49	0.47	-0.02
Aberrometer	0.98	0.95	-0.03	0.00	0.00	0.00
Corneal Topographer	12.25	14.89	+2.64	3.43	3.55	+0.12

Table 4.3: Instrumentation currently available in optometric practice and intentions for future purchases, 2008 and 2010. Fundus cameras and LCD test charts showed the largest increases between the two surveys

Respondents were given an option to list equipment not included in the above list under the “other” section. Instruments under this heading included head-mounted indirect ophthalmoscopes, OCTs, colourimeters, specular microscopes, nerve fibre imaging systems such as the HRT and the Zeiss GDx, Optomap imaging, Pelli-Robson charts, digital slit lamps, gonioscopy lenses, Burton lamps and Placido discs.

The equipment that was top of the ‘looking to buy’ list in the 2008 survey was further analysed by type of practice to see if there were any trends in which practices are most likely to have more modern equipment before the rest of the market (Figures 4.5, 4.6, 4.7 and 4.8). Due to the relatively small numbers of responses from laser clinics and other practices they were not included in the analysis as their data would not be significant.

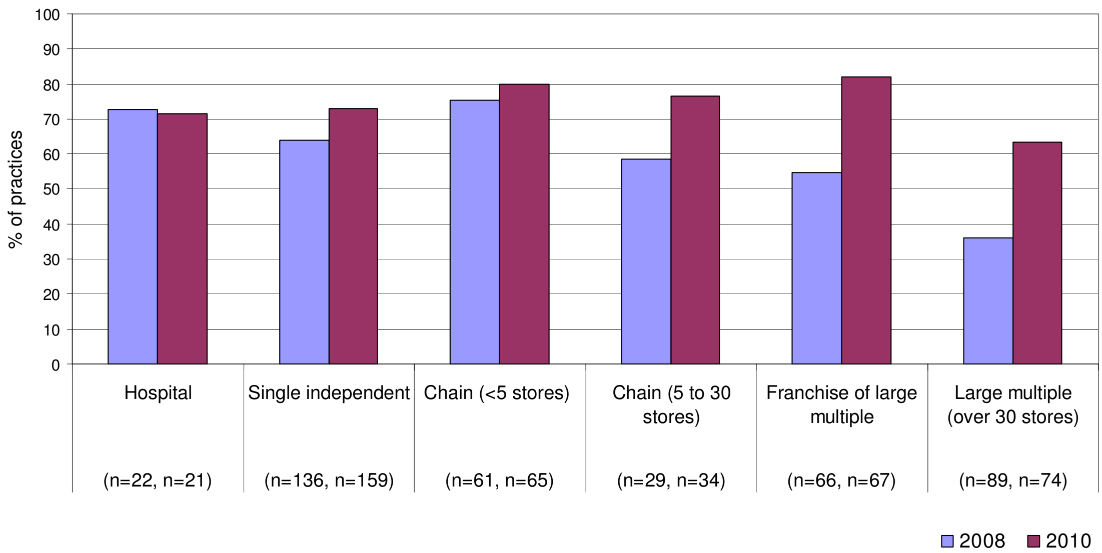

Figure 4.5: Availability of fundus cameras by practice type (total number of practices of each type (100%) is shown in brackets from 2008 and 2010 surveys respectively

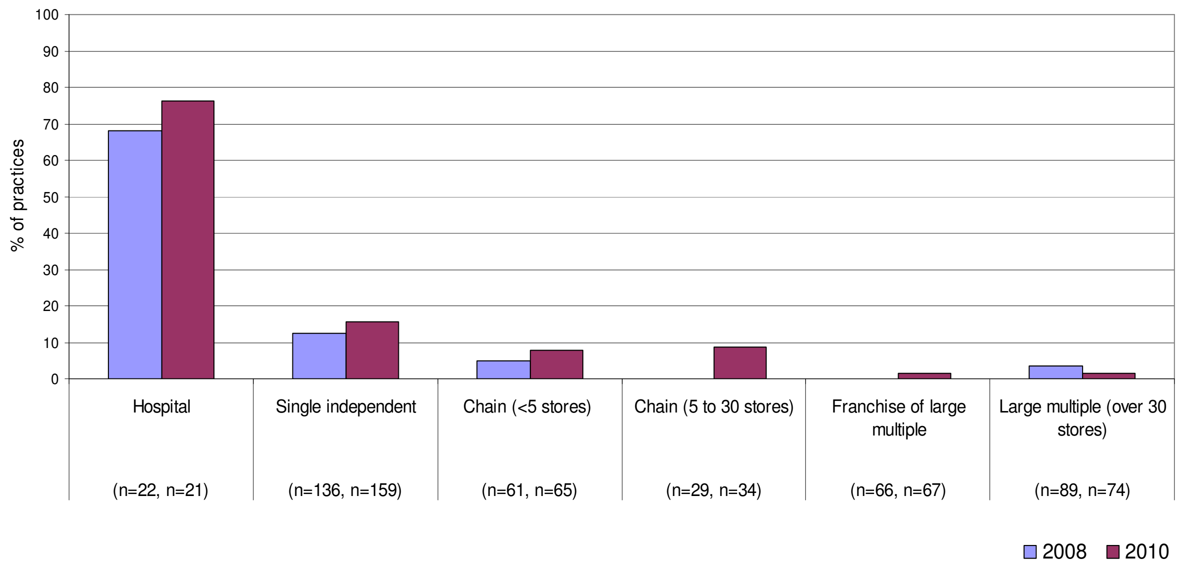

Figure 4.6: Availability of pachymeters by practice type (total number of practices of each type (100%) is shown in brackets from 2008 and 2010 surveys respectively)

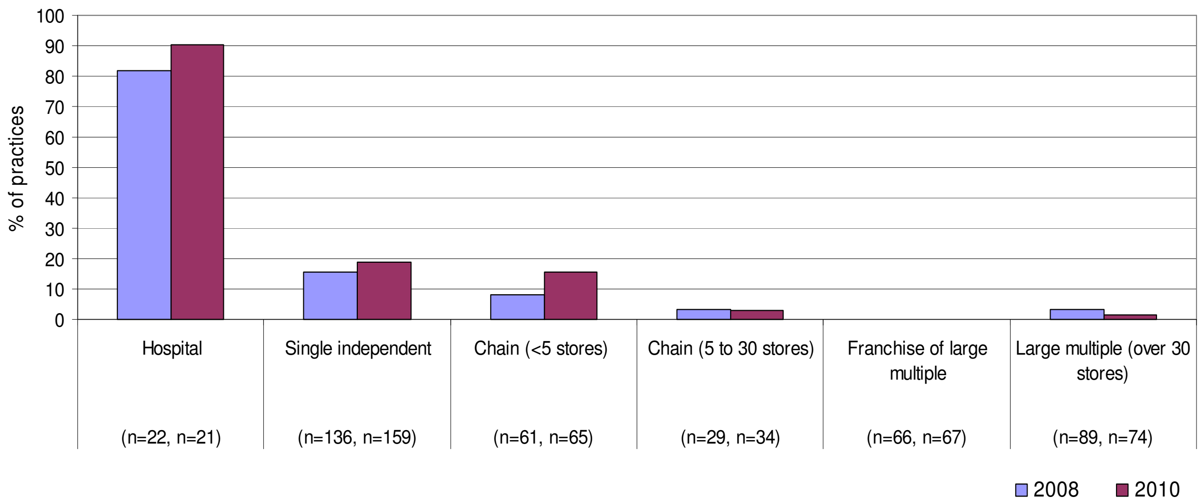

Figure 4.7: Availability of corneal topographers by practice type (total number of practices of each type (100%) is shown in brackets from 2008 and 2010 surveys respectively)

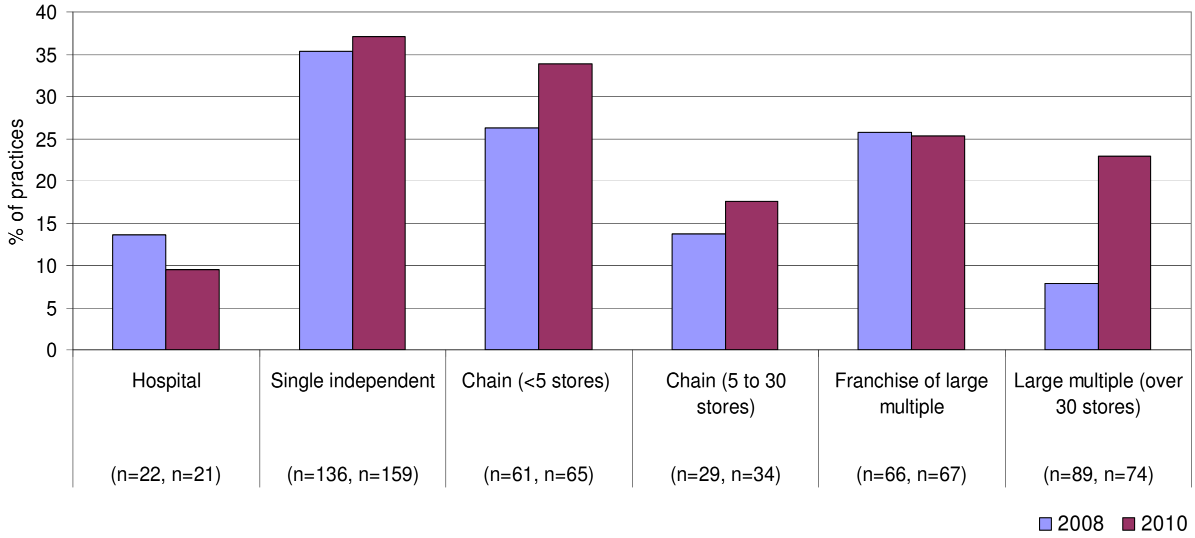

Figure 4.8: Availability of LCD test charts by practice type (total number of practices of each type (100%) is shown in brackets from 2008 and 2010 surveys respectively)

Question 6 looked at which tests were carried out by support staff rather than the optometrists themselves. The results are shown in Figure 4.9. Focimetry and perimetry were carried out by support staff in over half of practices. Support staff carried out fundus photography in 29.2% practices in 2008; this increased to 39.5% in 2010. Figure 4.10 shows that auto-refraction is carried out by support staff in over 70% of practices which have an auto-refractor.

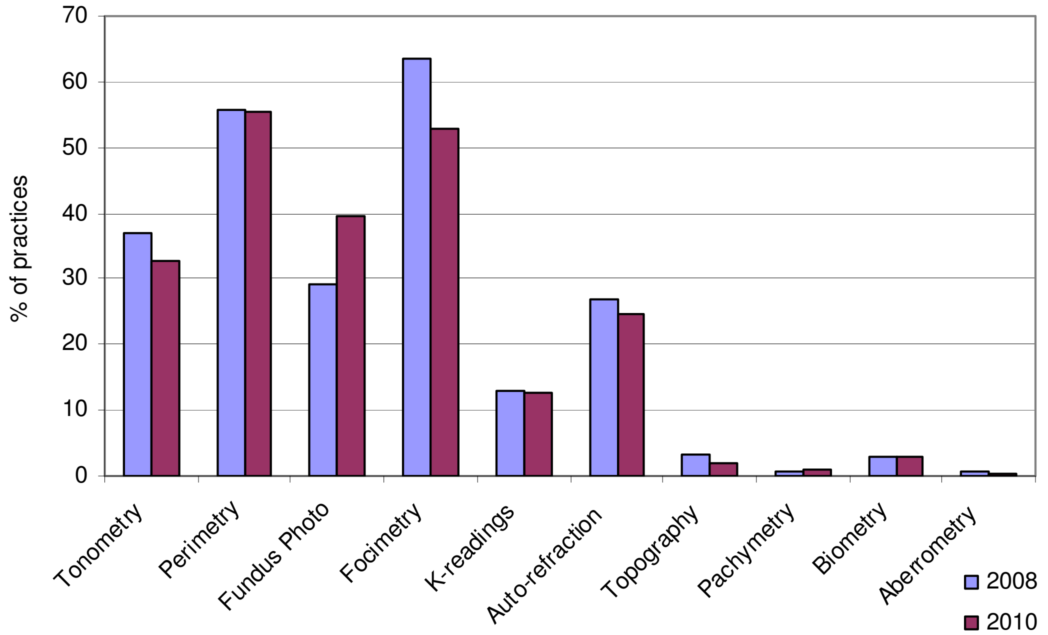

Figure 4.9: Tests carried out by support staff: fundus photography was carried out by support staff in a greater percentage of practices in 2010 than in 2008

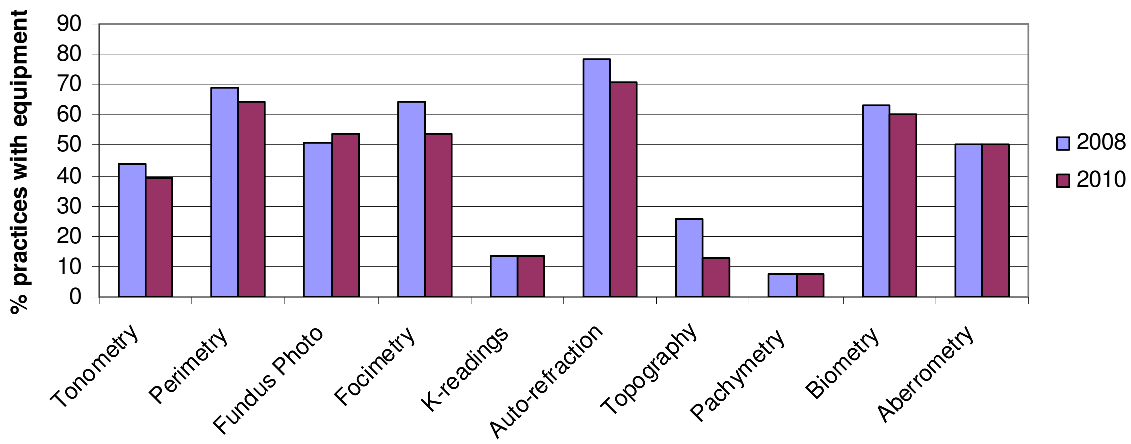

Figure 4.10: Proportion of practices with each piece of instrumentation where support staff carried out testing

Question 7 asked which specialities optometrists or their colleagues in the practice had. Cataract co-management and DVLA field screening were the most popular specialities in both the 2008 and 2010 surveys. Those that specified another speciality were all involved in diabetic co-management (Figure 4.11).

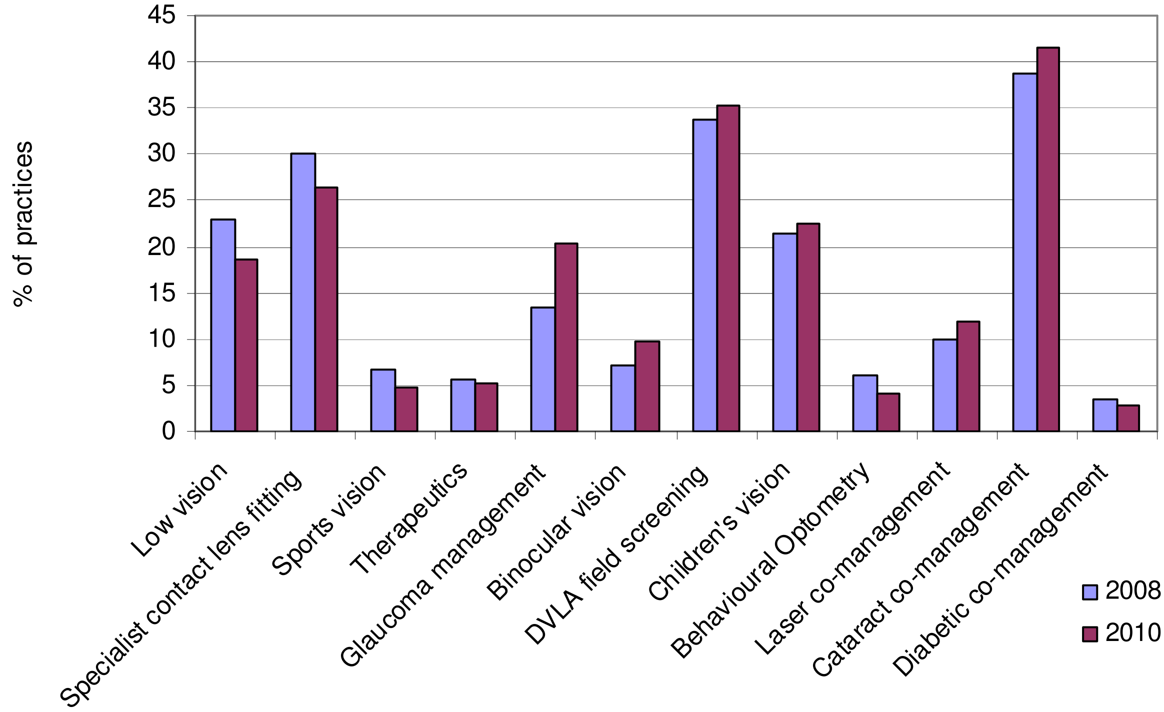

Figure 4.11: Optometrists' specialities: glaucoma co-management showed the largest increase in popularity between 2008 and 2010

Participants were then asked if they charged an extra fee for any specialist services. All hospital-based participants responded that they did not charge a fee as they were NHS funded. For specialities such as cataract co-management and low vision there were a variety of responses as some indicated the fee paid to them by the NHS while others responded that there was no charge directly to the patient. This was also the case with the DVLA fee which, although a standard fee, resulted in different responses as some respondents included Value Added Tax (VAT) while others did not, and a third group responded that there was no charge to the patient. The amount charged for each specialist service is shown in Figure 4.12; the mean charge for fundus photography showed a significant decrease ($p=0.013$) from £8.90 (±£6.82) in 2008 to £7.34 (±£6.93) in 2010. Conversely, the median charge for glaucoma co-management showed an increase from £0 (range: £0-£45) to £2.50 (range: £0-£55) as 50% of respondents charged for the service in 2010 compared to only 31.3% in 2008. Non-parametric tests were used as a standard deviation (±£12.38) greater than the mean (£7.60) indicated skewed data; Mann-Whitney U test found this change was not significant ($p=0.053$).

