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Investigating the barriers to implementation of new technology in primary eye care: a qualitative study

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ABSTRACT

Objective Optometric practices increasingly use ocular imaging as part of routine eye care. Alongside the increase in e-referral systems, the use of such images provides an opportunity for more accurate triaging of referrals, to ensure the most appropriate use of limited hospital resources. To encourage the incorporation of images into anterior eye pathology referrals, an NHS commissioner for Calderdale and Kirklees (West Yorkshire, UK) provided slit lamp mountable cameras to 20 local optometric practices. This study qualitatively explored the outcomes from this pilot study, identifying barriers and enablers for incorporating similar technology more widely.

Methods and analysis Six months after receiving the camera, participating optometrists were contacted to discuss their experiences via semi-structured interviews. Opinions were also sought from commissioners of the initiative. Transcripts were reviewed and coded by the research team and organised via thematic analysis.

Results Twelve semi-structured interviews took place. Five themes were identified: practice autonomy, communication, financial and time costs, hardware and software issues, and wider application of technology. Practitioners typically reported that the device had not been used much. This was partly due to difficulties integrating the device into their routine practice and partly due to the relatively low prevalence of anterior eye pathology requiring referral. A wider remit for the technology, other than simply improving triaging efficiencies, was also identified as part of this study.

Conclusion This study highlights the importance of conducting small pilot studies prior to significant investment of scarce NHS resources. It also highlights the importance of sharing negative findings to share best practice and avoid wastage. Limitations of this investigation included the voluntary approach of both the camera scheme and our interviews; practitioners who took part in the study were more likely to be engaged and to participate in these types of schemes compared with non-participating practitioners, and the study was unable to investigate the barriers to entry for non-participants. Nevertheless, consulting with local practitioners during service design for similar new schemes may pre-empt potential barriers and facilitate greater engagement and practice autonomy for future schemes.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Increased demand on NHS secondary care highlights the need to appropriately manage false positive referrals from primary eye care. Technological advances in ocular imaging and electronic referral pathways pose an opportunity to improve the accuracy of triage into the hospital eye service.

WHAT THIS STUDY ADDS

⇒ When implementing new schemes and protocols into primary care, it is crucial to allocate specific resources to encourage comprehensive engagement, considering the substantial time constraints already in play.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ It is important to thoroughly explore previous research and openly share negative findings. There should be recognition that every practice is unique and that a one-size-fits-all approach may not be the most appropriate.

INTRODUCTION

Ophthalmology has become the largest outpatient secondary care specialty in the UK, leading to longer wait times for patients.¹ The wait for ophthalmology outpatient appointments accounts for 10% of the current NHS backlog (patients waiting for a first appointment with a consultant ophthalmologist).¹ These figures do not take into account the number of patients waiting for a follow-up appointment. Avoidable vision loss is nine times more likely to occur in follow-up patients compared with new patients, and these patients currently account for 69% of ophthalmology appointments.²

Ophthalmology departments in the UK typically operate under a block contract, meaning that funding does not vary with increased patient numbers. This can result in an increased workload for staff, and the recent statistics point to an unsustainable burden within secondary eye care.³

Reducing the number of false positive referrals into secondary eye care would have several benefits. It would allow for more timely examination of true-positive cases, thereby reducing wait times and ensuring more efficient utilisation of resources.⁴ It would free up space for patients requiring a follow-up appointment. Additionally, patients would benefit from avoiding unnecessary hospital appointments, saving time, money and any associated health-related anxiety.⁵

Previous studies have highlighted a notable incidence of false positive referrals from optometrists.⁶ Although research specifically focusing on anterior eye referrals is limited, these cases account for approximately 10–13% of all referrals,^{7,8} with a reported false positive rate of 16%.⁶

To ensure appropriate prioritisation of referrals, all ophthalmology referrals from primary care are triaged prior to an appointment being scheduled. Triageing may be undertaken by an ophthalmologist, optometrist or ophthalmic nurse, depending on the hospital. Recently, Integrated Care Systems (ICSs; smaller National Health Service (NHS) organisations responsible for planning and commissioning local healthcare services within their area) have begun to adopt e-referral platforms for external referrals, such as those from primary eye care.

