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ORIGINAL ARTICLE

Factors influencing glaucoma medication adherence: A qualitative study in the United Kingdom using the Theoretical Domains Framework

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ABSTRACT

Purpose: Long-term adherence to glaucoma medication is often suboptimal, compromising treatment efficacy and increasing the risk of glaucoma progression. Existing interventions have limited success. This study explored behavioral factors influencing adherence from the perspectives of United Kingdom (UK)-based patients with glaucoma and eye care professionals (ECPs), using the Theoretical Domains Framework (TDF).

Methods: Semi-structured interviews were conducted with adults prescribed intraocular pressure-lowering eyedrops whose adherence status was classified based on self-reported medication use and UK-registered ECPs involved in glaucoma care. Interview data were analyzed using deductive and inductive thematic analysis guided by the TDF to identify key barriers and enablers influencing adherence-related behaviors.

Results: Twenty-six participants were interviewed (13 patients and 13 ECPs). For patients, adherence was influenced by factors relating to knowledge and understanding of glaucoma, skills required to administer and obtain medication, memory and routine formation, beliefs about treatment necessity, social support, and healthcare system factors such as medication availability. ECPs identified time constraints, limited resources, and uncertainty in assessing adherence as key challenges, whereas communication skills, multidisciplinary support, and tailored decision-making were viewed as important enablers.

Conclusions: Glaucoma medication adherence is shaped by a complex interplay of behavioral, professional and systemic factors. Applying the TDF highlights modifiable influences on adherence and supports the development of targeted, theory-informed interventions to improve glaucoma outcomes.

INTRODUCTION

Glaucoma is a progressive optic neuropathy characterized by loss of retinal ganglion cells, leading to irreversible vision loss if untreated.¹ It is a leading cause of irreversible blindness worldwide, with prevalence projected to reach

111.8 million people by 2040.^{2,3} Lowering intraocular pressure (IOP) remains the only proven strategy to slow disease progression,⁴ most commonly achieved through long-term use of topical ocular hypotensive medications. However, the effectiveness of treatment is dependent on sustained patient adherence.⁵

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Adherence to glaucoma medication requires patients to adopt and maintain complex health-related behaviors over time.^{6,7} Despite its importance, adherence to long-term glaucoma therapy remains suboptimal,⁸ with reported rates ranging from 30% to 70% depending on definitions and measurement methods.⁹ Poor adherence is associated with faster disease progression, higher healthcare costs, and reduced quality of life.^{5,10,11} This can compromise patients' ability to carry out everyday activities, with implications for their independence and overall wellbeing. With an estimated 76 million people aged 40–80 living with glaucoma in 2020,³ even conservative adherence estimates suggest that a substantial number of individuals are at risk of preventable vision loss.¹² As the global burden of glaucoma increases, addressing medication adherence represents a critical and potentially modifiable determinant of improving clinical, social, and economic outcomes.

Understanding the factors that influence medication-taking behavior is essential for developing effective interventions. Although many adherence interventions focus primarily on patient behavior, the role of eye care professionals (ECPs) in identifying, supporting, and managing nonadherence is equally important. ECPs are responsible for assessing adherence during clinical encounters and recommending strategies to support patients; however, nonadherence is often difficult to detect accurately.^{13,14}

The United Kingdom (UK) Clinical Eye Research study, which aimed to identify research priorities for clinical eye care in the UK, recently ranked nonadherence to glaucoma medication among the top 10 priorities for glaucoma care.¹⁵ To develop effective, evidence-based strategies, it is essential to understand the behavioral determinants that facilitate or hinder correct eyedrop use. Interventions aimed at improving adherence are more likely to succeed when they target these underlying determinants of behavior.¹⁶

Behavioral science frameworks offer structured approaches for examining the determinants of health-related behaviors. The Theoretical Domains Framework (TDF) integrates constructs from multiple behavior change theories into 14 domains encompassing personal, social, and environmental influences on behavior.¹⁷ The TDF has been widely applied to medication adherence in other chronic conditions^{18–20} and is linked to evidence-based behavior change techniques (BCTs) that support the development of theory-informed interventions targeting the root causes of behavior.^{21,22} However, its application within glaucoma care remains limited.²³

Previous work has largely examined barriers and enablers to glaucoma medication adherence from the patient perspective alone. Few studies have applied a comprehensive behavioral framework to explore adherence-related behaviors from both patient and ECP perspectives within a single study. Addressing this gap is

Significance

Poor adherence to glaucoma medication remains a major barrier to effective treatment. This study identifies behavioral factors influencing adherence from both patient and clinician perspectives, using a validated framework. These insights can inform the development of tailored interventions that may improve outcomes and guide clinical management of nonadherence.

important for developing interventions that are feasible, acceptable, and effective in real-world clinical practice.

The aim of this study was to explore the behavioral factors influencing glaucoma medication adherence in the UK. Specifically, the study sought to identify key barriers and enablers to adherence from the perspectives of both patients with glaucoma and ECPs involved in their care and to determine which TDF domains are most relevant to adherence-related behaviors in each group.