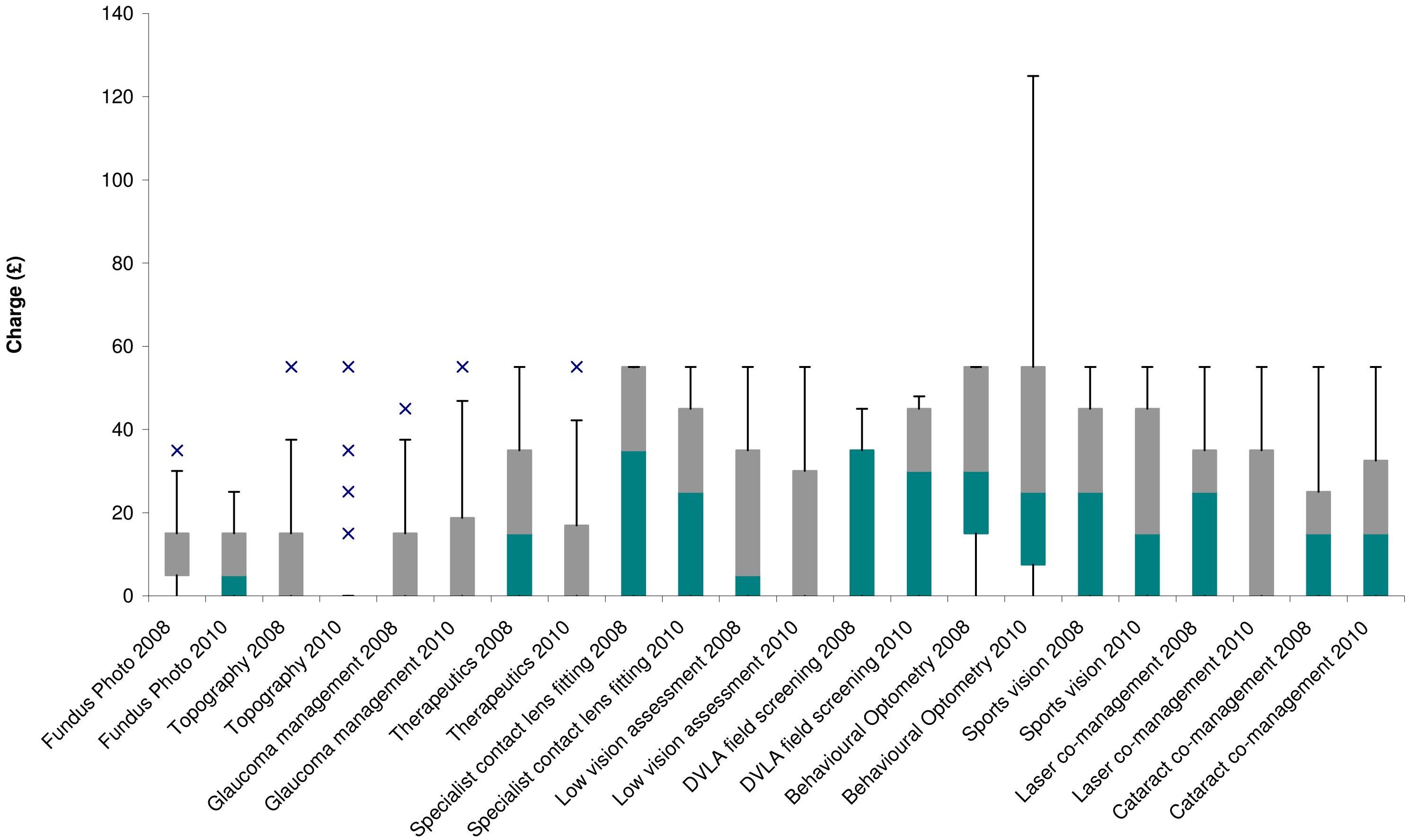

Figure 4.12: Amount charged for each specialist service provided: results show a significant decrease in the charge for fundus photography

The charges for specialist services provided were further analysed by practice type (Figure 4.13). Both surveys found that single independents had the highest charges, whilst franchises charged the least in 2008 and large multiples had the lowest charges in 2010. Whilst franchised practices may have more freedom to choose their instrumentation than those run by head office, fee levels are usually dictated to franchised practices by head office to ensure uniformity across the brand. For example, Specsavers has a policy of not charging for supplementary tests. Comparing the 2008 results with the 2010 results found a significant reduction in charges for single independent practices (Mann-Whitney U test p=0.010). However, the range of charges across independent practices increased from £0-£55 in 2008 to £0-£125 in 2010. Charges at large multiples also decreased from a median charge of £5 (range £0-£55) to £2.50 (range £0-£45), though this was not significant (Mann-Whitney U, p=0.079). Across all practices there was a significant decrease in charges for specialist services (Mann-Whitney U, p=0.003), from a median charge of £15 (range: £0-£55) in 2008 to a median charge of £5 (range: £0-£125) in 2010.

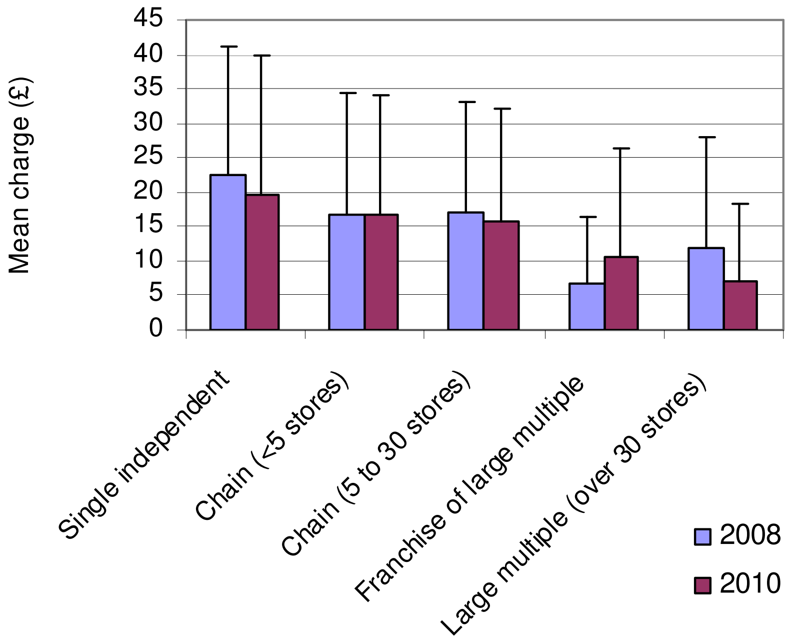

Figure 4.13: Mean charge over all specialist services for different practice types. Single independent practices showed a significant decrease in charges (p=0.010), franchised practices showed an increase though this was not significant (Mann-Whitney p=0.446). Across all practices there was a significant reduction in charges between 2008 and 2010 (p=0.003).

4.4: Discussion

4.4.1: Factors influencing instrument purchase decision making

The results from this research reveal some interesting insights into which factors practitioners consider to be important when purchasing equipment. The top two factors in both the 2008 and 2010 surveys were "easy to use by operator" and "patient friendly". Both of these would be important in terms of making the practitioner's job easier and quicker, and may allow the task to be delegated to another member of the practice staff. In all practices, the quicker a test can be done, the less of the optometrist's time it takes up and therefore the optometrist's time can be used more productively and cost-effectively. If a test is difficult for the practitioner to conduct it could give the impression to the patient that the practitioner is not confident or skilled at the test. A patient friendly test is important as this reduces the time needed to explain the test to the patient and the practitioner can have more confidence in the results generated.

The least important factors did not change in order of importance between the two surveys with "brand" being the third least important factor in both. This may be explained by the fact that "good quality of manufacture" is one of the most important factors. When choosing a new piece of equipment, the purchaser has no guarantee of quality except for a recognisable brand. However, the reason brand may be low down the list of factors is that practitioners are perhaps not brand loyal and would happily buy a piece of equipment from any manufacturer they had heard of or had an indication of the quality. "Aesthetic", as the second least important factor, is perhaps not the first thing that practitioners look for in a piece of equipment although a compact design can benefit the practice by taking up less room in what may be a limited consulting area. However, most optometrists would agree that functionality would be higher on their list of requirements than an attractive looking design.

"Cheapest" is the least important factor in both surveys. This shows that price alone is not a critical factor in instrument purchasing decisions, however as mentioned above, value for money is important. This may be due to practitioners considering it to be a false economy to buy cheap, unreliable equipment which may lead to spending more money in the long run due to loss of testing time and early replacement. It is important to note that practitioners will take a number, or even all, of these factors into account when making purchasing decisions and balance factors such as increased ease of use and increased cost. Equipment manufacturers must take all of these factors into account when developing and marketing new technology and the balance of factors may vary depending on the particular instrument.

4.4.2: Changes in instrumentation prevalence

Fundus cameras, contact tonometers and LCD test charts saw the largest increases in popularity between the 2008 and 2010 surveys. Meanwhile illuminated and projector test charts saw the largest decreases in popularity, primarily due to the corresponding increase in LCD test charts. LCD test charts create a more modern practice feel and allow a much greater variety of tests such as LogMAR, contrast sensitivity and even colour vision (Thayaparan *et al*, 2007; Pardo *et al*, 2004). Illuminated and projector charts also suffer from a limited range of letters leading to patient learning effects, whilst an LCD chart can allow complete customisation of tests and randomisation of letters (Laidlaw *et al*, 2008). Contact tonometers are increasing in popularity due to the introduction of NICE glaucoma guidelines which require that formal diagnosis of glaucoma is made using Goldmann applanation tonometry (Association of Optometrists, 2010b). Due to uncertainty over the interpretation of these guidelines, practitioners looking to replace an existing non-contact tonometer (NCT) may have been seeking clarification as to whether contact tonometry would be compulsory, and therefore delaying purchase of an NCT which may become redundant. Practitioners taking part in glaucoma co-management schemes also require a contact tonometer. The 2010 questionnaire showed an increase in the number of practices participating in these schemes since 2008, from 13.5% to 20.3%, as well as an increase in the amount charged for this service. The increasing popularity of new contact tonometers which do not require the use of anaesthetic, such as the i-Care rebound tonometer (Roberts, 2005; Davies *et al*, 2006), may also explain some of the increasing popularity of the contact tonometer.

The 2008 survey found that the instruments that the most respondents were looking to buy in the following 6 months were fundus cameras, pachymeters, corneal topographers and LCD test charts. Fundus cameras and LCD test charts saw the largest increases in prevalence between the two surveys, corneal topographers showed a small increase of 2.64%, and pachymeters did not increase to the predicted levels; this may again be due to uncertainty in how to interpret the NICE glaucoma guidelines as practitioners may have thought that a pachymeter would become essential. Although the trends in equipment purchasing were largely as predicted from answers to ‘looking to buy/upgrade’ questions, for some instruments, not all practices carried out their intended purchases (table 4.4). For example, although 3.19% of practices indicated that they were looking to buy a corneal topographer in the next 6 months (following the first survey), in fact only 2.64% more practices had a topographer in 2010, two years after the original survey. Towards the end of 2008, the ‘credit crunch’ resulted in a reluctance of banks and other lenders to lend to UK borrowers (HM Treasury, 2009), thereby reducing the availability of loans which may previously have been easily obtained in order to make equipment purchase possible. This may have prevented some practices from

Instrument	% looking to buy in next 6 months (2008)	Change from 2008 to 2010
Fundus camera	11.76	+16.41
Tonometer (contact)	1.72	+8.66
Test Chart (LCD)	4.90	+5.78
Perimeter	2.21	+5.41
Pachymeter	3.19	+2.73
Corneal Topographer	3.19	+2.64
Refractor Head	1.47	+1.99
Auto-refractor	2.94	+0.44
Biometer	0	+0.07
Aberrometer	0	-0.03
Focimeter	0.49	-0.2
Slit-lamp	0.49	-0.21
Keratometer	0.25	-0.81
Volk Lens	1.23	-1.1
Tonometer (NCT)	0.98	-1.11
Ophthalmoscope	0.25	-1.13
Retinoscope	0.25	-1.58
Test Chart (projector)	1.96	-1.87
Test Chart (illuminated)	0.25	-9.15

Table 4.4: Actual increase in instrument prevalence over 2 years compared to purchase intentions for next 6 months from 2008 survey. Instruments in green show expected or above expected increases (greater than 2 times '% looking to buy in next 6 months'). Instruments in red did not increase in 2 years to levels expected in 6 months.

In both surveys the most popular instrument that practitioners were looking to upgrade was the perimeter (6% in 2008 and 7% in 2010). This may be as a result of participation in DVLA field screening which requires the use of one of four approved perimeters. In 2008 the DVLA paid a practice £47 (including VAT) (DVLA, 2008) for each test which can be a useful source of income for the practice. Results showed that this is a popular specialist test with 33.8% of practices participating in 2008 and 35.2% in 2010. Upgrading will also occur due to natural turnover when the perimeter is no longer in good working order; however this study did not investigate the reason for upgrading instrumentation or the age of the equipment which was to be replaced.

4.4.3: Comparing instrumentation prevalence between types of practice

When breaking down the results of what equipment is currently used in practice, some noticeable differences emerge between types of practice. Importantly, fundus cameras are now as prevalent, if not more so, in high street practices as they are in hospital practice, allowing community optometrists to participate in future enhanced eyecare schemes. In the 2008 survey, fundus cameras were found in 75.4% of small chains (less than 5 stores) and 64.0% of single independent practices compared to only 36.0% of large multiple practices. By 2010 this profile had changed somewhat, although large multiple practices were still the least likely to have a fundus camera, the percentage with the instrument had increased dramatically to 63.5%. Franchised practices had seen a similarly large increase from 54.5% to 82.1% resulting in this type of practice being the most likely to have a fundus camera. This large increase in the popularity of fundus cameras across all practice types also resulted in a significant decrease in the amount charged by practices for a fundus camera examination, from £8.90 (±£6.82) to £7.35 (±£6.94). Their initial popularity among independents may be due to those practices taking part in local diabetic screening schemes, for which the equipment is considered essential to provide a photographic record (Doshi & Harvey, 2005). The benefits of a fundus camera to the practitioner are that they have a permanent record of the examination enabling better monitoring of conditions such as early glaucomatous changes, better patient education and a wide field of view combined with good magnification. Therefore this would indicate why the instruments were more quickly adopted in practices such as franchises where the optometrist is often the primary decision maker. Fundus cameras have now become the norm rather than the exception in high street practice with multiples such as ASDA and Specsavers including the test at no charge as part of routine eye tests (Optician, 2010b). As 'ease of use' is considered the most important factor when considering new purchases, increased automation of fundus cameras has been an important reason for their widespread adoption. This is emphasised in figure 4.9 which shows that support staff were carrying out fundus photography in 39.5% of practices in 2010 compared to in 29.2% of practices in 2008.

The 2008 survey showed an interesting difference between franchised practices of large multiples and head office run practices. Over half, 54.5%, of franchised practices had a fundus camera, a figure much higher than the 36.0% of large multiples. The difference was even more defined for LCD charts with 25.8% of franchises having one or more compared to 7.9% of non-franchised multiples. In 2010, the gap in the number of practices with a fundus camera remained constant (63.5% *versus* 82.1%), however head-office run multiples closed the gap with franchised practices in the case of LCD test charts (23.0% *versus* 25.4%). As mentioned previously, in a franchised practice the director or directors, usually optometrists or dispensing opticians, are the decision makers. Two reasons why they would be more likely to have advanced instrumentation are that they will see the benefit of new instrumentation in their own daily work and also the decision making process will be quicker as they can agree their own budgets. The 2010 study showed that fewer practices had instrumentation purchases decided at head office, from 26.0% to 20.3%, this would reflect reports in the optical press that companies such as Boots Opticians are increasing their number of franchised practices (Optician, 2011).