In March 2022, the West Yorkshire Health and Care Partnership commissioned a pilot initiative whereby portable cameras similar to mobile phone cameras (TCL 30SE, Telephone Communication Limited, Huizhou, China) and slit lamp mounts (figure 1, Celestron Basic Smartphone Adapter 1.25 Inch, Torrance, California, United States) were provided to optometric practices in Calderdale and Kirklees, two metropolitan boroughs of West Yorkshire which employ an e-referral system. The intention was to facilitate anterior eye image capture, subsequently increasing the inclusion of anterior eye images in e-referrals. This initiative was based on a previous service carried out in Scotland, which was not formally audited. It was hypothesised that enabling practices to image anterior eye pathology and provide these images within a referral would allow anterior eye referrals to be more accurately triaged. Therefore, it could allow for the earlier identification of false positive referrals at the triaging stage, with feedback provided to the referring optometrist, thus yielding the aforementioned benefits for patients and hospitals.

The e-referral system used a secure web portal for optometrists to send referrals to the hospital, making it an ideal location for piloting an imaging scheme. The Local Optical Committee (LOC) approached all 54 practices in the area who provided NHS primary eyecare services; 20 expressed an interest in taking part in this initiative and were each provided with a camera and slit lamp mount (figure 2). A guidance document was provided, which explained how to attach the camera to a slit lamp using the mount provided, how to take and store images with the camera, and how to attach images to referrals within the e-referral system. If practices struggled to use the camera, they could contact a nominated member of the



Figure 1 The adapter supplied to mount the camera to the slit lamp (Celestron Basic Smartphone Adapter 1.25 Inch, Torrance, California, USA).

LOC. Help was provided via email, over the phone, or as part of an in-person practice visit, as deemed appropriate. A questionnaire was also sent to practices 3 months after the camera had been received, in order to identify and address any remaining concerns.

Optometrists had the flexibility to use these cameras as they saw fit, with the expectation that they would capture images and include them with anterior eye referrals.

The aim of the present study was to explore the experiences of all stakeholders involved in the implementation and use of these new cameras within primary eye care. In particular, as only a small number of referrals had incorporated images from this new camera system, this study aimed to understand how to improve on the service design incorporated in the pilot study, to overcome barriers to the implementation of similar technology in optometric practice.

MATERIALS AND METHODS

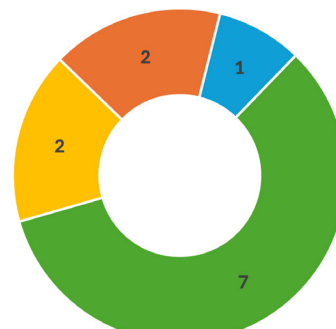
Six months after the introduction of the cameras to practices, stakeholders were invited to take part in this qualitative service evaluation via email in an opportunistic



Figure 2 Map showing the location of practices who participated in the initiative to receive a slit lamp camera.

approach. All practitioners who received a camera were invited to participate in a semi-structured interview online and had not been in contact with the study team before. Two commissioners of the study, that is, the ICS, were also invited to an interview. Interviews were conducted with consenting parties by all members of the research team (one female, two male) two at a time. Practitioners and commissioners were advised about the main goals of the research in the email invitation. One member of the research team conducted the interview, while another transcribed the responses and ensured that the interview was conducted in an unbiased manner. Open-ended questions were developed into a Topic Guide by researchers in collaboration with the West Yorkshire Health and Care Partnership. These questions were designed to explore both positive and negative experiences associated with the equipment and training provided, to allow a thorough deductive approach (online supplemental material A). Interviews lasted approximately 30 minutes and were voice recorded, with prior informed consent, to enable transcript validation and preparation for thematic analysis. On completion of the interview, a third member of the research team, who had not been present in the interview, reviewed the recording and ensured that the transcript accurately represented the discussion that took place. No repeat interviews were performed. This approach ensured that all members of the research team were familiar with the content of all interviews, thus satisfying the requirement for data familiarisation in thematic analysis via a deductive approach.⁹

The research team assessed whether they had achieved the required information power within the dimensions of qualitative work, as defined by Malterud *et al.*¹⁰ They also discussed whether saturation had been achieved, indicating that no new significant information was emerging. On agreement, transcripts were independently coded, following the method outlined by Braun and Clarke,⁹ to identify themes and patterns in the data for an inductive approach. The team then collaboratively developed and refined the themes, ensuring consistency and rigour in the analysis process. Patients and the public were not involved in the design, conduct, reporting or dissemination plans of this research, and transcripts were not seen by the



■ Practitioner from multinational chain ■ Practitioner from local chain practice
■ Practitioner from independent practice ■ Coordinator

Figure 3 Occupational background of stakeholders who participated in interviews.

participants. A COREQ checklist for the project and manuscript is provided in online supplemental material B, and a Reflexivity Statement by the authorship team is shown in online supplemental material C.