METHODS

Standards and ethics

This manuscript follows the Standards for Reporting Qualitative Research guidelines.²⁴ Ethical approval was granted by the Research Ethics Committee of the Department of Optometry and Visual Science at City St George's, University of London, UK (Ethics Approval Number: ETH2122-1657). All participants provided written informed consent. The study adhered to the principles of the Declaration of Helsinki.

Study design

A qualitative study using semi-structured interviews was conducted to explore factors influencing glaucoma medication adherence. Interview guides were informed by the TDF, with questions mapped across the 14 domains. Separate interview guides were developed for patients and ECPs, each tailored to their specific adherence-related behaviors. Patient interviews focused on behaviors related to the use of eyedrops, whereas ECP interviews centered on their approaches to managing medication adherence in clinical practice.

Questions were designed to facilitate open discussion rather than systematically addressing each TDF domain, allowing participants to express their views freely.²⁵ The guides were informed by previous research²³ and recommendations from researchers within the team (A.S. and J.G.L.) experienced in

qualitative research and behavior change studies. Both guides were piloted with one patient and one ECP, and minor refinements were made based on feedback. Final interview guides are provided in Appendix 1.

Participants and recruitment

Two participant groups were recruited: adults currently prescribed or previously prescribed one or more IOP-lowering eyedrops and UK-registered ECPs (ophthalmologists, optometrists, orthoptists, or nurse practitioners) involved in glaucoma management in either primary or secondary care settings.

Patients were recruited via the charity Glaucoma UK (website, magazine, and telephone helpline) and social media (e.g., X formerly Twitter, LinkedIn). Purposive sampling aimed to ensure diversity in age, ethnicity, geographical location, number of prescribed eyedrops, and duration of use. ECPs were recruited through professional bodies (e.g., Royal College of Ophthalmologists, College of Optometrists, British and Irish Orthoptic Society), social media, and the UK and Eire Glaucoma Society (UKEGS) annual conference. The sampling aimed for diversity in profession, experience, ethnicity, and location.

Procedure

One-to-one interviews were conducted online via Zoom (San Jose, CA, Zoom Video Communications Inc.) by the same researcher (D.B.) between September 2022 and February 2023. The video was enabled to facilitate rapport. Interviews were audio-recorded, transcribed verbatim, and anonymized prior to analysis.

Sample size

Sample sizes were guided by principles of data saturation in theory-informed interviews.²⁶ Following the approach described by Francis et al.,²⁶ we predefined an initial analysis sample of 10 interviews, after which additional interviews were conducted until no new themes emerged in a pre-specified number of consecutive interviews ($n = 3$).

Researcher characteristics and reflexivity

The interviewer (D.B.) is an experienced ECP working in glaucoma care. Although this background supported rapport and contextual understanding, reflexivity was maintained throughout to minimize potential biases in data interpretation. D.B. actively reflected on how her professional experience might influence data collection and interpretation, always trying to ensure that participants' perspectives were accurately represented.

Data analysis

Data were organized using NVivo 12 software (QST International, <https://lumivero.com/products/nvivo/>). Analysis was conducted separately for patients and ECPs to preserve the distinct perspectives of each group, using a combined content and framework approach (see Figure 1).²⁷

Transcripts were first coded deductively to the 14 TDF domains using a coding framework developed collaboratively by the research team. Within each domain, patient responses were classified as enablers when they were described as facilitating correct and consistent eyedrop use and as barriers when they reflected factors that hindered or disrupted medication use, irrespective of the adherence group. ECP responses were classified as enablers when they were perceived to support adherence management and as barriers when they represented challenges to identifying or supporting adherence. Inductive thematic analysis was then undertaken within each domain to identify patterns and generate themes representing key barriers and enablers to glaucoma medication adherence.

Coding was performed independently by two researchers, with discrepancies resolved through discussion and iterative refinement of the coding framework. Salient domains were identified using the established criteria of frequency (number of participants contributing to a domain), elaboration (number of themes generated within a domain), and spontaneity (extent to which responses were raised without prompting).^{28,29}

The most important TDF domains were subsequently mapped to the Behavior Change Wheel (BCW) using a systematic, structured approach guided by established TDF-BCW linking frameworks.³⁰ Two researchers independently reviewed each domain to identify the underlying behavioral sources (capability, opportunity, motivation) and the corresponding BCW intervention functions. Any discrepancies were discussed and resolved through consensus. The mapped domains then guided the identification of relevant BCTs using the Theory and Techniques Tool, which provides validated links between mechanisms of action and BCTs, supporting transparent and theoretically grounded selection of BCTs.³¹

RESULTS

Participant characteristics

Thirteen patients and 13 ECPs participated. Patient interviews ranged from 28 to 75 min (mean 57 min), and ECP interviews ranged from 25 to 55 min (mean 40 min). Data saturation was reached after 13 interviews in each group.