4.4.4: Tests carried out by support staff

If tests are carried out by support staff there is a benefit to the practice in terms of saving optometrist chair time. However, equipment must be easy to operate to facilitate training and ensure results are repeatable if unqualified staff are to carry out the tests. The tests most commonly carried out by support staff are non-contact tonometry, focimetry, perimetry and fundus photography. Focimetry may be carried out by dispensing opticians and hospitals will often have a medical photographer to carry out fundus photography, however other tests are usually carried out by optical assistants. Tonometry, perimetry and focimetry often comprise the pre-screening element of the eye examination; some practices will also include auto-refraction and fundus photography. When looking at the results in terms of the proportion of practices with a particular instrument which use support staff to carry out a test, auto-refraction is most frequently carried out by practice support staff rather than an optometrist (78.6% in 2008, 70.7% in 2010). Over half of practices with perimeters, focimeters and fundus cameras use support staff to carry out these tests. A 2008 survey found that 16% of practices have integrated their fundus camera into their practice IT system (Thomas, 2008), a figure which increased to 40% of practices by 2010 (Optisoft, 2010). This enables the optical assistant to take the photo which the patient then views in the consulting room with the optometrist. However, not all practices employ this strategy as the practitioner may prefer to take the picture themselves in case, for example, the patient has small pupils and a clear image is difficult or if there is a specific pathology that they wish to ensure is captured clearly.

4.4.5: Specialist services

The most popular speciality in both 2008 and 2010 was cataract co-management (38.7% and 41.6% of practices), also popular were DVLA field screening (33.8% and 35.2%) and specialist contact lens fitting (30.1% and 26.5%). Cataract co-management schemes are popular with patients as they benefit from fewer appointments and more convenient post-operative care, and research has shown that patients are more satisfied with optometrist rather than hospital post-op appointments (Warburton, 2000). These patients will all require some form of refractive correction (even if only a basic pair of reading spectacles) so the practice will benefit from extra income from dispenses as well as satisfied patients who are more likely to return in the future. As mentioned above, DVLA field screening can provide a useful extra source of income for the practice from the DVLA fee. Specialist contact lens fitting may be popular as it provides a challenge to the practitioner over standard soft contact lens fitting where lenses only have a choice of one or two base curves. It may be funded by contact lens exam fees and from the profit made on contact lenses if the patient purchases them from the practice. Contact lens patients form long-term relationships with the practice and make regular purchases, with research showing they are more profitable than spectacle wearers (Ritson, 2006). It is possible the popularity of specialities may change over the next few years if level 2 therapeutics prescribing becomes more widely taken up; currently there are only 70 optometrists with an independent or supplementary qualification (Courtenay *et al*, 2011). In a survey by the College of Optometrists, practitioners were asked where they would like to concentrate their personal development over the following year; glaucoma (47%), therapeutics (39%) and diabetes (36%) proved the most popular (Medix UK, 2008).

The amount charged for specialist services showed a significant decrease (Mann-Whitney U, p=0.003), from a median charge of £15 (range: £0-£55) in 2008 to a median charge of £5 (range: £0-£125) in 2010. As well as the increasing prevalence of fundus cameras, as mentioned above, economic conditions may have been a factor in this. Increased unemployment and rising inflation has reduced the spending power of consumers (ONS, 2010a) who may be unwilling to pay for tests they deem unnecessary or may shop around to compare prices. Practices may use supplementary tests such as fundus photography as a loss making marketing tool to attract customers into the practice with the aim to subsidise this with dispensing revenue. Single independent practices had the highest charges in both surveys, their customers are often willing to pay more for personal attention, and the increased range of charges (£125 compared to £55) in 2010 suggests that some are positioning themselves at the higher end of the market as a point of differentiation. Overall, the amounts charged by independent practices reduced significantly between the surveys showing that all types of practices have been affected by increased competition and economic conditions. Behavioural optometry had the highest average charge in both surveys; it was also one of the least popular specialities. This may allow practices to charge higher fees as patients are prepared to travel further and pay extra to consult practitioners with a reputation for services such as dyslexia testing.

4.4.6: Comparison with other research

A survey carried out by Optician magazine over summer 2010 aimed to quantify certain types of instrumentation used in practice and establish purchase intentions at 2011's Optrafair exhibition. The survey of 300 optical practitioners (optometrists and dispensing opticians) involved a smaller sample than this study and may have been biased as the population was limited to the readership of Optician magazine. The Optician survey found some results were very similar to those of the 2010 questionnaire in this study, such as the prevalence of pachymeters (13% and 12.53%). However, some results found differences, for example the Optician survey found 66% of respondents had fundus cameras, whilst this study found this to be 73.76%. Also OCTs was found to be more popular in the Optician study with 10% of practices indicating they had one compared to 4.49% in this study. Differences may be explained by the research methods used, Optician's survey was carried our online, whilst this study was postal. This may result in different types of practitioners responding to each survey, for example those who are more comfortable with IT will be more likely to fill in an online survey and may be more comfortable with adopting new technology such as OCT. A limitation of this study was that practitioners were not given OCT as an option on the list of equipment, as this technology was largely confined to hospitals prior to the 2008 survey. Whilst some respondents listed OCT under ‘other’ equipment, some may have omitted to mention it when completing the questionnaire.

Both parts of this study were conducted in July and August, and this may have had an effect on what equipment respondents were looking to buy in the forthcoming six months. Optrafair is a biannual trade fair which was held in April 2009 and 2011, which were periods not covered by the ‘looking to buy’ question. Optician’s study asks about purchase intentions in the next 12 months and, whilst some agreement was found, other results on what equipment practitioners were looking to buy differed. Whilst both the Optician survey and the 2010 study found that fundus cameras and pachymeters were amongst the top three instruments that practitioners were looking to buy, the Optician survey found that 23% of practitioners were looking to buy an OCT in the next 12 months, whereas only 1.4% were looking to buy the instrument in our 2010 survey. An explanation for this may be that practitioners were waiting for Optrafair in order to compare different instruments and take advantage of any discount that manufacturers may offer at the trade fair. In fact the survey showed that 14% were looking to buy an OCT specifically at Optrafair. Events such as Optrafair may affect purchasing decisions amongst some practitioners, especially as the population questioned are within easy reach of venues such as the National Exhibition Centre (NEC) where Optrafair is held, however Optician’s survey found that only 35% of respondents were definitely attending the exhibition and this study found that having seen an instrument at a trade fair/exhibition was only the 9th most important factor in the decision making process, meaning that the pattern of purchase may vary between practices and in different areas of the country.

4.5: Conclusions

Despite challenging economic conditions, practitioners appear to continue investing in new equipment. Fundus cameras, contact tonometers and LCD test charts showed the largest increases in prevalence between 2008 and 2010. Fundus cameras were still the most popular instruments that practitioners were looking to buy in the 2010 survey, however, as around three-quarters of practices now have this technology, the market for new purchasers is beginning to plateau. Practitioners indicate that cost is becoming a more important factor in their decision-making, however this is still behind the factors 'ease of use' and 'patient friendly' as these will save time and money over the long term. Cataract co-management and DVLA field screening are consistently the most popular specialities for practices to take part in. Future changes to DVLA vision screening may present an extended role for the optometrist as drivers could be required to have more regular and comprehensive vision screening (Nevin, 2010). A challenge to the industry is that the amount practices charge for specialist services showed a significant reduction between the surveys. This trend does not bode well for optometrists as market data also showed falling sales of spectacles and sunglasses over 2009 and 2010 (Lamouroux, 2011) however the same market research shows a 5% growth in the contact lens market in 2010. Practitioners will need to consider these challenges when investing in new instrumentation to ensure they have a sustainable long-term funding model either from charges to patients or income from co-management schemes.

This study focuses on optometrists in the East and West Midlands, however patient attitudes and demographics vary greatly across the country as does devolved health policy in Scotland and Wales. This means that different results could be obtained if extending the study to other areas. Areas covered by this study such as

Birmingham, Leicester, Derby and Wolverhampton are found to have some of the highest levels of NHS sight tests in the country (Optometry Today, 2011) This could mean particularly low incomes, high levels of older patients or children, or perhaps even an increased awareness of the need for regular sight tests. Therefore further studies to establish whether this study's conclusions are valid across England would be of benefit.

CHAPTER 5

Training methods

5.1 Introduction

When new instrumentation is introduced into an eye care practice, staff may receive training on its use. If they have previously used a similar piece of equipment, a quick read of the manual may be sufficient but in cases of new technology the instrument supplier would be expected to provide training. This could take a number of forms but traditionally for larger pieces of equipment the supplier would send a trainer to provide 'hands on' instruction at the end user's practice. The main disadvantages of this is that if a number of staff need to be trained they must all be present on the day of training and be exempt from other duties during the training, furthermore the costs for the instrumentation company can be increased if the trainer is required to travel a large distance. Training will usually take place during working hours, thus the practitioner may be required to cancel appointments, which will have a financial implication. Other disadvantages are that the training may be complicated and difficult to digest in one training session, and staffing may change, requiring further training and associated costs.

It goes without saying that if optometrists are to take part in advanced screening and shared care management of patients they must be competent in the use of relevant instrumentation and technology required for that task. Following the new GOS contract in Scotland, NHS Education for Scotland (NES) was awarded £1million to provide training to optometrists. Training included hands-on workshops on key clinical skills such as contact tonometry, pachymetry and gonioscopy, but also online distance learning courses in communication skills (NES, 2010). In Wales, optometrists who participate in the PEARS and WEHE schemes are required to pass theoretical modules and practical assessments (Sheen *et al*, 2009).

Universities are embracing new technology to teach their undergraduate students; for example, using various web based learning platforms (Hearse & Lee, 2005) or in practical training such as retinoscopy simulation software (Prajapati & Dunne, 2009). Research has shown that the majority of undergraduate optometry students were balanced learners who responded to a mixture of learning styles (Prajapati *et al*, 2011). Once optometrists have qualified and registered in the UK they must complete CET. A recent GOC survey showed that practitioners favour different types of learning; the most popular being Video Based Distance learning, with 56% of respondents indicating they would like more CET to be available through this training modality and 53% asking for more Skills Based Workshops (GOC, 2010b). Thirty percent of practitioners felt that their location was the greatest barrier to completing CET and the popularity of Video Based Distance learning, which may take the form of videos posted on websites or DVDs (Digital Versatile Discs) sent to practitioners, may be largely explained by this. Surveys of health workers based in rural Australia also found that lack of local availability was the biggest barrier to completing continuing education (Keane *et al*, 2011) and that good access to professional development training had a positive effect on job satisfaction and career aspirations (Buykx *et al*, 2010).

Practitioners have expressed that lack of time and cost of training are principle barriers to taking part in extended training courses, such as therapeutics prescribing (Needle *et al*, 2008). Distance learning allows the practitioner to learn at their own rate and reduces the costs of travel and time taken out of practice to attend training at universities or other venues. Hamam (2004) explored distance learning for laser surgery and discussed the advantages and disadvantages. Advantages include the ability for the learner to go at their own pace, reaching those unable to travel and that large numbers of learners can be taught. Disadvantages can include less human interaction, users feeling isolated in their learning, fear of technology and the risk that the learner may be a passive rather than an active participant. Disadvantages such as malfunctioning technology, or low bandwidth and speed of internet are not as relevant as at the time of the Hamam's study, since high speed broadband is now common even in rural areas.

A previous study compared training methods used to educate optometrists about patients with intellectual disabilities (Adler *et al*, 2005). The study found that those who received lectures followed by hands-on training with patients were significantly more confident in their abilities than those who received lectures only. This study, however, did not look at each method separately therefore those who received both methods of training had benefited from more hours of training as well as different methods. The study used only subjective methods of assessment and acknowledged that using an objective measure of ability would be preferable.

The aim of this study was to compare different methods of training on new instrumentation. Whilst previous studies have surveyed users' preferences, they have not measured the effectiveness of the training. As well as comparing the methods individually, the order in which several training methods are given was investigated to determine which was the most effective.

5.2 Method

Three methods of training were chosen to represent methods that could be employed by an instrumentation company looking to train customers after purchase of new equipment. The methods were:

- Traditional ‘hands-on’ training with a trainer
- Self-directed learning using computer based learning: a PowerPoint presentation with pre-recorded audio commentary
- Self-directed learning using the equipment training manual

An automatic phoropter head was chosen as the instrumentation to be used in this study as the participant groups would be final year optometry undergraduates who do not usually receive training on this as part of their optometry programme. This had two advantages: firstly at the stage of their degree the students would have had no experience in using the instrument and therefore would be starting from a similar baseline level of knowledge; secondly the students would be motivated to participate and would gain a benefit from taking part in the study in learning a new skill which they may be expected to use in practice after graduation (although it is not a required core competency for registration with the GOC). Informed consent was sought from all participants. The Nidek RT-5100 automatic phoropter head (Nidek, Gamagori, Japan) was used in conjunction with the Nidek SC-2000 LCD test chart (Nidek, Gamagori, Japan). With this setup the practitioner can change the lenses in the phoropter head and the target on the LCD chart using the phoropter control unit.

Aston University

Illustration removed for copyright restrictions

Figure 5.1: Nidek RT-5100 auto photopter and control panel (picture courtesy of Nidek UK)

Participants were randomly assigned to act as patients for their fellow participants. As some participants had a refractive error whilst others were emmetropic, prescriptive lenses were attached to the back of the viewing apertures to simulate a refractive error. These were selected at random and changed between training sessions so that subjects would not test the same prescriptive lens twice. In all three training sessions the participants were allowed 30 minutes in which to refract one eye using the phoropter.

In the 'hands-on' training a qualified optometrist (SS), experienced in the use of the equipment, explained the use of the instrument and was available during the training session to answer any questions that the participants had as they carried out the refraction with the phoropter. This training was based on training that would normally be delivered to a new user in a practice environment but tailored to the needs of each trainee depending on their performance and any questions they asked. The computer based training presentation was 10 minutes in duration; the participant was instructed that they could play, pause and review the presentation as necessary throughout a 30 minutes session. In the third training session the participants received no assistance from either the computer presentation nor from the trainer, and were only allowed to read the manual provided with the phoropter to familiarise themselves with the instrument.

The effectiveness of the each method of training was measured objectively and subjectively. Rae, in his book on measuring training effectiveness, recommends subjective evaluation and also asking the trainee to rate how effective they think they are in a number of aspects that will be covered by the training (Rae, 1991). Participants were asked to rate their knowledge of three aspects of the use of the instrument by giving a score out of a maximum high score of 10 and an overall score also out of 10. The three aspects were:

- Understanding of phoropter head setup
- Understanding of phoropter head operation
- Understanding of test procedure

These were used in order to distinguish whether certain aspects of learning to use the instrument were better taught using different methods. In order to account for those who may have some previous knowledge of the instrument, and for individual scoring differences (as no guidance was given as to what level each number represented), participants were asked to score their baseline knowledge before their first training session. To establish whether this would reflect their ability to use the instrument, the accuracy of their refraction was judged by a qualified optometrist using the same criteria that is used in the undergraduate clinical assessments, shown in table 5.1.

	Accuracy	Score
Sphere	±0.25 D	3/3
	±0.50 D	2/3
	±1.00 D	1/3
Cylinder	±0.25 D	3/3
	±0.50 D	2/3
	±1.00 D	1/3
Axis	±5°	3/3
	±10°	2/3
	±30°	1/3
Speed	Completed refraction within 30 minutes	1/1
Total		10/10

Table 5.1: Accuracy of refraction scoring criteria. Accuracy was scored out of a maximum 10 points.

A preliminary trial run was carried out using three postgraduate students. These subjects were chosen as they were familiar with receiving training in a practice environment but also with giving training on instruments as part of their role as undergraduate clinical demonstrators. The three participants received the three methods of training in the order shown in table 5.2.

Participant	A	B	C
Hands-on learning	1	3	2
Computer-based learning	2	1	3
Self-taught learning	3	2	1

Table 5.2: Order of training for participants in preliminary study

The postgraduate participants were asked to give feedback as to how the training could be improved for the main study. The main suggestion was to limit the cylinder power of the dummy lenses to 2 dioptres as to determine higher cylinders without the aid of a retinoscopy result was hampered by the patient's poor unaided vision. A limit of 2 dioptres of astigmatism was also applied to participants' refractive error. Of the two undergraduate participants to whom this applied, one wore contact lenses to correct the astigmatism, while the other had a lower degree of astigmatism in the second eye, therefore only this eye was used in refraction. Determining the cylinder power proved to be the most difficult part of the test as the automatic cylinder test uses a different technique to the manual cross cylinder test that would be used in trial frame refraction. To make this easier to understand, the postgraduates suggested showing a diagram of the patient's view through the split prism lens of two sets of dots as they had found the test easier once they had themselves acted as a patient. The diagram shown in figure 5.2 was added to the PowerPoint presentation.

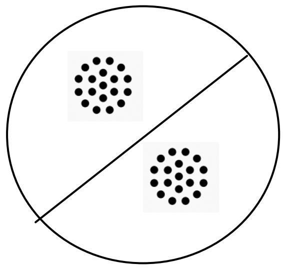

Figure 5.2: Patient's view of cross-cylinder test

In the trial study, the subject initially watched the computer presentation all the way through on a laptop in a separate room to the phoropter head, however it was felt that the presentation was more useful when viewed next to the phoropter head as it could be started, stopped and reviewed as required. This was felt to be a more accurate representation of how a practitioner would use material such as a DVD in practice. The postgraduates agreed that determination of sphere and cylinder only was the most appropriate test as the participants might not be familiar with the range of binocular tests. Time would also be a constraint as the postgraduates required almost half an hour to refract one eye on their first session whilst familiarising themselves with the system. After reviewing the results it was decided to add a fourth order of training as three did not allow for the permutation of computer-based learning before hands-on training. It was decided not to cover all 6 possible order combinations as this would mean smaller groups with less statistical power.