RESULTS

A total of 12 semi-structured interviews were carried out with all stakeholder groups (figure 3), with 10 practices not responding. Comments have been anonymised and are simply identified as originating from a ‘coordinator’ (a commissioner from the ICS) or a ‘practitioner’ (an optometrist in primary care, two of whom are part of the LOC). The participating practitioners had a median age of 49 (range 28–61) and had been qualified for a median of 28.5 years (range 6–33), 70% were male with a median number of days worked per week of 4.

Themes

Several important themes were identified that provided insight into the strengths and weaknesses of the initiative. These themes are summarised in figure 4.

Theme 1: practice autonomy

The initiative coordinators advised that compromises had to be made on equipment functionality for the sake of universality. A different adaptor was considered that was much easier to use, but was not compatible with all slit lamp designs, and therefore had to be rejected. Practitioners advised that any lack of functionality can give the wrong impression to patients—it is important that all aspects of the practice should appear efficient and professional, especially in a competitive market.

*The problem is, I probably tried it more when the patient was sat in front of me which kind've then made me a bit more flustered and I was kind've... 'right this ain't working...'.
Practitioner 3*

Practitioners highlighted the importance of practice autonomy and the need for equipment choices to align with individual practice requirements. They suggested that grants towards equipment costs, rather than direct

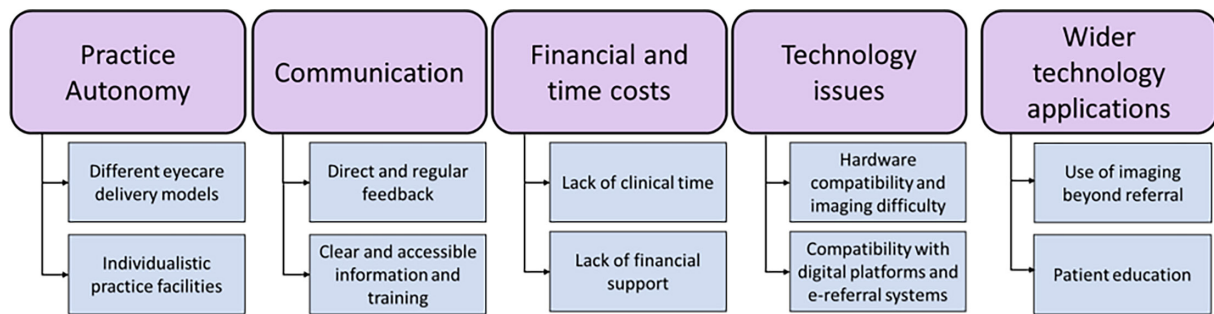


Figure 4 Summary of the themes identified from semi-structured interviews. Subthemes are listed below the main themes.

provision of equipment, may be a more suitable approach for future initiatives.

I think technology has got to play a big part in how we move forward, but it's got to be the right system... We should be just given the funding to work out what we need to buy for our particular clientele and our practice. Practitioner 5

Practitioners raised the point that primary care optometry works differently to many other areas of NHS primary care. All practices are categorised as private contractors, and even though they have signed an NHS contract, practices are autonomous and can vary widely in service delivery. This includes variation in equipment requirements.

Some practitioners raised concerns that this intervention would only benefit secondary care as the priorities of primary care are different. As such, there was a feeling of being undervalued, overlapping with the financial issues highlighted in subsequent themes.

Theme 2: communication

Another main theme that emerged during the interviews was the significance of effective communication. Both coordinators and practitioners identified a preference for in-person, on-site training in future projects, as this was not automatically available for this scheme. Coordinators recognised the effectiveness of this approach in previous projects, as it allows direct observation of the equipment's integration into each practice. This would ensure that protocols are fully understood and correctly followed, and enable the provision of practical advice on overcoming any challenges encountered. An in-person approach could also enhance communication within practices. Most practices seemed to rely on individual clinicians learning how to set up and use the equipment with the written guidance provided. It is therefore unclear whether all relevant information was accessible to all practitioners.