Based on self-reported medication use over the previous month, 10 patients described themselves as adherent (missed eyedrops once or not at all in the past month), 2 as unintentionally nonadherent, and 1 as intentionally nonadherent. Seven of the ECPs were qualified to prescribe

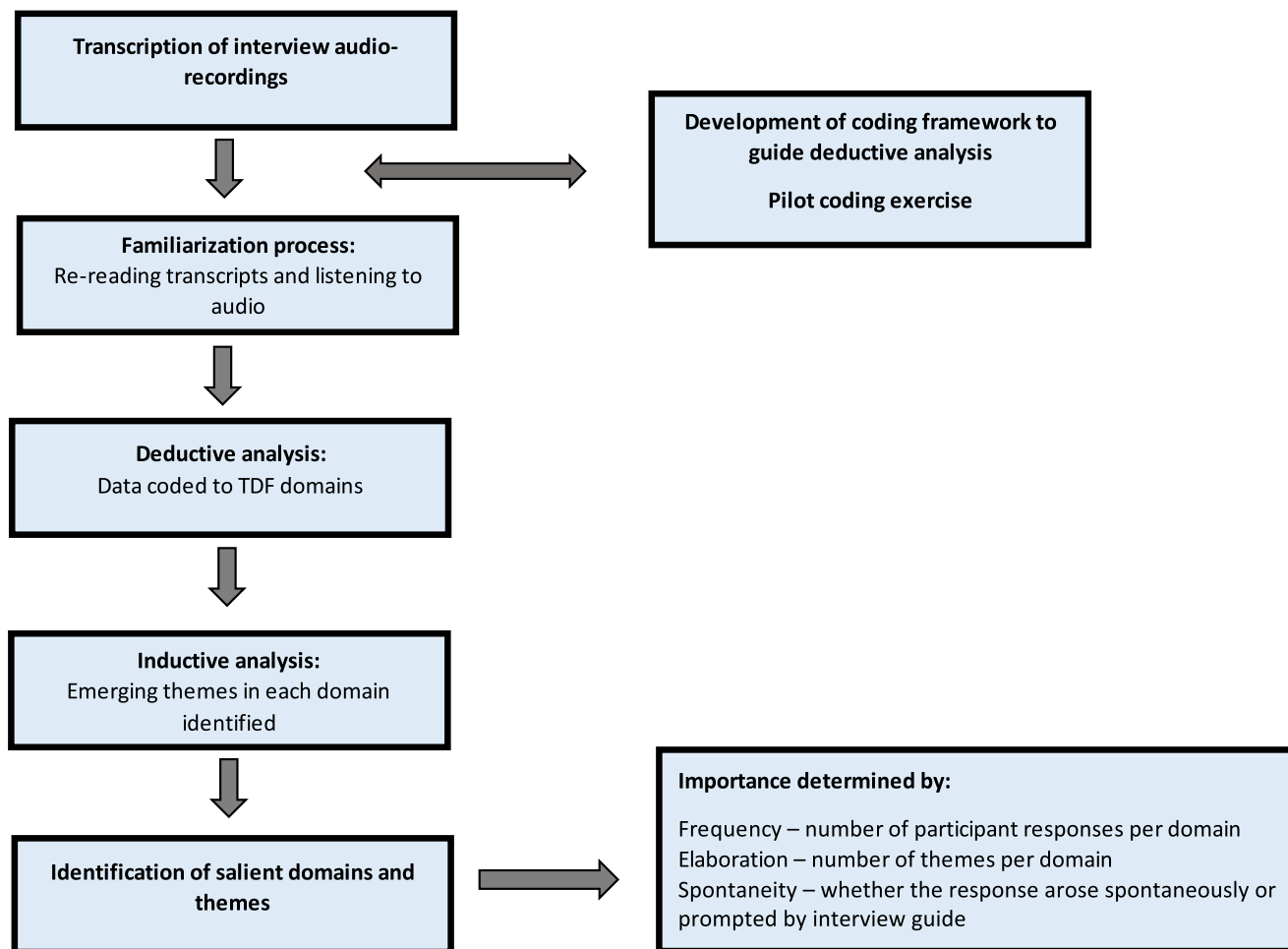


FIGURE 1 Flow chart representing step-by-step process of data analysis. TDF, Theoretical Domains Framework.

glaucoma medications. Participant characteristics are summarized in Table 1 (patients) and Table 2 (ECPs).

Overview of salient TDF domains

Barriers and enablers to glaucoma medication adherence were identified across 12 of the 14 TDF domains for patients and 11 domains for ECPs. Using the established criteria of frequency, elaboration, and spontaneity, nine domains were identified as particularly salient for patients and seven for ECPs (Table 3). A summary of the themes generated within these salient domains is presented below, with particular attention to contrasts between participants who classified as adherent and nonadherent. Illustrative quotations are provided in Table 4 (patients) and Table 5 (ECPs).

Patient perspectives

Patient adherence behaviors were most frequently associated with the domains of *environmental context and*

resources; skills; goals; memory, attention, and decision processes; social influences; behavioral regulation; knowledge; beliefs about capabilities; and beliefs about consequences.