The subjects for the study were all final year undergraduate optometry students. This population was chosen as they had experience of refraction (which was needed to operate the phoropter head), and they were motivated to learn about the phoropter head as most had no previous experience and some may be required to use the instrument in their upcoming pre-registration period. Students were asked to volunteer for the project to ensure that they would be motivated enough to attend four sessions. Students who were already qualified as contact lens opticians, and therefore already experienced in refraction, were excluded from this study. Fifty students volunteered to take part (39.4% of the final year students); from these 36 participants were selected at random (not all students were selected to allow for those who might drop out and for those with timetable commitments which prevented them from taking part). In order to estimate the power that would be given by this sample size, the expected standard deviation was required. The most similar previous study assessed the most effective means of teaching anterior eye imaging (Hunt & Wolffsohn, 2007), in which optometrists were asked to self-rate their knowledge following three methods of training. The results of reading an article and answering Multiple Choice Questions (MCQs) with a sample population of 24 practitioners gave a mean increase of 17.1±13.4%, a lecture (with 14 participants) gave an increase of 10.5±13.7% and a hands-on workshop (again with 14 participants) gave a mean increase of 11.9±7.9%. Across all three methods this gives an average standard deviation of 11.7% therefore, on a scale of 0-10 used in this study this is approximately 1. Assuming a standard deviation of 1.00, an alpha of 0.05 and two-tailed analysis, group sizes of nine subjects have 79.1% power to detect score differences of 1 (G*Power: Buchner *et al*, 2009). The students were then randomly allocated to one of four groups, A, B, C or D, who received training in the orders shown in table 5.3.

Group	A	B	C	D
Hands-on teaching	1	3	2	2
Powerpoint presentation	2	1	3	1
Manual only	3	2	1	3

Table 5.3: Order of training for participants in main study.

The participants were 66.7% female and 33.3% male. This is comparable to the overall demographics of the year group which is 61.4% female and 38.6% male. The participants' ages ranged from 20 to 30 years old. After all participants have received the three methods of training, they were asked to return for a fourth visit at which no training would be given and, as previously, they would carry out a refraction of one eye in up to 30 minutes. This was done 4-6 weeks after the final training session in order to assess long-term learning.

5.3 Results

The preliminary study had three participants: A, B and C. Their results are shown in table 5.4.

		A	B	C
Baseline	Setup	0	0	2
	Operation	0	0	2
	Procedure	0	0	2
	Overall	0	0	2
Session 1	Setup	5	3	3
	Operation	7	4	4
	Procedure	8	6	4
	Overall	7	4	4
	Accuracy	10	9	5
Session 2	Setup	7	4	6
	Operation	8	3	6
	Procedure	8	5	4
	Overall	7.5	4	5
	Accuracy	10	9	9
Session 3	Setup	8	5	6
	Operation	8.5	7	7
	Procedure	8.5	6	5
	Overall	8	6	6
	Accuracy	10	9	10

Table 5.4: Preliminary study results

The postgraduate students had a low baseline knowledge of the phoropter head (mean = 0.67), therefore they would encounter a similar learning experience to the undergraduate students, the majority of which also had no experience of the instrument. Their suggested improvements (see section 5.2) were implemented before the main study was conducted.

In order to determine whether the subjects' overall subjective scores of their ability were a reliable measure, the accuracy of their refraction was measured objectively by a qualified optometrist (using the scoring system shown in table 5.1) and the correlation of the two measures was calculated using Spearman's correlation coefficient. The result of r = 0.503 shows that the correlation is significant at a confidence level of 99%. This shows that the subjects' subjective scores of their performance were positively correlated with the accuracy of their refraction as shown in figure 5.3.

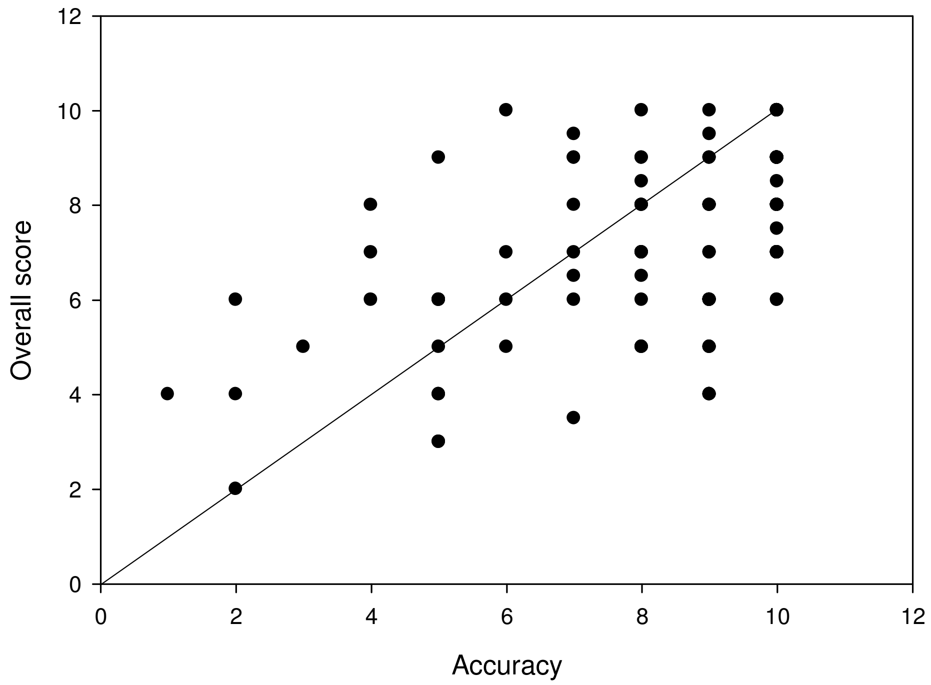

Figure 5.3: Correlation of subject's overall subjective score with objective measure of refraction accuracy.

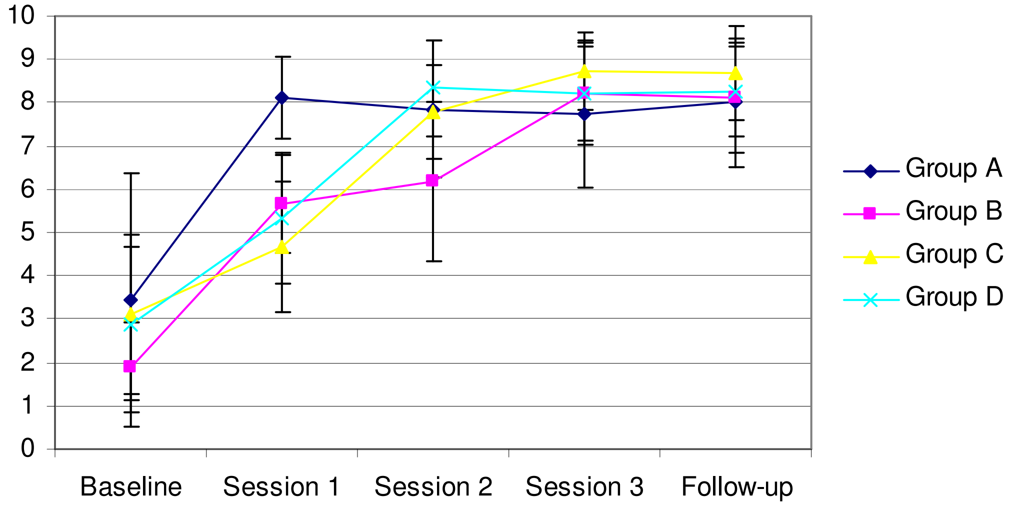

Figure 5.4: Overall mean subjective score (out of a maximum of 10) for each group of subjects

Sharipo-Wilk W test for normaility showed that the data was not normally distributed (p=0.004); therefore Kruskal-Wallis test and post-hoc Mann-Whitney tests were carried out. This compared the differences in overall subjective scores from the baseline to the follow-up as shown in figure 5.4. This showed no significant difference between any groups at the 95% confidence level (p=0.760). Results were then analysed comparing the change in score between each consecutive session to measure the effects of the different forms of training. Jonckheere-Terpstra tests were carried out where Mann-Whitney tests proved significant, to determine whether there was a trend in the most effective methods of training and the effect size of the trend. Results are shown in table 5.5 below:

	Kruskal-Wallis test	Mann-Whitney significant results	Jonckheere's test	Jonckheere's effect size
Baseline to session 1	p=0.025	Group B (computer-based) > Group C (manual) p= 0.008	J = 108.0 z = -2.857	r = -0.47 Hands-on > computer based > manual
Session 1 to session 2	p=0.000	Group C (hands-on) > Group A (computer-based) p= 0.000 Group D (hands-on) > Group A (computer-based) p= 0.001 Group C (hands-on) > Group B (manual) p= 0.003 Group D (hands-on) > Group B (manual) p= 0.002	J = 43.5 z = -4.825	r = -0.80 Hands-on > manual > computer based
Session 2 to session 3	p=0.008	Group B (hands-on) > Group D (manual) p=0.002	J = 91.5 z = -3.385	r = -0.56 Hands-on > computer based > manual

Table 5.5: Kruskal-Wallis tests and post hoc Mann-Whitney tests of overall subjective score differences between groups for each session. Jonckheere's test results show the order of significant trends.

In order to measure the long-term learning effects from the training, changes in overall subjective score from session 3 to the follow-up session were analysed. No significant difference emerged between the four groups (Kruskal Wallis test $p=0.495$), however groups B (-0.11 ± 0.93), C (-0.06 ± 0.88) and D (-0.13 ± 0.99) showed slight reduction in overall score, whilst Group A showed a mean improvement of 0.28 (±1.09).

A Kruskal-Wallis test was also carried out on the accuracy results. After the follow-up visit, the mean for each group was between 9 and 9.8 out of 10. The test showed that, after all four training sessions, there was no significant difference between the groups ($p=0.710$). As with the subjective scores, the accuracy scores were also analysed by the change in score between each session. The results are shown in table 5.6.

	Kruskal-Wallis test	Mann-Whitney significant results	Jonckheere's test	Jonckheere's effect size
Session 1 to session 2	P=0.001	Group C (hands-on) > Group A (computer-based) p= 0.000 Group D (hands-on) > Group A (computer-based) p= 0.002	J = 70.0 z = -3.983	r = -0.66 Hands-on > manual > computer based
Session 2 to session 3	P=0.018	Group B (hands-on) > Group D (manual) p= 0.003	J = 116.5 z = -2.643	r = -0.44 Hands-on > computer based > manual
Session 3 to follow-up	p=0.533 (not significant)			

Table 5.6: Kruskal-Wallis tests and post hoc Mann-Whitney tests of accuracy score differences between groups for each session. Jonckheere's test results show the order of significant trends.

Each factor was examined separately by one-way ANOVA and post-hoc Bonferroni analysis. Although the data was non-parametric, Levene's test showed homogeneity of variance across all three factors, and as one-way ANOVA is a robust test its use was appropriate. Two factors showed that hands-on training gave significantly higher improvement in scores than both computer-based training (factor 1 p=0.007 and factor 2 p=0.024) and self-taught training (factor 1 p=0.000 and factor 2 p=0.000), and that computer-based training gave significantly higher scores than self-taught training (factor 1 p=0.008 and factor 2 p=0.024). This was true for 'understanding of phoropter head setup' (factor 1) and 'understanding of phoropter head operation' (factor 2). For the final factor, 'understanding of test procedure', hands-on training scores were significantly higher than both computer-based (p=0.003) and self-taught training (p=0.000); however, whilst computer-based training gave higher scores than self-taught training, it was not significant at the 95% confidence level (p=0.383).

Each method of training was then analysed to determine whether all factors were taught equally well, or whether there was greater improvement in one factor. The results are shown in figure 5.5.

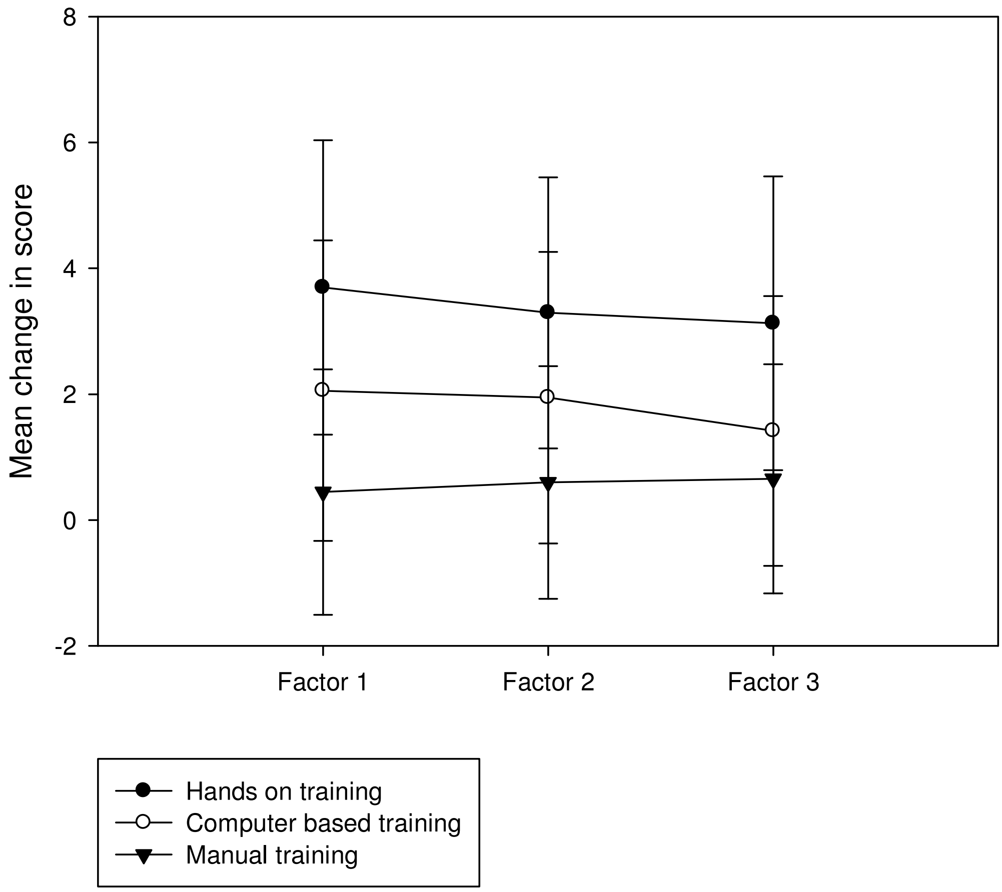

Figure 5.5: Mean change in subjective score for each factor across all training sessions

A one-way ANOVA showed that there were no significant differences between the mean scores of the three factors for individual types of training; hands-on training p=0.553, computer-based training p=0.451 and self-taught training p=0.888. Understanding of test procedure (factor 3) showed the least improvement of the three factors with hands-on and computer based training but the highest improvement with self taught training. This may be because practice alone improves the subject's knowledge of the order of tests, whilst understanding of the phoropter head operation and setup require more thorough explanation.

5.4 Discussion

The aims of this study were to measure the effectiveness of three methods of training, both in terms of the subjects' opinions of their ability and in terms of their performance; and also to determine whether the order in which subjects received the three methods of training affected these measures. The study found that although computer-based learning was more effective than self-taught learning, hands-on training is still the most beneficial form of training. The order in which subjects received the three methods of training had no significant effect on the overall scores, and results across all groups showed lasting effects when measured again at a follow-up session 4-6 weeks later.

The results show that from baseline scores to final scores, the order in which subjects received the three types of training did not show any significant differences in the outcomes, both subjective and objective. When long-term learning, carried out at 4-6 weeks after the third session, was investigated, again no significant differences emerged, however Group A showed a slight increase in overall subjective score compared to Groups B, C and D. As Group A received hands-on training in week 1 this may be due to gaining a good level of knowledge early in the study on which they could build with computer-based and self-taught learning. Group A showed less improvement in session 2, when they received computer-based learning, which may be due to their already high level of knowledge from hands-on training in week one. This may explain the anomaly in Jonckheere's test which shows a trend of self-taught learning as more effective than computer-based learning. This contradicts the results from sessions 1 and 3 where the trend is that hands-on training is most effective followed by computer-based learning and lastly self-taught learning.

Hands-on training proved to be significantly more effective than self-taught learning in two of the three sessions and significantly better than computer-based training for one of the three. The change in score from baseline to session one is the most accurate indicator of the effectiveness of each method of training as the subjects have received no other forms of training at this point. Hands-on training was the most effective, and computer-based training was significantly better than self-taught learning in session one. When the three factors that subjects were asked to score were individually analysed, two of the three factors showed that hands-on training was significantly more effective than both computer-based and self-taught learning, and that computer-based learning was significantly more effective than self-taught learning.