I think one of the difficulties [with the guidance document] was that, in order to make it really step-by-step, clear points of how to extract a photo off a phone, and even attaching it to the device, it meant we ended up with a significantly lengthy document of how to use it, which might have put people off. Coordinator 1

The LOC distributed a questionnaire to determine whether support was required following implementation, however very few practitioners recalled receiving it, and even fewer could remember if they had completed it. Coordinators suggested that a follow-up, in-person visit may be preferable to a questionnaire. This would more easily allow troubleshooting of any issues that had arisen and could provide a training refresher for those who had not had adequate opportunity to use the equipment.

All communication between the ICS and the participating practices occurred via the LOC. It was suggested that future studies would benefit from direct communication. While collaboration between organisations was viewed as positive, coordinators found it challenging to oversee the project with this indirect method of communication. Furthermore, this relied on LOC coordinators finding time alongside their full-time work, which imposed unnecessary burdens on them. The ICS themselves also expressed that a designated project manager would be better suited to take on this role.

Being able to get the project moving forward was at times quite difficult because I couldn't make contact with these optoms. Coordinator 2

The purpose of the study did not appear to be widely understood by practitioners, emphasising the need to ensure that expectations are clearly laid out for all involved parties at the outset. The perceived purpose of the study was given by different practitioners as: referring a large number of people, expediting referrals, and reducing the workload of optometrists. The significance of two-way communication with the Hospital Eye Service was frequently mentioned, with many expressing a desire to receive feedback on their referrals and proposing it as an idea to enhance referral quality. In addition to receiving management advice, it was anticipated that this feedback could improve optometrists' knowledge for future patients, ultimately reducing unnecessary referrals.

If I could send the image and get the question answered, that may save a referral, or stop a referral from going in and allow us to treat it rather than going into the hospital. Practitioner 3

It's useful to know when something has been rubbish and a referral isn't accepted. If you don't know you're doing something wrong, you'll keep doing it. Some of the feedback can be a little bit harsh but it is appreciated. That sort of feedback from everywhere would be really useful. Practitioner 7

Theme 3: financial and time costs

Although the equipment was funded, there was a financial disincentive to attach images to referrals due to the time it took to capture and integrate the images. Practitioners spoke of the need for any new system to be quick and easy—if they weren't, they would simply not get used. Additionally, there is a need to appear efficient and professional in front of patients, which many felt was difficult to achieve with the equipment provided for this study. The time needed to set up, capture and attach images further erodes the already limited professional time available to optometrists. Several practitioners raised the concern that General Ophthalmic Services funding for NHS sight testing is already insufficient to cover the time taken to conduct a basic eye examination. Some felt that the current funding model actively discourages enhanced clinical care schemes that require more 'chair time'. Many practitioners identified the need for adequate compensation for any scheme that takes additional time, including research studies. One practice owner in this study confessed that they were considering withdrawing from all NHS services due to the inadequate funding provided.

Time constraints are so bad. We lose money on every sight test now. Taking images does take time. Most of the time you're going to know what the issue is and can put that down in words, even though taking images is useful. Practitioner 10

I think that interventions that take up time of busy professionals should be remunerated in some shape or form, rather than the typical relying on the good will of everybody. Practitioner 2

Theme 4: software and hardware issues

Most practitioners that were interviewed reported difficulties with the software and/or hardware components of the imaging system.

Some practitioners advised of incompatibility with their practice systems, and therefore their use of the camera was limited. Further limitation came from difficulties transferring images from the camera, with large file sizes leading to lag and storage issues. Some practitioners were unaware of the guidelines provided by the LOC regarding image transfer and/or faced challenges in following them. In some cases, the workarounds performed by practitioners had the potential to compromise General Data Protection Regulation (GDPR) compliance.

Although participating practices were located within Calderdale or Kirklees, both of which had e-referral portals at the time of the study, not all patients attending

these practices resided in these areas. As such, practitioners were required to interact with other referral systems than those within the participating areas when referring patients. Varying referral systems between areas can make software compatibility and image inclusion more challenging.

Patients don't respect the trust boundaries. They come over from other areas as well. So it makes it very complicated to try and keep track of different referral pathways in each area. It's a nightmare in fact. Practitioner 5

[Practice] software will fight against anything else. It was quite difficult to get these to talk to each other. Practitioner 7

Hardware issues were more frequently reported than software issues. Although LOC representatives had tested the camera and mount with several slit lamp types prior to the study, several practitioners found that the mount was not suitable for use with their slit lamps. Some found that the mount interfered with the on/off button of the camera, such that they often couldn't set it up as desired. Most practitioners found that the equipment was awkward to set up and took time. Subsequently, some practitioners advised that they would instead use the camera free-hand, holding the camera manually in front of the slit lamp eyepiece.