Commonly reported barriers included disruptions to routine, difficulties obtaining medication (including pharmacy stock shortages and prescription delays), physical challenges with drop instillation, particularly early in treatment, and forgetfulness. Forgetting to instill eyedrops was more frequently reported by nonadherent patients; however, adherent patients described it became more challenging to remember to instill them at the correct time when they were particularly tired. Health system factors, such as limited access to clinics or difficulties contacting services, were also described as barriers.

In contrast, enablers included practical skills related to ordering and organizing medication supplies (e.g., forward planning, electronic prescription ordering, and home delivery services), the establishment of routines, access to social support, confidence in administering eyedrops, and understanding the purpose of treatment. Although adherent patients generally demonstrated awareness of the role of eyedrops in controlling IOP, gaps in practical

TABLE 1 Patient participant demographics.

Patient demographics		N (%) N = 13 total
Gender	Female	6 (46)
	Male	7 (54)
Age (years)	31–45	1 (8)
	46–60	4 (31)
	61–74	6 (46)
	75–90	2 (15)
Ethnicity	White British	11 (85)
	White Other	1 (8)
	Afro-Caribbean	1 (8)
Location	England	11 (85)
	Wales	1 (8)
	Scotland	1 (8)
Highest level of education	School education (up to 16)	3 (23)
	School education (up to 18)	2 (15)
	Degree or higher	8 (62)
Occupational status	Full-time job	6 (46)
	Part-time job	2 (15)
	Retired	5 (38)
Type of glaucoma (according to patient)	POAG	9 (69)
	PACG	2 (15)
	2° glaucoma	2 (15)
Number of topical glaucoma medications ^a	1	4 (33)
	2	4 (33)
	3	1 (8)
	4	3 (25)
Duration of glaucoma eyedrop usage (years)	<5	4 (31)
	5–10	3 (23)
	11–20	3 (23)
	30–35	2 (15)
	>50	1 (8)
Number of eyedrop instillations per day ^a	1	4 (33)
	2	2 (17)
	>2	6 (50)
Eyedrop administration ^a	Self-administer	10 (83)
	Dependence on others	2 (17)

^aP009 currently not using eyedrops since surgery in 2021 hence N = 12.

knowledge, particularly regarding timing and technique, were reported by unintentionally nonadherent participants. Beliefs about preserving vision and confidence in

TABLE 2 ECP participant demographics.

ECP demographics		N (%) N = 13 total
Gender	Female	11 (85)
	Male	2 (15)
Age (years)	18–30	3 (23)
	31–45	6 (46)
	46–60	4 (31)
	>60	0 (0)
Ethnicity	White	6 (46)
	Asian	6 (46)
	Afro-Caribbean	1 (8)
Location in UK	London	7 (54)
	Yorkshire	2 (15)
	Liverpool	1 (8)
	Kent	1 (8)
	Birmingham	1 (8)
	Cornwall	1 (8)
Profession	Optometrist	3 (23)
	Ophthalmologist	4 (31)
	Orthoptist	4 (31)
	Nurse practitioner	2 (15)
	Other	0 (0)
Time worked in glaucoma care (years)	<1	1 (8)
	5–10	6 (46)
	11–16	4 (31)
	21–26	2 (15)

sustaining long-term treatment were prominent among adherent patients, whereas skepticism about treatment necessity and doubts about ongoing use were reported by the intentionally nonadherent participant.

Eye care professional perspectives

For ECPs, adherence management was primarily associated with *environmental context and resources; social/professional role and identity; beliefs about capabilities; knowledge; skills; memory, attention, and decision processes; and behavioral regulation*.

Time constraints, limited staffing, and lack of educational resources were frequently identified as barriers to addressing adherence in clinical practice. Medication availability and inconsistencies in prescribing by other healthcare professionals (HCPs), such as primary care physicians (PCPs), were also reported to complicate adherence management. In contrast, multidisciplinary team structures, involvement of glaucoma nurses or Eye Clinic Liaison Officers (also known as ECLOs),³² and issuing clinic letters directly to patients were identified as enablers.

TABLE 3 Relevance of Theoretical Domains Framework (TDF) domains to medication adherence based on frequency, elaboration, and spontaneity for patients and eye care professionals (ECPs).

TDF domain	Patient group			TDF domain	ECP group		
	Frequency (number of patients reporting barriers/enablers within domain, max <i>N</i> = 13)	Elaboration (number of themes per domain)	Spontaneity (frequency of spontaneous response)		Frequency (number of ECPs reporting barriers/enablers within domain, max <i>N</i> = 13)	Elaboration (number of themes per domain)	Spontaneity (frequency of spontaneous response)
Environmental context and resources	13	4	0	Environmental context and resources	13	5	2
Skills	12	2	0	Social/professional role and identity	12	1	1
Goals	13	1	0	Beliefs about capabilities	13	1	0
Memory, attention, and decision processes	13	1	0	Knowledge	12	1	0
Social influences	11	1	2	Skills	12	1	0
Behavioral regulation	13	1	0	Memory, attention, and decision processes	11	1	0
Knowledge	11	1	1	Behavioral regulation	6	1	3
Beliefs about capabilities	10	1	0	Reinforcement	6	1	0
Beliefs about consequences	8	1	2	Social influences	4	1	0
Emotion	5	1	0	Beliefs about consequences	4	1	0
Social/professional role and identity	3	1	0	Goals	2	1	1
Intentions	2	1	0	Optimism	0	0	0
Optimism	0	0	0	Intentions	0	0	0
Reinforcement	0	0	0	Emotion	0	0	0

Note: Frequency indicates the number of participant responses per domain, elaboration the number of themes per domain, and spontaneity the number of unprompted responses.