This study shows that hands-on training is still the ideal method of delivering training; its advantages include the ability for immediate feedback and to learn at the trainee's own pace. However, computer-based learning is more effective than self-taught learning and could be incorporated in addition to hands-on training. Instrumentation suppliers could use DVDs or online training via their website as an alternative to visiting the customer or in addition for refresher training. Previous research shows that this type of learning is most popular with optometrists (GOC, 2010b). An alternative combining both distance learning and hands-on training may be audio-teleconferencing as has been used in rural areas of Queensland. This involves a slide presentation, workbook and discussion (Wildsoet *et al*, 1996) and overcomes some disadvantages of the computer-based learning used in this study. It gives the opportunity for the trainee to ask questions and interact with the trainer and other learners, however it is not as flexible as a computer-based presentation which the trainee can view at their own pace and at a time which suits them.

Follow-up training could take the form of online self-assessments such as have been used in optic disc assessments for glaucoma diagnosis (Kong *et al*, 2011) and for diabetic retinopathy diagnosis (Beynat *et al*, 2010). These could be accessed via the instrumentation company's website which would benefit the company as customers would be likely to view other products, and could also be of benefit to registered optometrists and dispensing opticians if CET points are awarded for the assessments.

When evaluating how effective the training has been, a cost benefit analysis must also be taken into account (Rae, 1991). The costs incurred in delivering hands-on training from an instrumentation company to a high-street customer could include:

- Any fee charged for the training;
- Travel and accommodation for the trainer;
- Time incurred in making arrangements (both for the practice and the trainer);
- Cost of the trainee's time and any losses of productivity.

For example, an hour's training might involve the loss of three appointments. With an average sight test fee of £23.05 (FODO, 2010) and two resulting dispenses at an average value of £118 (FODO, 2008), this would lead to a loss of earnings of £305.15 for the practice. In the case of distance learning, if the practitioner can complete their training at a convenient time for the practice, for example if an appointment is cancelled or after practice hours, the practice does not suffer this loss of earnings and may only have to pay for the cost of the practitioners time. The Office of National Statistics (ONS) in its 2010 Annual Survey of Hours and Earnings (ASHE) states the median hourly rate for optometrists as £22.18 (ONS, 2010b). The only costs incurred by the trainer are for the time taken to produce the material and to deliver it to the practitioner (by post or via the internet).

The following example (table 5.7) is used to illustrate the cost benefit comparison of hands-on training *versus* computer-based training. A number of assumptions are made: firstly, that there is no charge for the training, secondly that the computer based training takes a day (8 hours) to prepare (this may be shorter if training has already been prepared and needs no alteration), that no accommodation is required and the training provider travels by car, that the training lasts an hour in both instances and that the computer-based training is completed outside of normal testing hours though the optometrist is still paid for their time. If the trainer has to travel further and accommodation is required, the costs of hands-on training will be significantly higher. It also assumes that the accuracy and subjective scoring is a linear scale which is unlikely as a small improvement in ability may lead to a large increase in score as the participant gains confidence.

Hands-on training	Cost (£)	Computer-based training	Cost (£)
Fee charged	0	Preparation time (8 hours)	177.44
Travel/ Accommodation (sample journey Birmingham to London = 118 miles each way @ 45p per mile)	106.20	Time to arrange access / provide support	22.18
Time to make arrangements (1 hour practice/ 1 hr trainer)	44.36	Trainee's time	22.18
Trainee's time	22.18		
Loss of productivity to practice	305.15		
Total cost	477.89	Total cost	221.80
Mean gain in subjective score (session 1)	4.67	Mean gain in subjective score (session 1)	3.11
Subjective cost/ benefit ratio (cost per point improvement)	102.33	Subjective cost/benefit ratio (cost per point improvement)	71.32
Mean accuracy score (session 1)	9.67	Mean accuracy score (session 1)	6.83
Objective cost/ benefit ratio (cost per point improvement)	49.42	Objective cost/ benefit ratio (cost per point improvement)	32.47

Table 5.7: Cost benefit analysis of hands-on versus computer-based training

When looking at the cost benefit model of hands-on versus computer-based training (table 5.7), the latter would come out on top as it was not significantly worse than hands-on training yet is significantly cheaper. The cost benefit ratio is £71.32 per point increase in subjective score, compared to £102.33 per point for hands-on training. However, the training provider must consider whether to provide the best possible training at increased cost in order to deliver high levels of customer service. Visiting a practice in order to deliver the hands-on training has the added benefit of building the relationship between the instrumentation company and the customer, and may allow the trainer to discuss other instrumentation purchase intentions.

In addition to the compulsory CET points which optometrists must gain, the College of Optometrists now operates an optional Continuing Professional Development (CPD) scheme for its members. This was launched in November 2009 (College of Optometrists, 2010) to enable optometrists to record their professional development online which will be particularly relevant if and when revalidation is introduced. Revalidation will require optometrists to demonstrate that they are fit to practice every few years rather than only at the point of registration. Practitioners are likely to choose the CET that they complete based on existing areas of interest rather than in areas where they have identified a weakness (Adler *et al*, 2005). Professional development based on analysing weaknesses and learning from managing complex cases in practice enables practitioners to progress towards an expert level of knowledge rather than simply maintaining a baseline standard (Faucher, 2011). If CPD is widely adopted, those who currently provide CET may need to reassess the content and delivery of their material to address areas of learning raised by practitioners. As discussed earlier, practitioners favour distance learning and hands-on workshops but find time and location to be constraints. Interactive computer-based learning would seem to provide a possible solution.

When applying these results to optometrists across the country it is worth considering that the subjects are all final year undergraduates who are familiar with computer based learning as part of their degree and therefore may be more computer literate than an average optometrist. However, the preliminary study results with optometrists who had graduated between 5 and 7 years previously also showed the same pattern of results, with hands-on training the most effective followed by computer-based then self-taught learning. Older practitioners and those who were unfamiliar with computer-based learning may not be as comfortable with computer-based learning therefore may show differences in their preferences, however, as subjects were only required to view a PowerPoint presentation, the training did not require anything more than a basic knowledge of computer operation. The participants were selected as they had a broadly similar baseline level of knowledge, therefore this study tested the effectiveness of the training rather than the participants' own learning and experience. These subjects will also go on to become the high street optometrists of the future and therefore the target audience for both instrumentation manufacturers and CET providers.

Subjects were all final year undergraduate students, however their ages varied from 20 to 30 years old, and some participants had previous BSc degrees in subjects other than Optometry. Subjects were randomly allocated to the four groups, however to ensure the groups were comparable, the study could be improved by matching the groups by age, educational level and refractive error of the participants.

Further research into training in optometry could investigate interactive computer-based learning, and video rather than the presentation used in this study. The long-term effect of the training could also be measured several months later. This is likely to depend on whether the subject has had the opportunity to use the equipment in the intervening period, as otherwise they may forget some aspects of the training resulting in lower scores compared to session 3. This was not possible in this study as the subjects were studying for their final university examinations. A limitation to this study is that training on an automatic phoropter, as in this study, may differ from training practitioners on imaging equipment such as fundus cameras and digital slit lamp where an appreciation for focussing is required. Further research to investigate whether these findings hold true for training on a variety of instruments would be of benefit. Additionally, operation of fundus cameras and other instrumentation can be carried out by practice support staff (figure 4.9) that may have different learning preferences to the optometry students who participated in this study.

A combination of training methods may be the best approach for training providers to take, as all four groups of subjects achieved a mean accuracy score of between 9.0 and 9.8 out of 10 in the follow-up study. This reflects the research by Prajapati *et al* (2011) which found that optometry students respond to a mixture of learning styles. Long-term follow-up of a training programme for optometrists showed that a combination of lectures and hands-on training had resulted in changed clinical behaviour of optometrists five years after the original training (Kleinstein *et al*, 1985).

In conclusion, when more than one method of training is used, the order in which the training is conducted does not have a significant effect on the outcome. Hands-on training is shown to be the most effective form of training, however computer-based training has a superior cost-benefit ratio. Computer-based training has an important role to play in equipping optometrists with the skills necessary to utilise new instrumentation and develop areas of expertise.

CHAPTER 6

Measuring service quality in an optometry setting

6.1: Introduction

Customer service is an essential part of success for an optometric business. Optometry combines both professional service and retail industries; the service element being the eye examination, advice including referral if required and dispensing of spectacles, and the product spectacles or contact lenses. Both aspects play a part in successfully attracting customers to the practice and retaining them in the long term. While large multiples can benefit from economies of scale to reduce the cost of spectacles and contact lenses, independent practices must differentiate themselves in order to compete, and providing excellent customer service is one way of achieving this. Service quality is an increasingly important factor to all high street practices when competing against internet retailers. Irrespective of the size of business, if a customer is satisfied with their experience of a practice they will remain loyal (Boulding *et al*, 1993). Retail aspects of a business can be monitored easily by analysing key performance indicators (KPIs) such as profit, conversion rate, and average spend per customer. Conversely, customer service is a more abstract concept that depends upon a personal opinion and what aspects of service are particularly important to the individual (Parasuraman *et al*, 1988).

The need to measure service quality was first established in service industries where there was no product to give an indication of quality (Grönroos, 1998). Questionnaires have been developed to measure customer service including SERVQUAL (Parasuraman *et al*, 1988), SERVPERF (Cronin & Taylor, 1992) and SERVPEX (Robledo, 2001). SERVQUAL uses the 'disconfirmation of expectations' concept which proposes that consumers judge service quality by comparing their experiences to previously held expectations (Oliver, 1980). SERVQUAL is a validated service quality questionnaire which calculates the 'service gap' between what a customer expects of an excellent service provider and what they perceive to be the service they receive. Expectations (E) are scored on a Likert scale of 1-7 with 1 being a factor that is not at all essential and 7 being a factor considered absolutely essential for an excellent service provider. The customer then scores their perceptions (P) of the service they have received on the same 1 to 7 scale. The gap or service quality (Q) is calculated by Q=P-E. This can be used to identify negative factors where the customer's expectations are not met and positive factors where their expectations are exceeded.

The SERVQUAL questionnaire was chosen to be used in this study primarily as it has been shown to be valid across a variety of industries for example in Carman's (1990) study which compared a tyre store, a job placement centre and a dental clinic. Other questionnaires are less proven, such as the SERVPEX questionnaire which was developed using only businesses from the airline industry, therefore its relevance to health industries has not been validated. SERVPEX combines expectations and perceptions into a single scale by labelling the scale 'much worse than expected' to 'much better than expected' (Robledo, 2001). However, Robledo concedes that this questionnaire does not provide as much information as the SERVQUAL questionnaire. Much discussion has taken place in the service quality literature regarding whether expectations and their disconfirmation need to be measured. Cronin and Taylor (1992) argue that it is only necessary to measure perceptions, however Parasuraman *et al* (1994b) argue that SERVQUAL gap scores give greater variation across the five dimensions than perception only scores and therefore provide more information as to the specific strengths and weaknesses of a company. This is supported by Bolton and Drew (1991) who found that disconfirmation explained a greater proportion of service quality variance than the measurement of performance only. As there is no previous service quality research in the optometric field, it is also important to gain knowledge about the level of customers' expectations or it will be impossible to find out why they are or are not being met (Robledo, 2001).

Parasuraman *et al* (1988) developed the SERVQUAL scale using factor analysis to identify 22 items on the scale which fell into 5 categories:

- *Tangibles*: the physical features of the business such as equipment and appearance of staff (items 1-4);
- *Reliability*: can the business perform the service on time and dependably? (items 5-9);
- *Responsiveness*: the willingness of staff to help customers (items 10-13);
- *Assurance*: are the business and its staff trustworthy? (items 14-17);
- *Empathy*: does the business provide personal service and care about its customers? (items 18-22).

Bitner (1990) describes how customers use tangibles to make a judgement about service quality before they interact with service personnel and how expectations and perceptions may also be influenced by perceived experiences of other customers.

The SERVQUAL questionnaire has been carried out in many different settings such as the airline industry (Ling *et al*, 2005), electronics retailers (Kumar *et al*, 2008), dentists (Baldwin & Sohal, 2003) and hospitals (Lam, 1997); however it has not been used in an optometric setting before. Yavas *et al* (2006) compared patient and practitioner views of customer satisfaction, though without using a validated questionnaire, and found that optometrists with better understanding of their customers' satisfaction levels showed higher practice sales levels. It is important to differentiate between customer satisfaction and service quality, as Parasuraman *et al* (1994a) explain that customer satisfaction is specific to each transaction while service quality is the customer's overall attitude towards the business. In the current economic climate it is essential that optometrists excel in service quality to attract and retain customers. In a practice, the customer comes into contact with staff at many different points in the customer journey from making an appointment to undergoing an eye examination, through to choosing and collecting their spectacles. It is these interactions that form a customer's perceptions in the service elements of reliability, responsiveness, assurance and empathy. Hirji (2009) advises practices to develop a 'patient satisfaction index' to monitor how well they are delivering services, however the use of a standardised questionnaire such as SERVQUAL would allow for results to be compared between practices and without bias.

This study aims to validate the SERVQUAL questionnaire for the measurement of optometric service quality. Additionally, it aims to examine the key factors affecting service quality in an optometric commercial practice setting, measure SERVQUAL scores for each factor and the five dimensions. It will also examine any influence that patient demographics have on views of service quality.

6.2: Method

The SERVQUAL questionnaire developed by Parasuraman *et al* (1988) and modified (1991) was used as the basic questionnaire. As recommended by the designers, the wording of several questions was changed to make them more appropriate to the optometry setting and the questionnaire revalidated. The rewording was based on a SERVQUAL study carried out by Baldwin and Sohal (2003) in private dental practice as this was a more similar setting to optometric practice than the original SERVQUAL study which was conducted in a supermarket. To ensure the SERVQUAL results reflected the overall views of the subjects and to confirm its validity, an additional question asked “overall, how would you rate the service from your optician?”. This question was included in the development of the SERVQUAL questionnaire and the relationship between this question and the service quality gap scores was analysed by one-way ANOVA (Parasuraman *et al*, 1988). To validate the reworded questionnaire and the validity of SERVQUAL in an optometry setting, reliability co-efficients, correlations between questionnaire items and factor rotations were carried out (section 6.3.1).

A preliminary study of 50 customers was carried out to ensure that the questions were well understood and to identify the best times within the customer journey to conduct the two sections of the questionnaire. This was carried out at an independent practice in the West Midlands. Practices who participated in the main study were recruited from those who had already expressed an interest in research participation (a Midlands Clinical Research Network) following a previous study. These practices were located in the East and West Midlands. After these practices had commenced the study, further practices from around the UK were invited to participate through an article placed in the Optician magazine. Each participating practice completed 50 questionnaires.

The questionnaire was self-completed by the customer in order to remove any bias from the practice staff, but an initial explanation of the questionnaire was given to customers. The questionnaire was completed by consecutively presenting patients to avoid bias of patient selection. Subjects excluded from the study were those under 16 years of age, those unable to complete the questionnaire without help from the practice staff, and those not attending for an eye examination, contact lens trial or contact lens aftercare. Those attending solely for supplementary tests such as pupil dilation or repeat intraocular pressures, or for dispensing only were excluded from the study as they would not experience a comparable customer journey. In order to establish the most appropriate times in the customer journey at which to carry out the two parts of the questionnaire, a preliminary study was conducted. Ethics approval was obtained from Aston University Business School (17/01/08). Customer participation was optional and completed questionnaires were placed in a sealed box to assure the patient that their views were confidential and would not affect their patient care. Around 5% of patients asked to participate declined, however demographics were not collected from this group to protect patient confidentiality.

Demographics from participating customers were collected regarding age, gender, frequency of visit, eye conditions, contact lens wear, reason for visit and services received. Data analysis was carried out using PASW statistics software version 18.0.0 (© SPSS, Inc., 2009, Chicago, IL, www.spss.com).

6.3: Results

The preliminary study questionnaire asked customers to comment on any questions that were not clear or any aspects of service quality that were important to them that had not been covered by the questionnaire as the question “Are there any other aspects of service that you expect from an excellent optician?” was added. Table 6.1 shows the responses from the seven customers who responded to this question.

Other aspects of service	Related to
Important to see the same optician	Assurance
Keep to arrangements	Q5, Q8
No jargon	Q17
Being told what's being done	Q17
Provide answers on diabetes	Q17, Q22
Education & information about your eye condition	Q17, Q22
Provide everything	Reliability

Table 6.1: Other aspects of expected service suggested by participants in the preliminary study

Aspects related to communication and providing information were raised by four customers. These were already covered by the questionnaire items "employees of excellent opticians should have the knowledge to answer customers' questions" and "employees of excellent opticians should understand your specific needs". Other aspects were not covered specifically by one question but fell into one of the five dimensions described by Parasuraman *et al*.

The study revealed that customers were able to complete the questionnaire without consulting the practice staff and the questionnaire should ideally be conducted in two parts: firstly, the expectations section should be conducted before the eye examination, secondly the perceptions section should be completed after the eye examination and any dispensing but before the customer left the practice. The second part was to be carried out in the practice rather than after the customer left in order to maximise response rate. The subjects handed in the expectations section before their eye examination, therefore they completed the perceptions section without reference to their expectations score. The word ‘optician’ was used to describe the service industry as ‘optometrist’ was felt to refer to a specific individual (the optometrist conducting the test). The preliminary study confirmed this term was generally well understood.