There were mixed opinions on the quality of the images taken. Some practitioners reported that several photos were required to obtain an adequate image, while others advised that the quality was sufficient and would take just one or two. Some users speculated that the inadequate image quality they obtained may have been influenced by the optical quality of the slit lamp itself, rather than the camera. Others felt that image quality was dependent on what was being imaged, with some pathology photographing more easily than others due to location, required magnification, or contrast. Many practitioners indicated that superior image quality could be achieved with alternative imaging systems, such as their own integrated slit lamp cameras, or their own mobile devices.

It's an extremely useful piece of kit but difficult to use. Practitioner 10

[The camera] never seemed to fit quite successfully on our slit lamp...I never managed to capture a good image, nothing that I would have been really happy sending as my referral. Practitioner 8

Due to the low prevalence of anterior eye pathology in practice, most practitioners reported that the camera was not used regularly. As such, the camera battery would often be flat when it was then required. Subsequently, it was reportedly used even less frequently due to the unreliable battery.

The provision of one camera for each practice, irrespective of the number of consulting rooms, may also have limited its use. Storing the camera in a non-clinical

room meant that it was easy for all practitioners to access, but easy to forget about, and time-consuming to locate.

Overall, the process was viewed as slow and inefficient. This discouraged practitioners from using the equipment in a busy practice environment, where time is often limited.

Theme 5: wider application of technology

From the interviews conducted, it became apparent that simply evaluating the numbers of referrals generated, triaged and rejected did not provide an accurate reflection of the equipment's usefulness in clinical practice. This theme was exclusively raised by practitioners and is an endorsement of the equipment beyond the scope of simply reducing referral numbers. Once taken, the image becomes part of the patient record, of use for future monitoring, audit, or potential litigation purposes. Many practitioners found the equipment more useful for ongoing monitoring than for potential hospital triage, due to the often slow progression of anterior segment pathology. The use of imaging also enabled practitioners to seek a second opinion from peers in practice. Practitioners also described how images were used for education - this could be education of the patients, to enable them to understand their eye care better, self-reflection, or practitioner peer review following the consultation.

If it's just narrowed down to looking at how it affects secondary care, and the advantages of secondary care, I think you're missing a large chunk of what really using the technology in primary care should be about. Practitioner 5

Two further subthemes emerged regarding anterior eye pathology. First, there were relatively few anterior eye referrals from primary eye care, suggesting that many conditions were managed within the practice. Consequently, practitioners had limited experience with the new equipment or sometimes forgot about its availability. Second, the inclusion of images did not always enhance an anterior eye referral. Practitioners were often confident in their diagnosis or in their ability to accurately describe the pathology in their referral letter. As such, it was often felt that the addition of an image would not impact the triaging outcome. If there was less certainty, practitioners were more inclined to attach accompanying images to the referral. Many practitioners contrasted this approach with posterior segment pathology, stating that they included images more frequently, as it was perceived as being more beneficial to the referral.

Practitioners identified that being given a camera had raised awareness of the usefulness of anterior segment imaging. Some practices were considering the purchase of a dedicated slit lamp camera as a result of participation in the service. Purpose-built and integrated equipment to assess the posterior segment is currently more common in practice, and was identified as an integral part of the clinic toolkit. Practitioners spoke of the importance of easy integration and good image quality when choosing technology for clinical use.

I'm not convinced it's as big of an issue as others that need solving. I don't think that solving the anterior segment referral problem is going to deliver a great impact on anything. Practitioner 4

DISCUSSION

The ICS provided cameras to optometric practices with the aim of improving efficiency of anterior eye referral triage by the inclusion of images. As a result, it was anticipated that this would enable false positive referrals to be identified at the triage stage, thereby reducing costs. This qualitative analysis has identified several benefits arising from the initiative, however these wouldn't necessarily translate into system cost savings.

Feedback from all stakeholders within this initiative indicated that usage of the technology was much lower than anticipated. As such, it was determined that the provision of further cameras in other areas of England would not be a cost-effective use of limited resources.