ECPs viewed adherence management as a core professional responsibility, particularly among prescribing clinicians. However, confidence in identifying non-adherence varied, with many expressing uncertainty when relying on patient self-reporting. Uncertainty regarding how to define acceptable adherence further hindered consistent management. Communication and patient education skills were described as important enablers and were perceived to improve with experience. Tailoring treatment decisions to individual patient circumstances, including simplifying regimens or considering alternative treatments such as selective laser

trabeculoplasty (SLT), was also described as supporting adherence management.

DISCUSSION

This study used the TDF framework to identify behavioral barriers and enablers influencing glaucoma medication adherence. A key strength is its dual focus on patients and ECPs, addressing a notable gap in the glaucoma adherence literature. Although previous research has largely examined patient-reported factors,^{33–35} this is, to

TABLE 4 Summary of key themes and illustrative quotes from patients assigned to TDF domains identified as relevant to adherence behavior.

Theme	Barrier/enabler/ mixed	Illustrative quote(s)
TDF domain: Knowledge		
An understanding of glaucoma and treatment rationale	Enabler	'to keep your pressure down to reduce the damage at the back of your eye...ultimately, reducing that damage is going to slow down sight loss' (P003).
TDF domain: Skills		
Skills needed to order ongoing supplies of eyedrops	Enabler	'I signed up with Lloyds Direct...I just request [my eyedrops] by mail' (P007).
Poor physical skills and/or lacks vision required to instill eyedrops	Barrier	'my hands were very swollen and weak...I had trouble opening the bottle, especially when it was new' (P012).
TDF domain: Beliefs about capabilities		
Believing can continue to use eyedrops long-term	Enabler	'I'm completely confident that I can continue doing it' [instilling eyedrops] (P013).
TDF domain: Beliefs about consequences		
Believing eyedrops are necessary to preserve sight	Enabler	'when I decided I'm stopping medications, I didn't stop my eyedrops...to me that has been far more important than all the other tablets...I suppose it's the preserving of eyesight' (P001).
TDF domain: Goals		
Not wanting to lose sight/go blind	Enabler	'It would be pretty disastrous for the lifestyle we lead' [losing eyesight] (P002).
TDF domain: Memory, attention, and decision processes		
Forgetting to instill eyedrops as prescribed	Barrier	'I can be quite forgetful about putting my drops in...at least once a week I forget to put them in' (P012).
TDF domain: Environmental context and resources		
Change in lifestyle	Barrier	'It's even trickier when you go away' [instilling eyedrops] (P008).
Difficulties obtaining medication	Barrier	'but that one [Simbrinza eyedrops] repeatedly would be out of stock' (P009).
Issues within the healthcare system	Barrier	'Even when I got the secretary's phone number, left a message. No one called me back'. [when patient had an issue with eyedrops] (P005).
Nature of eyedrop container	Enabler	'I always carry the pilocarpine...It's a Minim...it just fits...in your jeans' (P010).
TDF domain: Social influences		
Positive social influence from family/partner/charities/HCPs	Enabler	'One thing that's motivated me to follow the regime more correctly, has been a session I had just by accident—Glaucoma UK did a small workshop one morning' (P001).
TDF domain: Behavioral regulation		
Developing a routine and/or reminder strategies	Enabler	'I'm going to bed this is the perfect time. Put my head on the pillow, Brenda then just puts the eyedrops in, gives me a good-night kiss, job done' (P007).

Note: Codes such as P001 refer to anonymized patient participants.

Abbreviation: TDF, Theoretical Domains Framework.

our knowledge, the first study to systematically explore adherence-related behaviors from both perspectives using a shared theoretical framework. The findings expand the current understanding of adherence, highlighting its complexity, shaped by interacting personal, professional, and system-level influences rather than any single determinant.^{23,36}

Interpretation of key findings

From the patient perspective, adherence was supported by understanding the purpose of treatment, confidence in the ability to use eyedrops long-term, and strong motivation to preserve vision. These enablers were most evident among participants who described consistent

TABLE 5 Summary of key themes and illustrative quotes from eye care professionals assigned to TDF domains identified as relevant to adherence management behavior.