Completed questionnaires were received from nine optometric practices located across England. Five of the practices were recruited from the Midlands Clinical Research Network and four had responded to the article placed in the Optician magazine. Eight out of the nine practices were independent practices, the other was from a medium-sized national chain. The practice locations are shown in figure 6.1. Twenty-four questionnaires (4.8%) were either not returned by the practice or were disregarded as the subject had failed to complete the perceptions section making calculation of ‘gap’ values impossible. This left 426 questionnaires which were used in the results analysis. This sample size gives a confidence interval of ±4.75% for the whole population (Bartlett *et al,* 2001).

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Figure 6.1: Location map of participating practices. Five practices were located in the East and West Midlands region

The sample was 35.0% male, 54.7% female and 10.3% did not indicate their gender. The mean age (±SD) of the sample was 53.5 (±17.9) years old. The age profile of the respondents is shown in figure 6.2. 17.1% indicated that they had an ocular condition and 12.7% were contact lens wearers. Twenty-one subjects (4.9%) indicated it was their first visit to an optician, while the remaining subjects responded that they visited an optometrist every 2.3 (±1.6) years on average.

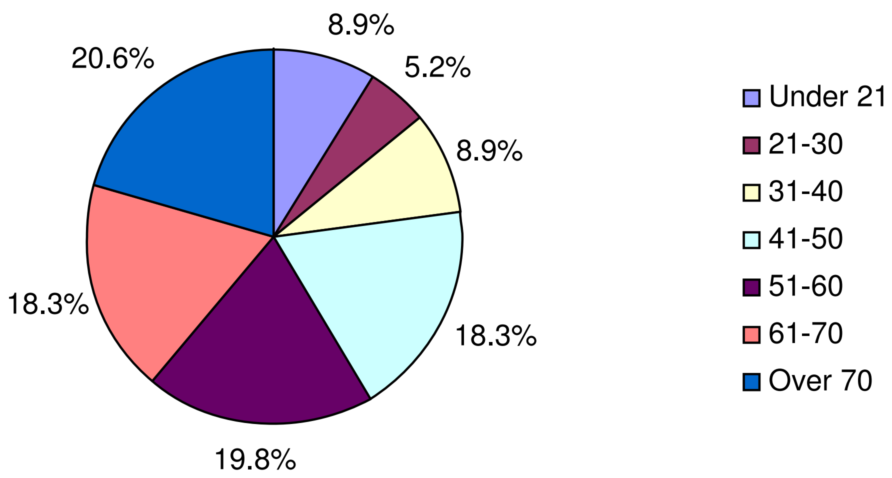

Figure 6.2: Age profile of subjects

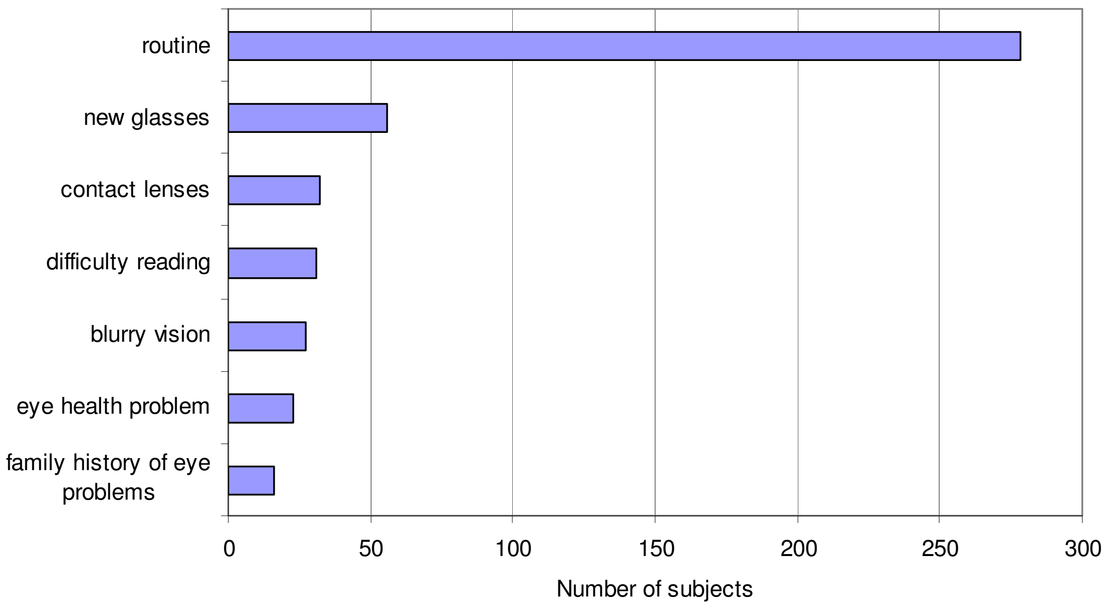

Figure 6.3: Reason for visiting practice. The majority of patients were attending for a routine eye examination or contact lens check-up

Figure 6.3 shows the reason for the customers' visit to the practice. This could include more than one reason for attending. The most common reason for the customers' visit to the practice was a routine eye examination or contact lens appointment (65.3%).

6.3.1: Validation of SERVQUAL in an optometric setting

In order to validate that the questionnaire was measuring its intended question, a one-way ANOVA was conducted between Q values and overall quality scores, as had been carried out by Parasuraman *et al* (1988). Overall quality scores were obtained from the question 'Overall, how would you rate the service from your optician?'. Participants could rate the service as 'very poor', 'poor', 'fair', 'good' or 'excellent'. 'Very poor' received a score of 1 increasing to a score of 5 for 'excellent'. The mean Q value across all questionnaire items was used as the overall SERVQUAL score. Shapiro-Wilk W test showed normal distribution across Q values and overall quality scores (p=0.000), therefore one-way ANOVA was appropriate. Levene's test showed non-homogenous variances (0.014) therefore Welch's and Brown-Forsythe F-ratios were calculated, these were p = 0.011 and p = 0.010, respectively. This indicates that the gap value correlates at a significant level with the overall quality score. Figure 6.4 shows the relationship between overall quality and the mean Q score across all participants.

To assess the internal consistency of the questionnaire, reliability coefficients were calculated. Cronbach's alpha values were calculated to establish the reliability of each dimension for predicting the overall SERVQUAL E, P and Q values. The results are shown in table 6.2. It is generally accepted that values of around 0.8 or higher indicate good reliability (Field (2009); Cronbach (1951)).

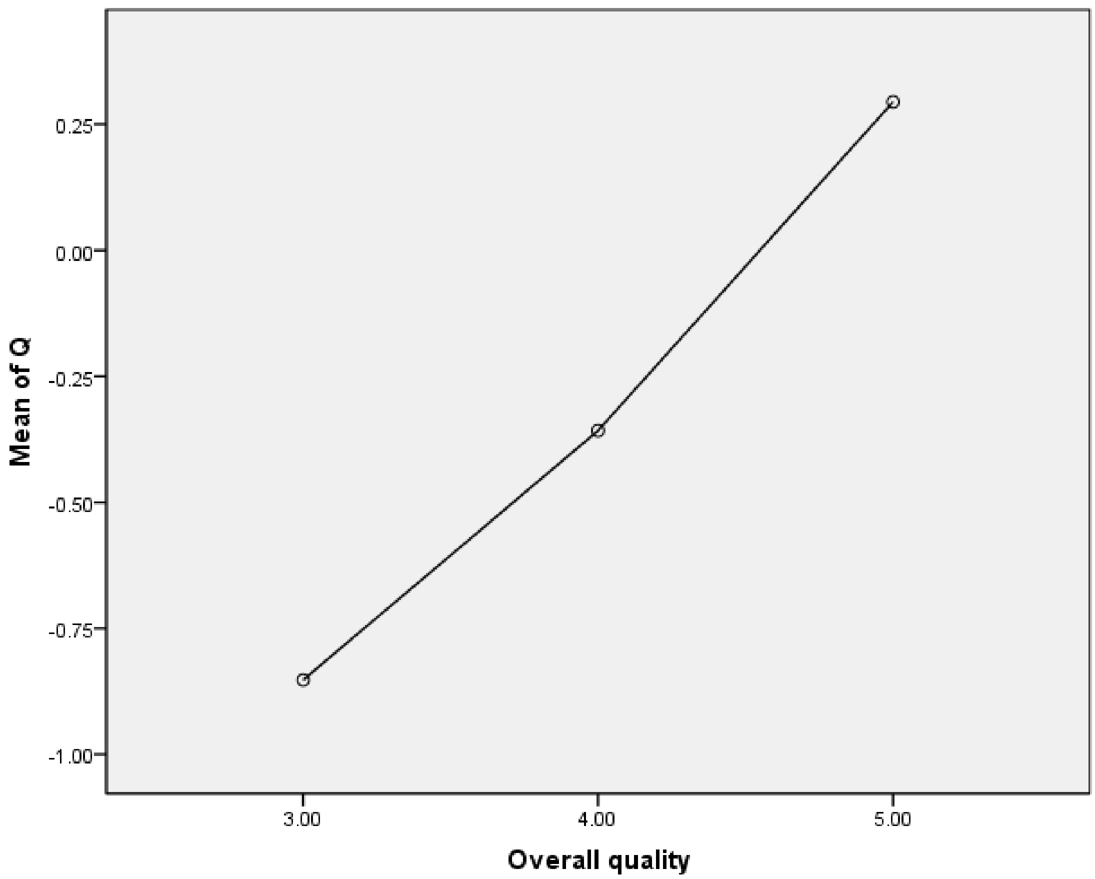

Figure 6.4: Mean Q (gap) score compared to overall service quality rating by all participants. 3 indicates participants who rated the service "fair", 4 indicates "good" and 5 indicates "excellent". There were no responses in categories 1 or 2.

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Table 6.2: Cronbach's Alpha Reliability co-efficients show good overall reliability of the original 5 factors from Parasuraman et al (1988)

Standard deviations for each of the 22 questionnaire items ranged from 0.71 to 1.33 for expectations and perceptions from 0.54 to 0.91. A large standard deviation could indicate a confusing wording of the question (Baldwin & Sohal, 2003), however some deviation is desirable as it indicates a range of views amongst the customers.

Spearman's rho test was carried out to determine correlation coefficients between all items for expectations, perceptions and gap scores. For expectations and perceptions, all items correlated to the 0.01 level. Correlations that are too high indicate unnecessary questions, whereas correlations that are too low imply that the items are not addressing the same issue. The distribution of the correlations was from 0.228 to 0.760 for expectations and from 0.385 to 0.804 for perceptions. Five pairs of questionnaire items did not show significant correlations in the analysis of gap scores. Four of the pairs involved question 2: "Excellent opticians should have visually appealing facilities".

Factor analysis was carried out to discover whether Parasuraman *et al*'s five factor construct was valid for this data. The method of factor extraction was the same as that used by Baldwin and Sohal (2003).

	Component			
	1	2	3	4
Q1	.538	.036	.135	.314
Q2	.061	.062	.105	.837
Q3	.081	.186	.160	.748
Q4	.214	.109	.170	.754
Q5	.766	.210	.115	.164
Q6	.634	.387	.266	-.060
Q7	.638	.219	.233	.103
Q8	.733	.308	.281	.129
Q9	.664	.350	.141	.021
Q10	.558	.432	.339	.105
Q11	.432	.445	.420	.302
Q12	.335	.693	.261	.145
Q13	.156	.602	.340	.238
Q14	.323	.803	.088	.023
Q15	.411	.700	.154	.086
Q16	.162	.700	.290	.200
Q17	.102	.365	.632	.149
Q18	.437	.055	.652	.187
Q19	.217	.061	.721	.201
Q20	.194	.339	.745	.126
Q21	.389	.461	.516	.003
Q22	.201	.439	.595	.116

Table 6.3: Rotated component matrix showing a four factor construct

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 6 iterations.

Bartlett’s test of sphericity: chi-squared 4237.892, df 231, sig 0.000.

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy: 0.930

Kaiser and Rice (1974) described a KMO value of over 0.9 as at the highest level of sampling adequacy. The factor rotation (table 6.3) extracts 4 factors from the 22 item questionnaire. Parasuraman *et al* found five factors in the original SERVQUAL questionnaire: tangibles, reliability, responsiveness, assurance and empathy. The factor analysis above uses factors giving a score of over 0.4 as significant. This shows that tangibles (component 4) and reliability (component 1) are identified, however there is overlap between the final three factors which constitute components 2 and 3. Further to the factor rotation, a regression analysis was also carried out on the five original factors to calculate the amount of variance explained by each dimension (table 6.4). Tangibles showed the lowest result, accounting for 19.3% of the variance, while responsiveness accounted for the largest amount of variance (60.7%).

Dimension	**Adjusted R^2 value**
Tangibles	0.193
Reliability	0.483
Responsiveness	0.607
Assurance	0.459
Empathy	0.504

Table 6.4: Regression analysis showing amount of total Q value explained by each SERVQUAL dimension (an R^2 value of 1 indicates the dimension perfectly fits the overall data)

6.3.2: Analysis of results

SERVQUAL gap scores were calculated for each item of the questionnaire using the formula Q=P-E. The results show positive gap scores for questions 2 to 22 (shown in figure 6.5), meaning perceptions of service quality exceeded expectations. Question 1, ‘Excellent opticians should have up-to-date equipment’, showed the only negative gap score. Questions 2, 3 and 4 showed the highest positive gap scores (0.85, 0.89 and 0.77 respectively).

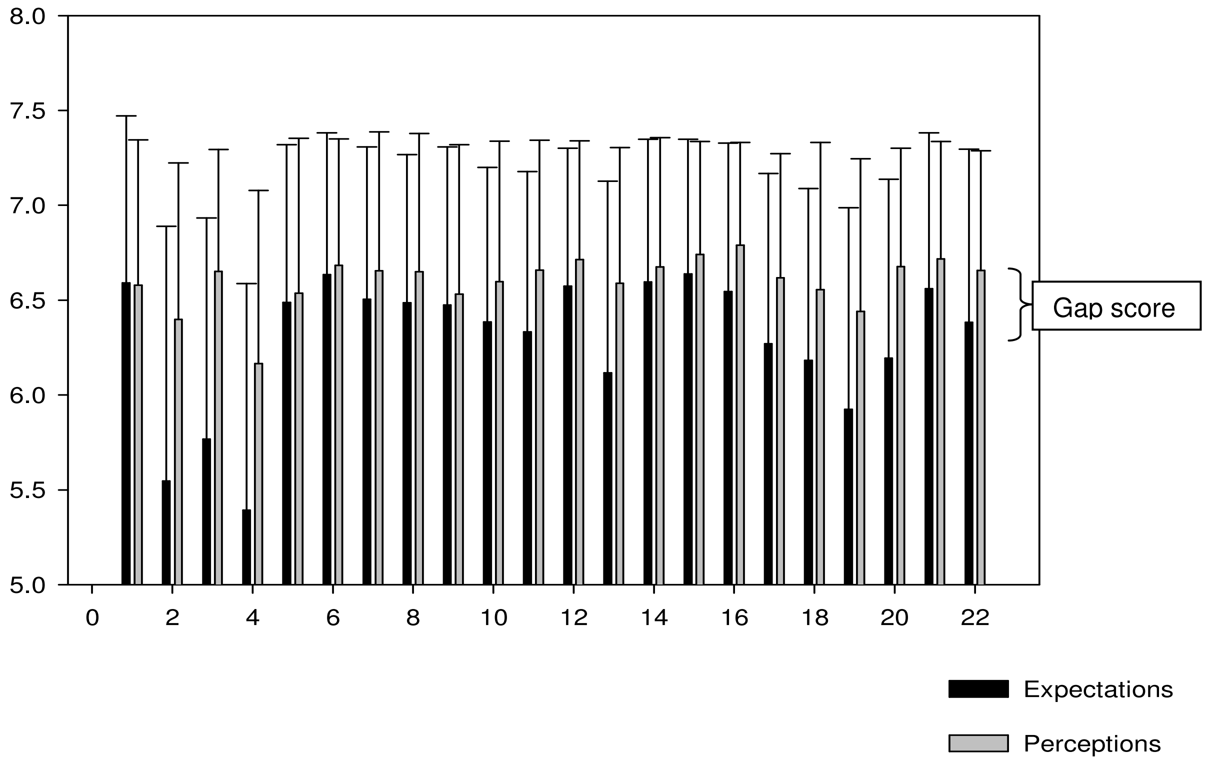

Figure 6.5: overall expectations and perceptions for each SERVQUAL item. Question 1 showed the only negative gap score.

	Tangibles	Reliability	Responsiveness	Assurance	Empathy
Expectations (mean ±SD)	5.83 (±1.25)	6.52 (±0.80)	6.35 (±0.87)	6.51 (±0.80)	6.25 (±0.96)
Perceptions (mean ±SD)	6.45 (±0.81)	6.61 (±0.75)	6.64 (±0.69)	6.71 (±0.62)	6.61 (±0.70)
Gap score (mean ±SD)	0.61 (±1.16)	0.10 (±0.89)	0.28 (±0.84)	0.18 (±0.76)	0.35 (±0.91)

Table 6.5: Mean scores across the five SERVQUAL dimensions. Tangibles had the lowest expectations score and also the highest gap score

Table 6.5 shows the mean scores across the five SERVQUAL dimensions. The results show that customers had the lowest expectations in ‘tangibles’ and the highest in ‘reliability’ and ‘assurance’. ‘Tangibles’ also received the lowest score for customers’ perceptions, however the gap score between expectations and perceptions was the largest. The highest perceptions score was in ‘assurance’. The gap scores show that the practices in this study were greatly exceeding customers’ lower expectations of the tangible elements but were only exceeding their expectations of reliability by a very small amount (0.10).