It is inevitable that some new initiatives will not fully succeed—a pilot study would be unnecessary if success was already assured. However, given that this study was based on a prior, unpublished initiative in Scotland, there were missed opportunities to learn from past mistakes. Direct communication with the team in Scotland occurred only after the cameras had been provided to the West Yorkshire practices. This conversation then revealed that practitioners in Scotland had encountered similar difficulties to those since identified in West Yorkshire. Had this information been known in advance, it is likely that this initiative would either not have been commissioned at all, or would have undergone significant modifications. Therefore, this study underscores the importance of publishing negative findings, adopting the 'do once and share' approach that has been implemented in other areas of the NHS.^{11 12}

The perception from coordinators was that practitioners were uninterested in the study, however this was not evident from interviews conducted with practitioners. Instead, practitioners expressed frustration with the difficulties encountered. They acknowledged the value of conducting pilot studies like this one and expressed an interest in being involved in future studies. Moreover, many practitioners recognised the benefits of anterior eye imaging because of their involvement in the initiative. Although many found the supplied equipment did not meet their practice's needs, several indicated that they were in the process of purchasing other means of capturing anterior eye images, such as a different camera, or a slit lamp with an incorporated camera. This approach is preferable to practitioners using their own mobile devices, which some practitioners reported doing, but has substantial GDPR issues.

Compared with the cameras provided as part of the initiative, purpose-built imaging equipment is typically of higher quality and is easier to use, although substantially more expensive. As noted in Theme 1, some practitioners

suggested that a grant towards equipment costs, rather than the provision of pre-selected equipment, might be better received by practitioners. This would allow practitioners to consider which equipment would be best suited to their practice, adding practice's money to the grant if needed. This would allow practices to account for differences between patient demographics and existing practice equipment, thus helping to maintain practice autonomy.

Most practitioners found the integration of images with the e-referral portal to be quite straightforward. Some, however, expressed frustration that the portal was not compatible with their practice software, and that portals differed between ICSs. It should be noted that some of these frustrations may now be mitigated by the new e-referral platform introduced in Calderdale and Kirklees soon after the completion of this study. However, given the increasing number of ICSs introducing e-referral systems, these frustrations should be carefully considered. As this study illustrates, a new initiative that increases an optometrist's already stretched workload is unlikely to be viewed positively, and optometrists may be disinclined to engage with such an initiative.

Practitioners emphasised the need for NHS services to be adequately funded, with many expressing frustration that current services are not. Practices must subsidise this funding shortfall through retail sales in order to remain financially viable.¹³ This creates a conflict between the clinical and financial aspects of optometric practice, which many optometrists struggle to balance.¹⁴ As noted in 'Theme 3', one practice owner in this study confessed that they were considering withdrawing from all NHS services due to the inadequate funding provided. For related reasons, some practitioners in this study reported that they were inclined to 'squeeze in' Minor Eye Conditions Service (MECS)/Primary Eye Care Acute Referral Scheme (PEARS) appointments in between routine appointments, rather than allow dedicated availability. As these appointments are often used for acute anterior eye problems, any additional time taken for imaging increases time pressure further.^{15 16}

Practitioners expressed the belief that improving referrals for anterior eye conditions was not likely to have a significant impact on the Hospital Eye Service. Anterior eye pathologies are often slow to progress and typically do not require immediate referral on identification, such as eyelid lumps or pigmented lesions. As articulated by Practitioner 4, anterior eye pathologies requiring referral to secondary care are relatively low in number, and priority may be better given to other areas of eye care. This is supported by a previous study indicating that the majority of anterior eye referrals come from GPs rather than optometrists.⁷

Previous research has shown a wide range in referral accuracy among optometrists.⁶ A number of factors have been found to influence false positive rates, including gender, number of years of experience and practice type.⁶ In the present study, it was suggested by

one practitioner that career breaks and/or fear of litigation, particularly if an optometrist has undergone a Fitness to Practice investigation by the General Optical Council (GOC), may increase referral rates. Although some evidence supports this, explicit investigation is still lacking.^{6 17} Clinician experience has been found to have the greatest impact on false positive rates, which is perhaps not surprising.⁶ With the current changes in optometric education, where UK optometrists will no longer be assessed by a single professional body during the Scheme for Registration, there is the potential for referral rates to become more varied depending on where students receive their education. While minimising false positive referrals is important, it is also crucial to ensure that false negatives do not increase, which is a more challenging metric to assess.