Theme	Barrier/enabler/ mixed	Illustrative quote(s)
TDF domain: Knowledge		
Difficulties classifying an acceptable level of adherence	Barrier	'it's difficult to have an exact cut-off' (ECP009 Ophthalmologist).
TDF domain: Skills		
Practitioner communication, education, and clinical skills	Enabler	'I ask them an open-ended question about their drops...in a way that they're going to feel comfortable to say, I'm not really using them' (ECP004 Optometrist).
TDF domain: Social/professional role and identity		
Professional role in the management of adherence	Enabler	'we have a duty to make sure we've educated the patient so... they understand why they're on treatment' (ECP005 Orthoptist).
TDF domain: Beliefs about capabilities		
Perceived confidence/lack of confidence in own ability to identify nonadherence	Mixed	'I would feel fairly confident...trying to identify people who are adherent' (ECP008 Ophthalmologist). Enabler 'I've got no idea...as a clinician, you don't really know' [if patient is adherent or not] (ECP004 Optometrist). Barrier
TDF domain: Memory, attention, and decision processes		
Tailoring decision-making process according to patient needs	Enabler	'I'm looking at why they're not compliant, if they're suitable for a selective laser trabeculoplasty' (ECP013 Optometrist).
TDF domain: Environmental context and resources		
Lack of time	Barrier	'we've only got a finite amount of time...that can be a bit of a barrier' (ECP005 Orthoptist).
Lack of resources (manpower/materials)	Barrier	'there's less resources out there...we used to get District Nurses involved but that's really difficult... nowadays you haven't got those options' [to help patients put their eyedrops in] (ECP001 Nurse practitioner).
Multidisciplinary team/organizational structure	Enabler	'they have dedicated ophthalmic nurses within the glaucoma team...they work very well to communicate levels of questions to their patients...that's helpful' (ECP008 Ophthalmologist).
Issuing clinic letters directly to patient after their appointment	Enabler	[I] 'always give a letter...if they get home and are confused about the regime then they can look at the letter and it's all documented what drops they're to take' (ECP001 Nurse practitioner).
Lack of availability of medications	Barrier	'on more than a few occasions [patients] not being able to get the actual drops due to [PCPs] not continuing prescribing' (ECP011 Orthoptist).
TDF domain: Behavioral regulation		
Action planning and/or habit formation	Enabler	[I attended] 'a talk about educating patients and sight loss in glaucoma...following on from that I started using [visual illustrations] in my own practice' (ECP005 Orthoptist).

Note: Codes such as ECP001 refer to anonymized eye care professional participants. Abbreviations: GP, general practitioner; TDF, Theoretical Domains Framework.

routines, adequate physical ability to instill drops, perceived treatment as essential to protecting their eyesight, and had access to social support. In contrast, barriers emerged when these internal drivers were disrupted by practical challenges, including forgetfulness, lifestyle changes, physical difficulty with instillation

(particularly early in treatment), and problems accessing medication due to prescription delays or stock shortages. Importantly, unintentionally nonadherent patients often demonstrated good conceptual understanding of glaucoma but reported gaps in practical knowledge, such as timing or instillation technique, suggesting that

knowledge alone is insufficient to ensure sustained adherence.

ECPs regarded adherence management as a core professional responsibility, yet their ability to support patients was constrained by environmental and systemic factors. Time constraints, limited resources, and reliance on patient self-reporting made it difficult to accurately identify nonadherence or provide tailored support. Uncertainty around how to define acceptable levels of adherence further complicated decision-making. Despite these challenges, practitioners emphasized the value of communication skills, patient education, and multidisciplinary working as key enablers of effective adherence support.

A central finding was the misalignment between patient and practitioner perspectives. Although many patients expressed confidence in their understanding and self-management of their condition, ECPs frequently questioned the reliability of self-reported adherence. This disconnect highlights the limitations of subjective assessment alone and suggests a need for structured, nonjudgmental conversations that normalize adherence difficulties and encourage open disclosure. Framing adherence as a shared challenge rather than non-adherence as a patient failure may help bridge this gap.

Medication availability emerged as a shared barrier across both groups. Patients reported interruptions due to pharmacy stock shortages, whereas ECPs described difficulties arising from delays or errors in repeat prescriptions, especially from other HCPs. These disruptions not only place an additional burden on patients, who have to go to extra lengths to source ongoing supplies, but also increase the workload for practitioners and hospital staff as they handle additional patient queries,³⁷ reinforcing the view that adherence is a system-level issue rather than solely an individual behavior.

Value of the Theoretical Domains Framework

The TDF enabled the systematic identification of salient, modifiable influences on adherence using predefined criteria and facilitated interpretation beyond descriptive theme generation, highlighting how multiple domains interact to shape behavior. Importantly, the framework also provides a structured pathway for intervention development through its linkage with the BCW³⁸ and the Behavior Change Technique Taxonomy (BCTT).³⁹ In this study, key TDF domains were mapped to relevant BCW intervention functions (e.g., *education, training, environmental restructuring*) and policy categories (e.g., *legislation, service provision, and guidelines*) to inform the selection of appropriate intervention strategies. The BCTT was then used to specify the likely 'active ingredients' of these strategies, using standardized terminology, such as *instructions on how to*

perform the behavior, prompts or cues, and behavioral practice/rehearsal. The recently developed 'Theory and Techniques Tool' further supported this process by linking specific BCTs to their underlying theoretical domains.⁴⁰ Together, the BCW and BCTT provide a transparent, theory-driven rationale for the intervention components proposed in this study, increasing the likelihood that they are both effective and reproducible.⁴¹ Similar theory-informed approaches have shown success in improving medication adherence in other chronic conditions, such as type 2 diabetes.⁴²

Implications for practice

Improving glaucoma medication adherence requires a coordinated, multi-level approach.