SERVQUAL gap scores and subject demographics were analysed by one-way ANOVA to discover if factors such as age group, gender, frequency of visit, ocular conditions or contact lens wear had a significant effect on service quality score. None of the ANOVAs showed significant differences at the 95% confidence level. One trend that was apparent was that contact lens wearers appeared more satisfied with service quality than non-contact lens wearers, with a mean SERVQUAL gap score of 0.36 compared to 0.19 among non-contact lens wearers. However, this was not significant at the 95% confidence level (p=0.101).

One practice received a negative mean gap score (-0.01), however this was only significantly lower than one other practice (p=0.011), that with the highest mean gap score (0.44).

6.4: Discussion

A one-way ANOVA showed that the SERVQUAL gap score is significantly related to overall service quality score and therefore the SERVQUAL questionnaire measures its intended outcome. Reliability analysis showed that all 5 components of Parasuraman *et al*'s original study (Parasuraman *et al,* 1988) showed good reliability across expectations, perceptions and gap scores. Internal consistency of all 22 items proved to be high as all expectations and perceptions questions correlated at the 0.01 level and the correlation scores were evenly distributed. Spearman's Rho correlations of the gap scores showed that all except 5 pairs of questions correlated at the 0.01 level. Of those that didn't, four contained the same question "Excellent opticians should have visually appealing facilities". This indicates that subjects did not necessarily see visually appealing facilities as particularly relevant to good service quality in optometry practices.

Factor rotation of the gap values resulted in 4 components being identified. The tangibles and reliability components were clearly identified, whilst responsiveness, assurance and empathy were split over the remaining 2 components. Of the original five factors, responsiveness and empathy were the best predictors of variance, whilst tangibles was the least predictive factor.

The SERVQUAL questionnaire is appropriate for use in an optometric setting as it shows good reliability measured by Cronbach's alpha (table 6.2) and good correlation between overall quality scores and SERVQUAL gap values. Factor analysis identified four factors instead of Parasuraman *et al*'s five factor construct. In their review of the SERVQUAL scale, Babakus and Boller (1992) conclude that this construct may depend on the type of service studied and, whilst some industries have a complex factorial make-up, others are simple and may even be unidimensional. Baldwin and Sohal (2003) also found four factors in their survey of dental practices having found significant overlap between empathy and assurance. They combined these two into a single factor of empathic assurance. This study found overlap between three components: empathy, assurance and responsiveness. This may be due to customers perceiving similarity between questions such as "employees of excellent opticians should be always willing to help customers" and "excellent opticians should have your best interests at heart", the first question belonging to the responsiveness component and the second to empathy. Parasuraman and co-workers acknowledged in their 1994 study (Parasuraman *et al*, 1994b) the possibility of responsiveness, assurance and empathy forming a single factor. This was described by Robledo as "customer care" (Robledo, 2001).

Carman (1990) reviewed the 1988 SERVQUAL study and compared results from several different industries. He concludes that tangibles and reliability are common factors across each industry but suggests three further factors for the dental industry are security, convenience and cost. Cost would be a difficult factor to explore in the optometry setting as there is the added complication of those entitled to free eye examinations and help with the cost of glasses. This includes over 60s, those with family history of glaucoma, complex prescriptions, diabetics and those on low income (College of Optometrists, 2010). The study could be further extended to look at whether paying for the service affects the customer's opinion of service quality. Cost may have an effect either way on service quality as lower costs may reduce expectations, conversely, where cost is high the customer may perceive they have received a higher quality service (Carman, 1990).

Tangibles received the highest gap score of the five SERVQUAL dimensions, meaning that this was the area in which their expectations were exceeded by the largest amount. This was due to the low expectations customers had in this area. These results, and the fact that tangibles explained a lower amount of variance than the other four factors, would indicate that customers consider the intangible elements of service quality from opticians to be a better indicator of a good optician than the tangible elements. The implication of this could be to focus less on the tangible elements of the practice and more on the intangible elements, as has been found in previous research in medical situations (Winsted, 2000). However it is important to note that the customers surveyed have already been attracted to the practice by the fact that they have attended an appointment. Tangible elements may be more important in attracting new customers than in retaining existing ones.

It is interesting to note that, of the tangible questionnaire items, item 1 had a much higher expectations score of 6.59 compared to an average of 5.57 across the other three items. This indicates that, whilst customers have relatively low expectations as to the appearance of the practice and its staff, they have high expectations that the practice will have modern equipment. Interestingly, the factor rotation shows that item 1 loaded onto factor 1 which represents reliability, whereas items 2, 3 and 4 loaded onto factor 4 representing tangibles. It may be that customers link modern equipment to problem solving and accuracy, perhaps in relation to prompt and reliable diagnosis of their eye condition or refraction. As this item was the only one to receive a negative gap score, it indicates that there is room for improvement in meeting customers' expectations in this area. The equipment itself may be modern looking but how this is communicated to the customer is important as they do not view it as a purely tangible aspect. The role of equipment in service quality will be further investigated in Chapter 7.

Contact lens wearers appeared to have a higher opinion of service quality from their optician than non-contact lens wearers. Factors affecting this may be their increased contact with the optician due to more regular aftercare appointments or perhaps a higher opinion of their optician if they have managed to solve problems such as previous intolerance of contact lenses or dislike of wearing glasses. Research has shown that contact lens patients are more profitable in the long term than spectacle wearers as they have more regular interactions with the practice (Ritson, 2006). They may also be more profitable as they are more satisfied with the service quality that they are receiving. Contact lens opticians may carry out contact lens consultations in some practices, though only appointments with optometrists were included in this analysis to ensure patients' experiences were comparable.

An interesting result to emerge was the identification of a factor which did not appear to strongly correlate with others: "excellent opticians should have visually appealing facilities". Customers of opticians may not see this as a high priority, however there may be other reasons for this such as that 89% of participating practices were single independent practices or that the average age was fairly high. Further research may indicate whether younger customers and those who visit a practice belonging to a large chain see this as a more important factor.

Perhaps the most notable result is the positive gap scores for all but one of the SERVQUAL items. This compares to other studies which found overall negative gap scores. This includes studies in other health settings such as a university health clinic (Anderson, 1995), a LASIK clinic (Lin *et al*, 2009) and a hospital (Lam, 1997). This result is positive for the industry as it indicates that practices are generally surpassing patients' expectations. However, as practices volunteered to take part, this may have created a bias towards those with a particular interest in providing excellent customer service. Mintel reports how 'the more successful independent opticians tend to aim at the higher end of the market and emphasise quality and service in their marketing mix' (Mintel, 2010). The recruitment of practices, initially from the Midlands Clinical Research Network, led to some geographical bias among the participants, therefore this sample may not be representative of practices across the UK. A broader cross-section of practices would give a more accurate picture of the optical industry as a whole.

CHAPTER 7

Instrumentation and Service Quality in Optometric Practice

7.1: Introduction

Chapter 6 showed that the SERVQUAL instrument is valid for use in optometric practice. Parasuramen *et al* (1988) concluded that ‘tangibles’ is one of the five factors taken into account by customers when judging service quality, however the previous chapter found that this factor explained a smaller amount of variance in SERVQUAL score than the other four factors (table 6.4). The first question on the SERVQUAL questionnaire used in this study is “an excellent optician should have up to date equipment”. This was the only question to return an overall negative gap score (figure 6.5) indicating that patients expected higher levels of quality than they received. Factor rotation found that this question contributed to the reliability dimension rather than the tangibles dimension as found by Parasuraman *et al* (1988).

This raises a number of questions such as: how do patients judge whether a practice has modern equipment? And are they aware of the introduction of new equipment? Investing in a new piece of equipment can be an expensive outlay for a practice and purchases are not purely made with the aim of improving the visual appearance of the practice, but to enable the optometrist to do his/her job more easily and effectively, as discussed in Chapter 4. The purchase may be to enable them to take part in a shared-care scheme such as diabetic retinopathy screening or to enable them to offer an additional service to differentiate themselves as a specialist practice.

This study implemented the SERVQUAL questionnaire in practices both before and after a new piece of equipment was introduced to investigate the effect on various aspects of service quality. It would appear most likely that question 1 would be affected, but are factors such as reliability and assurance affected?

The aims of this study were to measure any changes that occurred in SERVQUAL score when a new piece of instrumentation was introduced into a practice. This study also aimed to compare SERVQUAL results across demographic groups to investigate whether, for example, age or frequency of visit affected patients' views and awareness of new instrumentation. Practices who purchase new instrumentation may wish to use this information in their marketing strategy to target groups who are most likely to consider instrumentation an important factor in good service quality.

7.2: Method

Practices who took part in the original SERVQUAL study were invited to trial a new piece of instrumentation. The instrumentation available was an electronic test chart, a fundus camera, a refractor head, a digital slit lamp, a tear analyser (Tearlab) or a macular pigment densitometer (MacuScope). The practices were invited to choose the instrumentation as they could identify what equipment would be of particular benefit to their practice population or choose equipment related to an area of specialist interest. Two practices chose to trial the MacuScope macular pigment densitometer (Macuvision Europe Ltd, Solihull, UK) shown in figure 7.1. The third practice chose to trial the Nidek SC-1600 LCD test chart (figure 7.2).

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Figure 7.1: MacuScope macular pigment densitometer (image courtesy of Macuvision Europe, Solihull, UK. www.macuscope.com)

The MacuScope measures macular pigment optical density (MPOD) which can identify those patients who may be at risk of AMD and also monitor any effect on the macular pigment optical density with intervention such as nutritional supplements. Macular pigment, consisting of lutein and zeaxanthin, is found in the inner retinal layers and is one-hundred times more concentrated at the macula than in the peripheral retina (Bartlett *et al*, 2010). It has been found to have a photoprotective function, therefore patients with low MPOD have less protection from blue light damage for retinal structures behind the macular pigment (Bone *et al*, 2003). Some studies have found that, due to this blue light damage, patients with low MPOD are more at risk of developing AMD (Beatty *et al*, 2001; Bone *et al*, 2001).

The Macuscope measures MPOD using heterochromatic flicker photometry. A flickering target consists of light at two alternating wavelengths: 465nm (which is absorbed by macular pigment) and 550nm (which is not absorbed). The patient is required to observe the flickering target and indicate the point at which the flicker is minimised. The minimum flicker point is measured at one central location, where peak MPOD should occur, and one peripheral location, where minimum MPOD should occur. The logarithm of the ratio of these values gives the MPOD value of the eye under test (de Kinkelder *et al*, 2011).

Research has shown that supplementation with high doses of lutein increases MPOD (Bone *et al*, 2003; Berendschot *et al*, 2000) and therefore may reduce the risk of AMD. Practitioners advising patients to take lutein supplements, particularly where risk factors such as family history exist, can carry out MPOD measurement in order to monitor any changes over time and demonstrate a benefit to the patient. Clinical evaluation of the MacuScope found that measurement differences over 0.58 units were clinically significant (Bartlett *et al*, 2010).

The instrumentation was in addition to equipment that the practices already used, therefore the patient underwent an extra test in addition to their usual eye examination. There was no additional charge for the test to ensure that this did not impact on the patients' expectations and perceptions. The macular pigment testing was carried out on successive patients attending for eye examinations or contact lens appointments and was carried out by the optometrist. The optometrist received half an hour of hands-on training in the practice from a qualified optometrist (SS) to ensure they were familiar with the operation of the instrument and how to interpret the results produced.

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Figure 7.2: Nidek SC-1600 LCD test chart (image courtesy of Birmingham Optical Group, Birmingham, UK. www.nidek.co.uk)

The Nidek SC-1600 is a flat screen LCD test chart which can be controlled by the practitioner using a remote control or through a linked phoropter head. In this study a remote control was used so as not to introduce a second new piece of instrumentation. The LCD test chart was used instead of the practice's existing illuminated test chart, therefore no extra tests were carried out compared with those that they would normally encounter in a routine eye examination. The test chart was operated by the optometrist who had received 30 minutes of hands-on training in the practice from the instrument distributor's product manager (MB).

Questionnaires were completed by patients using the same criteria as in the previous study, excluding those under 16 years of age, those unable to complete the questionnaire without help from the practice staff, and those not attending for an eye examination, contact lens trial or contact lens aftercare. Informed consent was obtained from all participants. Ethics approval was obtained from Aston University Business School (17/01/08).

The questionnaires were carried out before the introduction of a new piece of instrumentation and immediately after the introduction of the instrumentation. The questionnaires were carried out as close together in time as possible to reduce variables such as the appearance of marketing materials which may be changed if a new promotion is introduced, or any staffing changes which may occur. As the patients were attending for routine appointments, different patients participated before and after the introduction of instrumentation.

Overall gap scores, individual questions and the five SERVQUAL dimensions were compared before and after new instrumentation was introduced. Results were analysed by comparing demographic groups across age, frequency of visit and the presence of an eye condition.

7.3: Results

A total of 119 customers across the three participating practices completed questionnaires prior to the introduction of new instrumentation. Between the two practices where the MacuScope was introduced, 69 questionnaires were completed after the introduction of the instrument. In the practice where the LCD test chart was introduced, 20 questionnaires were completed. These sample sizes give 80% power to detect a difference of 0.2 between the group mean scores (G*Power: Buchner *et al*, 2009).

Sharipo-Wilk W test showed that the results before and after the introduction of new instrumentation were normally distributed (p=0.003 and p=0.000). The mean results of the overall gap scores were compared by t-test. The mean Q values were almost identical at 0.28 (±0.58) before new instrumentation was introduced, and 0.28 (±0.48) after new instrumentation was introduced. Therefore there was no significant difference between the results ($p=0.990$).

Independent sample t-tests were carried out between each individual questionnaire item mean gap score before and after the introduction of new equipment. No items showed significant differences ($p = 0.114$ to 0.996). T-tests were also carried out between gap scores for each SERVQUAL dimension, tangibles, reliability, responsiveness, assurance and empathy. No significant difference was found between the questionnaire periods ($p = 0.127$ to 0.610).

Demographic factors were examined to investigate whether age, frequency of visit or the patient having an ocular condition affected their opinions on service quality. Figure 7.3 shows the correlations between gap scores and age. Spearman's Rho carried out on results from the second round of questionnaires (after the introduction of the new instrument) showed no significant correlation with age ($r=0.224$) or frequency of patient visit ($r=0.877$). Each age group was then analysed by comparison of results before and after the introduction of equipment using t-tests. No significant differences emerged ($p = 0.166$ to 0.937), however in the younger age groups (41-50 and younger) mean gap value increased after the introduction of new instrumentation, whereas in the older age groups the mean Q value reduced or did not show significant change. Due to the smaller numbers of younger patients in the practice populations in this study, the results were not significant. The practices involved in this study had more elderly patient populations as two were in rural locations and all three were single independent practices, which tend to attract and retain older patients through forming long term relationships (Mintel, 2010).

Frequency of visit also showed no significant effect on whether a patient found better or worse service quality after the introduction of new instrumentation ($p=0.052$ to $p=0.530$). No significant change in score was found with those patients who indicated they had been diagnosed with an eye condition ($p=0.601$) or with those who did not ($p=0.199$).

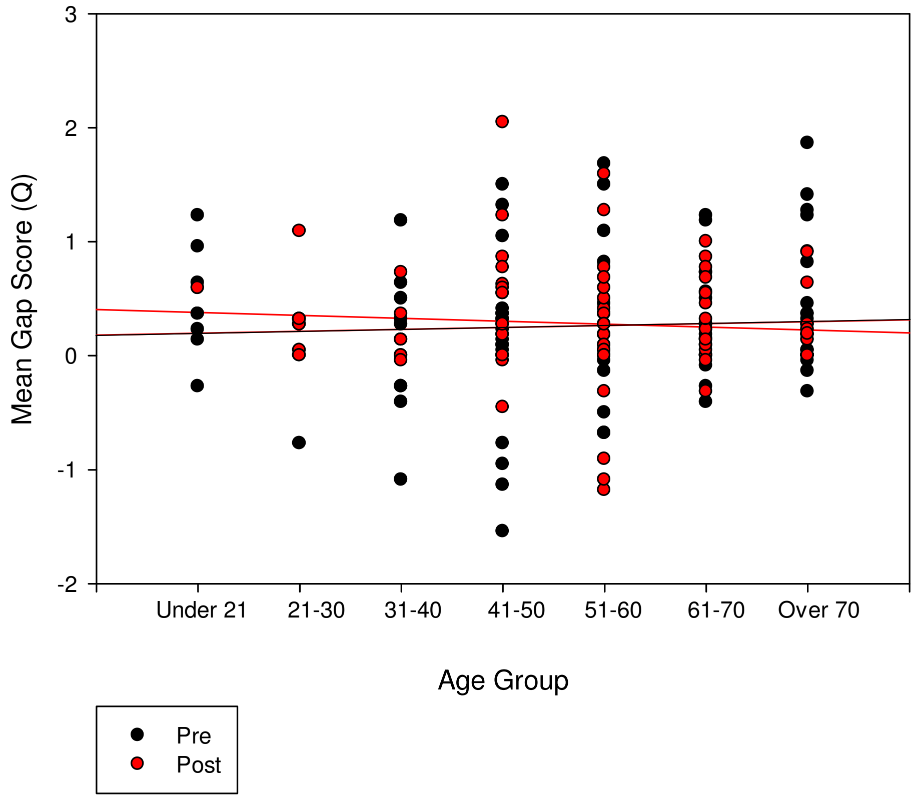

Figure 7.3: Gap scores pre and post introduction of new instrumentation analysed by patient age. This shows a trend that the gap score is higher for younger customers than for older customers after the introduction of new instrumentation.