There are several limitations associated with this research. It is important to consider that the practitioners who volunteered to receive a camera are likely to be more engaged and enthusiastic than the average optometrist in practice, introducing potential self-selection bias. Those participants who did not take part may likely have different views, as they may not be practitioners who are more proactive with new technologies or schemes. This may be illustrated by the differing response rates: 36% of practices in the area responded to the invitation to receive a camera. Of those who received a camera, 50% responded to our invitation to take part in an interview, likely indicating the higher engagement of this particular cohort of practitioners. It should also be noted that there was an over-representation of independent optometrists and practice owners, which is likely to have influenced participant responses. More engaged practitioners may already feel confident in their clinical decision-making, thereby not fully using the anterior eye camera for referral purposes. These practitioners may not necessarily be those who would benefit the most from the equipment provided. Attracting optometrists who are less confident, and finding approaches to encourage their participation in similar studies, would be beneficial but such an undertaking would pose a considerable challenge. Incorporating input from a diverse range of practitioners and patients from an early stage of study design could help identify and address potential difficulties before they arise.

There may of course be other reasons for non-participation. Those who are not practice owners themselves may have wished to take part, but may not have had the authority to sign up to receive a camera. No non-franchised multiple practices signed up to receive a camera, which may indicate corporate constraints prohibiting involvement in research studies without central approval. The lack of remuneration may have put off practitioners who were otherwise interested, particularly if they already felt time-pressured in a busy practice. Alternatively, the practice may simply already have means by which to take anterior eye images. The lack of input from non-participating practices is a substantial limitation,

and as such the reasons presented here to explain non-participation are purely speculative.

In conclusion, this study demonstrated the importance of openly sharing negative findings from any research, in order to learn from all available evidence. Improving NHS services is of paramount importance, however it must be recognised that every practice is unique, and therefore a one-size-fits-all approach may not be appropriate.

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Contributors CJD acts as guarantor of the data. Conceptualisation, methodology, data collection, data analysis, writing (all stages): all authors. Data curation: LR and CJD. Project administration: CJD. Visualisation: CJD and NG-M.

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Competing interests NG-M is an Editorial Board Member of BMJ Open Ophthalmology.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was conducted in accordance with the Declaration of Helsinki. As this study was an evaluation of an existing service and did not interfere with routine care, it was exempt from ethical consideration. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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QUESTIONNAIRE

I7(26)

Investigating the barriers to implementation of new technology in primary eye care: a qualitative study

INSTRUCTIONS

- Read through the article and answer the multiple-choice questions provided below.
- **Some questions may have more than one correct answer;** in which case you must mark **all** the correct answers.

Introduction

Question 1: What is the primary reason that the backlog in ophthalmology follow-up appointments is considered particularly dangerous for patients?

- A:** Avoidable vision loss is nine times more likely to occur in follow-up patients compared with new patients
- B:** Follow-up patients are typically much older and have more complex multi-system diseases
- C:** New patients are prioritized by NHS block contracts leaving follow-up patients without funding
- D:** Triaging protocols automatically reject follow-up patients if they miss their initial screening

Question 2: What was the primary hypothesis behind providing primary care practices with cameras to image anterior eye pathology?

- A:** It would allow optometrists to independently diagnose and treat all anterior segment conditions
- B:** It would reduce the financial costs associated with purchasing purpose-built slit lamp cameras
- C:** It would allow anterior eye referrals to be more accurately triaged
- D:** It would enable nurses to replace consultant ophthalmologists in secondary care settings

Materials and methods

Question 3: Why did a third member of the research team, who had not been present during the actual interview, review the audio recording?

- A:** To assess whether the interviewing researcher maintained a completely neutral and unbiased tone
- B:** To confirm whether the required information power and data saturation had been successfully achieved
- C:** To begin the preliminary process of independently coding themes for an inductive approach
- D:** To ensure that the transcript accurately represented the discussion that took place

Results

Theme 1: Practice autonomy

Question 4: TRUE or FALSE: The initiative coordinators opted for an easier-to-use adaptor even though it meant excluding some slit lamp models from the pilot?

- A:** TRUE
- B:** FALSE

Question 5: What specific concern did some practitioners raise regarding who would actually benefit from the intervention?