Patient-level interventions

Strategies should reinforce the understanding of glaucoma and treatment necessity, develop practical instillation skills, and support habit formation through routines aligned with daily life.

Patient education is essential, as understanding glaucoma and its treatment impacts adherence.^{43–45} Studies suggest that when healthcare professionals explain the treatment rationale, provide guidance on drop administration, and discuss glaucoma progression, patients report greater intention and perceived capability to adhere to therapy, although direct evidence of improved adherence is not established.²³ This aligns with the TDF domains *knowledge and beliefs about consequences* and the corresponding BCW intervention functions of *education* and *training*, which promote understanding and skill development.

Establishing a routine also supports adherence and is consistent with findings from other qualitative studies.^{33,46} Routines draw on the TDF domains of *behavioral regulation* and *memory, attention, and decision processes*. Developing a routine that aligns with a patient's lifestyle, rather than requiring substantial lifestyle changes, is likely to encourage automatic, habitual adherence behaviors.^{47,48} Interventions incorporating BCTs, such as *prompts or cues* and *self-monitoring*, could help facilitate this.

Social and family support, linked to the TDF domain *social influences*, plays a key role in adherence. This mirrors findings from other chronic conditions, such as diabetes, where support networks have been shown to improve self-management.^{49,50} Integrating personalized education, behavioral strategies, and tailored support systems to promote habit formation could further support adherence and align with the BCW intervention function *environmental restructuring*.

Practitioner-level interventions

Clearer guidance from professional regulatory bodies on defining and detecting nonadherence may help standardize adherence management practices. Training programs informed by BCTs, such as *instruction on how to perform the behavior* and *feedback on the behavior*, could improve ECP practice. Online, CPD-accredited modules on adherence strategies, effective patient communication, and glaucoma management updates could offer accessible, flexible training solutions. BCW policy categories, such as *guidelines and service provision*, could help support these initiatives.

Tailored clinic letters providing relevant and accessible information, summarizing diagnosis, treatment, and dosing schedules may reinforce patient understanding and recall, addressing *environmental context and resources* and aligning with BCW functions of *education* and *training*. Providing patients with supportive information in an understandable, digestible, and relatable manner follows best practice and encourages patients to take greater responsibility for managing their condition.^{51,52}

For patients who continue to experience adherence difficulties despite support, alternative therapeutic strategies such as SLT may offer a means of maintaining IOP control while reducing reliance on long-term topical therapy.⁵³ Current guidance in the UK, United States, and Europe recognizes SLT as an initial or adjunctive option for ocular hypertension and primary open-angle glaucoma.^{54–56} Given the medication access and adherence challenges identified in this study, SLT may represent an appropriate treatment for certain patients, although its effect may not be sufficient or sustained in all cases, and while uncommon, complications can arise.^{57,58}

System-level interventions

Addressing structural barriers, such as high patient volumes, limited clinic time, and resource shortages, could further enhance adherence. These barriers fall under the TDF domain of *environmental context and resources* and can be addressed through structural reforms. A multidisciplinary approach incorporating contributions from allied health professionals, utilizing each professional's expertise in areas such as patient education, clinical management, and administrative support, aligns with the BCW function of *environmental restructuring*. Such strategies could help create a more integrated care environment, streamlining patient management within busy clinics.

Promoting electronic prescribing, linked to the TDF domain of *environmental context and resources*, has the potential to reduce prescription errors, simplify the prescription process, and improve prescription quality.⁵⁹ A coordinated care model that includes pharmacists, primary care providers, and glaucoma specialists could

provide patients with a seamless, supportive environment. Pharmacy policies focused on stock availability and optimizing resource distribution further support consistent adherence and align with *environmental restructuring*.

Strengths and limitations

The dual-perspective, theory-based design provides a comprehensive view of adherence that integrates patient, professional, and system influences. Inclusion of ECPs from diverse professional backgrounds enhances the relevance of our findings, reflecting the increasingly multidisciplinary nature of glaucoma care in the UK, where shared-care models are often adopted to meet rising demand.^{54,60,61}

However, several limitations should be acknowledged. Adherence classification relied on self-reporting, which is known to overestimate true adherence.^{62,63} This limitation is particularly salient given the high proportion of participants who self-identified as adherent, meaning that individuals experiencing greater difficulty may be underrepresented. As a result, the dataset may disproportionately reflect enablers rather than barriers, limiting the depth of insights into more severe adherence challenges. Recruitment through patient support networks and social media may have introduced selection bias toward more engaged individuals. Additionally, Afro-Caribbean patients, who experience higher glaucoma prevalence⁶⁴ and lower adherence,^{65,66} were underrepresented; the sample was relatively highly educated compared with the general population⁶⁷; and all ECPs were based in England, which may limit transferability.