Factor rotation (table 7.1) identified four factors. Although the Kaiser-Meyer-Olkin measure of sampling adequacy was not as high as in Chapter 6 (0.930), a value of over 0.8 indicates a very compact pattern of correlations and therefore a good level of sampling adequacy. Reliability is clearly identified as factor 1 as in Chapter 6 (table 6.3), however tangibles and assurance form factor 3, whilst responsiveness and empathy are split across factors 1, 2 and 4. As previously found in the validation of SERVQUAL for optometric use, questionnaire item 1 is grouped with reliability rather than tangibles.

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Q1	.493	.206	.144	.194
Q2	-.052	.103	.797	-.024
Q3	.059	.131	.780	-.131
Q4	.012	-.115	.782	.020
Q5	.549	.258	.289	-.567
Q6	.733	.026	-.109	.311
Q7	.694	.343	-.165	.136
Q8	.696	.335	-.121	.017
Q9	.762	.071	-.097	-.029
Q10	.631	.331	.228	-.044
Q11	.454	.596	.311	.120
Q12	.529	.348	.446	.206
Q13	.396	.317	-.046	.720
Q14	.667	.291	.470	.029
Q15	.478	.173	.462	.386
Q16	-.026	.326	.661	.482
Q17	.184	.806	.037	.145
Q18	.239	.813	.105	.072
Q19	.216	.787	.039	.081
Q20	.126	.638	.260	.541
Q21	.609	.344	.288	-.168
Q22	.390	.636	.070	-.061

Table 7.1: Rotated component matrix. Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 6 iterations.

Bartlett's test of sphericity: chi-squared 1164.071, df 231, sig 0.000.

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy: 0.826

Dimension	Adjusted R^2 value
Tangibles	0.369
Reliability	0.512
Responsiveness	0.769
Assurance	0.741
Empathy	0.727

Table 7.2: Regression analysis of results after introduction of new technology showing amount of total Q value explained by each SERVQUAL dimension.

Regression analysis (table 7.2) found that the tangibles dimension explained the lowest amount of variance in the SERVQUAL scores (36.9%), whilst responsiveness, assurance and empathy explained the highest amounts.

Results were separated into those from the practice where the LCD test chart was introduced and those from the two MacuScope practices, and the overall mean gap scores after the introduction of new instrumentation were compared by t-test. The mean scores were 0.29 for the MacuScope patients and 0.25 for the test chart patients. There was no significant difference between these results ($p=0.735$)

7.4: Costs and benefits of new instrumentation

The two pieces of instrumentation chosen, the MacuScope and the LCD test chart, give different benefits to the practitioner. The MacuScope measures macular pigment density, a test which identifies those who may be at increased risk of age-related macular degeneration, and is therefore of clinical benefit to the practitioner with a clear purpose for conducting the test. The LCD test chart replaced an existing illuminated test chart, therefore the practitioner did not carry out additional tests (additional functions such as contrast sensitivity were not used in this study) but had benefits such as randomization of letters, which reduces learning effects and therefore improves the accuracy of the test (McMonnies 2001), and having a more modern appearance than the illuminated test chart. Though the types of instrumentation were different, the results after the introduction of the equipment were similar in both cases.

In this study, MacuScope examinations were carried out by the optometrist, however increasingly automated technology allows diagnostic testing such as fundus photography and corneal topography to be carried out by practice support staff rather than by the optometrist (figure 4.9). One disadvantage of introducing new instrumentation to carry out additional tests can be the increased time required, resulting in increased cost to the optometrist. Using support staff to carry out some functions can allow the optometrist to spend more time on the interpretation of the results, emphasizing the SERVQUAL dimensions of assurance and empathy by explaining to the patient the importance of the test and its relevance to them, for example if there is family history of a particular eye condition. As the testing was carried out by the optometrist in this study, the practitioner would have had less time to explain the clinical benefits of the Macuscope examination than if a member of practice support staff had carried out the testing. Another method of communicating the clinical benefits of new instrumentation to patients is through posters and patient information leaflets. Instrumentation manufacturers and distributors may offer these materials to practices which purchase equipment such as fundus cameras and OCTs in order to promote the technology in the practice.

As in Chapter 6, item 1 “excellent opticians should have up-to-date equipment” rotated onto the reliability dimension rather than tangibles (table 7.1). This suggests that patients view equipment as part of providing an efficient and accurate eye examination rather than adding to the professional look of the practice. Patients can make an instant judgement about the quality of equipment by their tangible impressions of whether it looks new or well maintained, however as this item rotates onto an intangible dimension it appears that they build their impression more from how the role of the equipment is communicated to them.

Regression analysis shows that the intangible aspects of service quality explain a greater proportion of the variance than the tangibles dimension, however patients may use tangible aspects to choose a practice. They may also use word-of-mouth recommendations based on the quality of service others have received. Case studies from the United States of America (USA) (American Optometric Association, 2009) and most recently the UK (Moss, 2011) show the benefits to businesses of investing in new instrumentation. An Air Force clinic found that introducing more automated instrumentation and training support staff in its use allowed twice as many patients to be seen, therefore reducing waiting times for appointments. This would clearly have an impact on the reliability dimension of service quality. In high street optometry, doubling the number of patients seen would also have an economic benefit to the practice in terms of increased eye examination and dispensing income which would offset the cost of investing in new technology. However, patients may view this approach negatively due to reduced contact time with the qualified optometrist. They may feel they cannot discuss all their concerns if the appointment is shorter.

Rather than reducing appointment times, a UK practice (Moss, 2011) used investment in the latest technology to allow its optometrists to provide high quality eye examinations. By using technology to differentiate the practice and target the top section of the market, higher patient spend, with an average dispense of £600, created a successful business model. This supports Mintel's market report found that the more successful independent practices target the higher end of the market and focus on quality and customer service (Mintel 2010). The same report found that 20% of consumers agreed with the statement "My eyesight is important; it doesn't matter how much it costs to correct it", suggesting that a significant minority of patients are willing to pay more for higher levels of service.

Lower cost instrumentation, such as an LCD test chart at around £1500, can be offset by the benefits to the practice discussed above. However, more expensive instrumentation such as an OCT requires consideration of finance models. Options include:

- Absorbing the cost into the practice running costs as a method of differentiating from the competition and attracting more patients;
- Increasing the sight test fee to include the OCT examination;
- Charging patients a separate fee if the OCT examination is conducted; or
- An all-inclusive monthly direct debit plan.

If a separate fee is charged, a balance must be achieved between the amount charged and patients' willingness to pay. An example is shown in table 7.3 based on an OCT purchase price of £50,000 over 4 years and 260 testing days per year (adapted from Eyeplan, 2009).

Price per OCT examination	Examinations per day	Revenue per year	Annual return on investment
£20	3	£15,600	£3100
£25	2.5	£16,250	£3750
£35	2	£18,200	£5700
£40	1.5	£15,600	£3100
£45	1	£11,700	-£800

Table 7.3: Income estimates based on the level of charge for OCT examination. In this example, the optimum charge is £35 per examination.

If extra services such as OCT are included in a monthly direct-debit scheme, the scheme becomes more attractive to the patient. The scheme may be made more attractive by also offering discounts on spectacles and contact lenses. A direct debit scheme priced at £2 per month, attracting 3 patients per day, would provide an income of £18,720; higher than the maximum revenue of £18,200 from the charge per test model, and with the potential for increased income from patient loyalty and related purchases.

7.5: Discussion

Introducing new instrumentation in itself does not appear to significantly affect patients' views of service quality, however other types of instrumentation where the benefits are obvious to the patient may produce different results. Research has shown that some individuals found the task of identifying the minimum point of flicker in the MacuScope examination to be difficult (Bartlett *et al*, 2010; Howells *et al*, 2011). This may create uncertainty in both the practitioner and patient as to whether the outcome of the test can be relied upon and therefore be of clinical benefit. The MacuScope is also used to identify those who may be at risk of AMD, rather than those who currently have pathology, in contrast to imaging equipment which can be used to make patients aware of their existing pathology and increase their knowledge and understanding of the condition. Future research could look at the effect of introducing a fundus camera or OCT into a practice, and also at the impact of using materials such as patient information leaflets to increase patients' understanding of the technology. It is unlikely that patients would have previously undergone MacuScope testing due to the small number in high street practices, however, as around a quarter of practices have LCD test charts (Table 4.3) they may have already encountered this technology at other practices and their expectations would be influenced by this. Not all practices had the same level of instrumentation before the introduction of the new equipment, which may also influence patients' expectations and perceptions scores. For example, introducing a Macuscope into a practice which already has technology such as an LCD test chart and fundus camera may not have as large an impact as introducing the equipment in a practice where new instrumentation is rarely introduced and is therefore more noticeable. Conversely, where a practice has an existing emphasis on advanced technology, patients may have greater awareness and appreciation of the benefits of new instrumentation.

Seven of the nine practices who took part in the validation study were reluctant to take part in the second phase of introducing new instrumentation due to the extra time needed for patients to complete the questionnaires and to carry out an additional test. The time taken to complete the questionnaires in practice could be reduced by allowing the patient to take the questionnaire home and return it in a stamped-addressed envelope. This is likely to have a negative effect on the response rate, however patients may feel they can be more honest when they are not in the practice and may have more time to consider their views and record them accurately. Another limitation of the study was that different patients were surveyed before and after the introduction of new instrumentation. It was not possible to use the same individuals in each survey as most patients only attend for a regular eye examination every 1-2 years, therefore either an additional full eye examination which was not clinically necessary would be required or the large timescale involved would result in other variables such as changes to practice décor and staffing.

A larger scale study, addressing the issue of low numbers of patients in certain demographic groups, across different types of practices rather than solely independent practices which took part in this study, would be of benefit to further investigate any significant differences between patients. A sample size of 384 is required to give data with a margin of error of 5% for the whole population (Bartlett *et al,* 2001). This could involve 8 practices carrying out 50 questionnaires, however to investigate differences between practice types, it would be more beneficial to carry out 20 questionnaires at 20 practices. The benefits of introducing new instrumentation may become more noticeable once the practitioner is more familiar with the technology and can provide expert knowledge on the test results and their relevance. Therefore a long term follow-up of the practices would be of interest.

CHAPTER 8

Discussion and conclusions

Ophthalmology resources in the UK are under increasing demand due to the ageing population and budget constraints caused by the current economic climate. Optometrists are well placed to play a role in the management of these patients; however opportunities for optometrists to be involved in co-management services vary across the country. The College of Optometrists and other optical organisations identified the importance of close relationships between ophthalmologists, orthoptists and optometrists, and recently agreed on a strategy to improve public eye health with two of its key aims to:

- ‘Meet the ophthalmic health needs of the most at risk populations across the country’ and;
- ‘develop understanding of where unmet need exists and what can be done to tackle it’

As government proposals (Health and Social Care Bill, 2011) are that GP consortia, rather than PCTs, will in the future be responsible for commissioning NHS services, an opportunity exists for optometrists to present the case for community eye care schemes as high quality, accessible to patients and cost-saving, both on a local and national level. This thesis provides evidence that supports this case and evaluates areas of future optometrist involvement.

8.1: Future research

The profession has highlighted the need for further research in this field, for example the College of Optometrists is planning to fund research evaluating different models of ‘enhanced’ eye care around the UK (College of Optometrists, 2011d). Further research based at Aston University and a local practice will analyse the outcomes and sustainability of introducing enhanced services along with identifying future demand for such services based on predicted prevalence of eye disease.

Expanding the role of the optometrist provides a solution to the increased demands on the NHS and, with a sustainable funding model, could help to provide an extra funding stream for the optometrist based on professional fees rather than sales of goods. Research has shown that 85% of optometrists were dissatisfied with 2002 GOS fees (Mason & Mason, 2002), and UK average private eye examination fees, currently £21.30 (FODO, 2011), are little higher than the NHS eye exam fee (£20.70) due to market pressures. Dissatisfaction remains in the profession as the 2011 GOS fees were frozen at the 2010 levels (OFRC, 2011). The traditional model of subsidising these fees through sales of spectacles and contact lenses is under threat as the optical goods market fell by 2.2% in 2009 compared to 2008, and supermarkets and internet retailers are able to offer low prices due to their reduced overheads. The 2010 Mintel report suggests that independent practices will survive ‘as long as they continue to offer high levels of personal service’ and higher eye examination fees could be justified by ‘adding more elements’ (Mintel, 2010). Some independent practices are introducing regular direct debit plans to cover the cost of extra eye examination elements. As the practice can predict a certain level of income, they are able to invest in new technology. Further research to measure the long term outcomes of introducing such a fee model would be of benefit to establish whether it is sustainable in practices with a variety of patient populations. Patient satisfaction is a key element in growing a practice through continued custom (such as encouraging commitment to a direct debit plan) and word-of-mouth advertising to attract new patients. This thesis found that the SERVQUAL questionnaire was an appropriate tool to measure service quality in optometric practice, and this could be further utilised to measure the impact of introducing new fee structures and new clinical services into a practice.

The profession has also found a drop in applicants to optometry courses in recent years, leading to the formation of the Careers in Optics Working Group in April 2010. The opportunity to participate in a broader range of patient management schemes alongside career development opportunities such as supplementary and independent prescribing may play a role in attracting a greater number and higher quality of students into the profession. The College of Optometrists surveys its members to identify areas in which they plan to concentrate their career development (Medix, 2008); similar research to gather the views of current and potential optometry students regarding their career development and the future of the profession would be of benefit to ensure that there will be sustainable interest from optometrists in any new initiatives introduced.

The introduction of independent prescribing (IP) in 2008 has provided an excellent opportunity for optometrists to extend their clinical role but, as discussed in section 1.1.6, uptake has been greatest among hospital-based optometrists and limited by training and remuneration barriers. One scheme to show the benefits to the HES of optometrists with the IP qualification has been introduced at Hinchingbrooke hospital in Cambridgeshire. At this hospital, the emergency eye care service has been led by optometrists since 2008, and independent prescribing has enabled over 80% of patients to be managed by optometrists (Mukhopadhyay, 2010). The initial success of this scheme has led to discussion regarding its implementation in a community setting (Newsom, 2009). This thesis showed that community based triage of ophthalmic patients could save many routine HES appointments; however emergency referrals were not within the scope of this research. Further research is needed to audit this scheme and evaluate the cost implications to both the HES and practices of a community-based scheme. This information, alongside reviews of other existing schemes such as PEARS in Wales, will help to establish best practice in terms of patient convenience, cost effectiveness and training.

8.2: Conclusions

This thesis has explored the key considerations of unmet needs, patient satisfaction, training, instrumentation and financial implications which must all be addressed to create innovative eye care schemes. Successful schemes can achieve optimum patient outcomes, and be both financially sustainable and rewarding for the optometrist.

This thesis found that many practices do not charge for extra elements of the eye examination, such as fundus photography, and the average charge across practices is decreasing. In the current economic climate, practitioners have placed greater importance on the ‘value for money’ aspect of new instrumentation; therefore new technology must add value to the eye examination and a sustainable business model is needed to support continued investment.

SERVQUAL is a valid tool to measure service quality in optometric practice and can be used to assess how successfully a practice is addressing the needs of its patients. Patients view the intangible aspects of the eye examination as most important, in particular responsiveness, assurance and empathy. These elements must be considered when devising a marketing strategy to communicate to patients the benefits of new technology and enhanced eye care services.

The cost of training has so far been a barrier to participation in higher qualifications which would allow the optometrist to participate in a greater range of enhanced eye care schemes. High speed internet allows distance learning to include video demonstrations of new technology and advanced techniques, whilst greater use of web cams allows for interactive training sessions. This thesis identifies distance learning as a cost-effective method of training optometrists which is also convenient for practitioners. The GOC plans to introduce a scheme for revalidation of optometrists in January 2013 and proposes that interactive learning will carry greater weight than text based distance learning (GOC, 2010); whilst face-to-face interactive learning is ideal for maximum learning outcomes, interactive distance learning should be considered as a valid option particularly for practitioners in remote locations and as a cost-effective option.

Community based management of ophthalmic patients would allow HES resources to be focussed on those patients with sight-threatening eye conditions and those requiring surgery. This thesis showed that triage of newly referred patients by optometrists could enable around half to be managed solely in the community, thereby reducing the demand for valuable HES appointments, cutting waiting times and improving patient convenience. Other areas where optometrists could further expand their role are in the diagnosis and treatment of anterior eye conditions and in the long term management of diabetic retinopathy and glaucoma.

With the profession and the NHS undergoing periods of change with the proposed introduction of GP commissioning and revalidation, an opportunity exists to engage with other health professionals and healthcare commissioners to establish the optometrist as the primary point of contact for eye health in the community. This thesis found that, with appropriate investment in advanced instrumentation and specialist training, optometrists are well placed to adopt an expanded role.

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