- A:** The intervention would primarily benefit private optical practices because they could charge a premium for digital imaging
- B:** Some practitioners raised concerns that this intervention would only benefit secondary care as the priorities of primary care are different
- C:** The intervention would disproportionately benefit younger patients who were more comfortable with digital health records
- D:** The intervention would only benefit consultant ophthalmologists by reducing their overall legal liability for misdiagnosis

Theme 2: Communication

Question 6: What was identified as a specific negative consequence of attempting to make the guidance document comprehensive?

- A:** It led to copyright issues regarding the extraction of photos from mobile devices
- B:** It confused practitioners who were already familiar with older referral portals
- C:** Ending up with a significantly lengthy document of how to use it, which might have put people off
- D:** It required mandatory in-person training sessions that practitioners could not attend

Theme 3: Financial and time costs

Question 7: Despite the equipment being fully funded, what created a financial disincentive for practitioners to use the new system?

- A:** There was a financial disincentive to attach images to referrals due to the time it took to capture and integrate the images
- B:** The requirement to pay monthly subscription fees for secure data storage
- C:** The necessity to hire additional administrative staff to manage the e-referral portal
- D:** The cost of upgrading practice computers to handle large image file sizes

Theme 4: Software and hardware issues

Question 8: What consequence was directly attributed to the large file sizes of the images captured by the provided cameras?

- A:** Practitioners had to frequently delete older patient records to clear space
- B:** Difficulties transferring images from the camera, with large file sizes leading to lag and storage issues
- C:** The e-referral portal automatically compressed the images causing a loss of diagnostic quality
- D:** Patients experienced longer appointment times waiting for images to upload

Question 9: What specific hardware issue did practitioners report regarding the interaction between the mount and the camera?

- A:** Some found that the mount interfered with the on/off button of the camera, such that they often couldn't set it up as desired
- B:** The mount lacked sufficient grip to hold the camera steady during high-magnification imaging
- C:** The mount was too heavy and caused the slit lamp illumination arm to drift out of focus
- D:** Some found that the mount blocked the camera lens when attached to older slit lamps

Question 10: Due to the equipment being awkward and time-consuming to set up, what alternative method did some practitioners employ to take images?

- A:** They referred patients to the local hospital for professional medical photography
- B:** They utilized their own personal smartphones instead of the provided TCL 30SE cameras
- C:** They asked the patient to hold the camera steady while looking into the slit lamp
- D:** They advised they would instead use the camera free-hand, holding the camera manually in front of the slit lamp eyepiece

Theme 5: Wider application of technology

Question 11: Why did many practitioners find the imaging equipment more useful for ongoing monitoring than for potential hospital triage?

- A:** Due to the immediate need for surgical intervention in retinal detachments
- B:** Due to the frequent requirement for daily photographic updates in primary care
- C:** Due to the often-slow progression of anterior segment pathology
- D:** Due to the strict legal requirement to document all healthy eye examinations

Question 12: Under what circumstance were practitioners more inclined to actually attach accompanying images to an anterior eye referral?

- A:** When they were entirely confident in their diagnosis and wanted to prove it
- B:** When there was less certainty
- C:** Only when the patient specifically requested that a photograph be sent to the hospital
- D:** When dealing with posterior segment pathology that required urgent surgical intervention

Discussion

Question 13: What alternative method of funding was suggested to better maintain practice autonomy regarding equipment?

- A:** Reimbursing practices per image successfully uploaded to the e-referral portal
- B:** Providing tax deductions for clinics that purchase their own dedicated slit lamp cameras
- C:** A grant towards equipment costs
- D:** Implementing a block contract system where funding increases with the number of referrals

Question 14: TRUE or FALSE: Previous studies have indicated that the majority of anterior eye referrals actually originate from general practitioners (GPs) rather than optometrists?

- A:** TRUE
- B:** FALSE

Question 15: What final conclusion does the study reach regarding the implementation of new NHS services across different optometric practices?

- A:** Standardizing equipment across all practices is the only way to ensure clinical safety
- B:** Every practice is unique and therefore a one-size-fits-all approach may not be appropriate
- C:** Pilot studies are unnecessary if the technology has been proven to work in secondary care
- D:** All primary care optometry practices should be legally required to adopt e-referral platforms

THE END



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ANSWER SHEET

17(26)

Investigating the barriers to implementation of new technology in primary eye care: a qualitative study

*Time spent on activity						hour					min				
	A	B	C	D	E		A	B	C	D	E		A	B	C
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2						9									
3						10									
4						11									
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6						13									
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How relevant was the content of this activity to your scope of practice?			
			
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