Future research directions

Future research should evaluate the acceptability and feasibility of theory-informed intervention components identified in this study, with particular emphasis on codesign with diverse and underrepresented patient groups. Multicomponent interventions addressing behavioral, professional, and system-level influences should be piloted and tested for effectiveness in improving adherence and clinical outcomes.

CONCLUSIONS

Glaucoma medication adherence is a complex, multi-level behavior influenced by patient capabilities, practitioner practices, and health system structures. By integrating patient and ECP perspectives using the TDF, this study provides a foundation for designing targeted, theory-informed interventions. Addressing adherence through

coordinated, people-centered strategies has the potential to improve clinical outcomes, support practitioner decision-making, and reduce preventable vision loss in glaucoma care.

AUTHOR CONTRIBUTIONS

Deborah Bott: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; writing—original draft; writing—review and editing. **Ahalya Subramanian:** Conceptualization; data curation; formal analysis; investigation; methodology; writing—review and editing. **David F. Edgar:** Conceptualization; data curation; formal analysis; investigation; methodology; writing—review and editing. **John G. Lawrenson:** Conceptualization; data curation; formal analysis; investigation; methodology; writing—review and editing. **Peter Campbell:** Conceptualization; data curation; formal analysis; investigation; methodology; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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APPENDIX 1

INTERVIEW TOPIC GUIDE

Patient interviews

Introduction

'My name is _____, a researcher at City, University of London. The main purpose of this interview is to understand your experiences using eyedrops in glaucoma'.

'I will also be interviewing eye care practitioners to understand their experiences of eyedrop compliance in practice and how they manage it. I plan to use the information gained from these interviews to help me develop some form of technology-based solution to help patients use their eyedrops correctly'.

'Have you read the participant information sheet that you have been provided with?'

'I will just re-cap some information. The interview should last about 45 minutes. Everything you say will be kept strictly confidential. You are free to stop participating at any time with no consequences. You do not need to answer any questions that you do not wish to. I will be audio recording the interview so that I don't have to take too many notes and can listen to what you are saying. After the interview any identifiable information, such as your name, will be removed'.

'Please feel free to be open and honest about your experiences using eyedrops. There are no right or wrong answers, we are keen to learn from your experiences both positive and negative'.

'Are you happy to take part in this interview? Before we start do you have any questions?'

Complete consent form

'I'm going to start recording now'.

Demographic information

'I'd like to ask some questions about yourself first. This information will be used to describe the people who took part in our study, all your responses will be combined so you will not be identified'.

Please can you confirm:

- your gender, ethnicity, where you live in the country—first part of your postcode

- what age range you fall into (18–30, 31–45, 46–60, 61–74, 76–90, 91+)
- what is your highest level of education (e.g., school/college—up to 18 years old, graduate, postgraduate)?
- your employment status
- if you live alone/with family members (if yes ask which members)
- what type of glaucoma do you have (if known)?
- how long approximately have you been using eyedrops for glaucoma?
- is this the first type of eyedrop you have used/have you been changed to a different type? If yes do you know how many times they been changed?
- what drops are you currently taking—how many times a day do they go in? Do not worry if you do not remember the names of the drops
- do you instill your eyedrops yourself/family member/carer?
- do you pay for your prescriptions?
- how often do you have check-ups for your glaucoma?
- you have no visual difficulties/have visual difficulties but not formally registered as sight impaired/registered as sight impaired/registered severely sight impaired

Questions aligned with domains of Theoretical Domains Framework (TDF)

1. Do you know why you take your eyedrops? (*Knowledge domain*).
Prompts—explore understanding of glaucoma and rationale for using eyedrops and possibility of losing vision.
2. On a daily basis do you have any problems putting your eyedrops in? (*Skills domain*).
Prompts—if yes, explore why, maybe have problems with opening bottle due to arthritis in hands/unable to see to put your drops in/drops keep running down the cheek.
3. If answer yes to above question—even though you have some difficulties putting your drops in, how confident are you that you can continue using your drops as prescribed (i.e., once/twice a day) on a long-term basis? (*Beliefs about capabilities*).
If answer no to above question—as you do not experience any difficulties putting your drops in on a daily basis, how confident are you that you can continue to use your drops as prescribed (i.e., once/twice a day) on a long-term basis? (*Beliefs about capabilities*).
4. Is it important to you to use your eyedrops as instructed? (*Goals domain*).
Prompt—explore why.
5. What do you think the benefits of using your eyedrops correctly are?
What do you think the disadvantages of not using your eyedrops correctly are? (*Beliefs about consequences*).

6. Who do you think is responsible for making sure your eyedrops are used correctly every day? (*Social/professional role and identity domain*).
Prompt—your eye practitioner, your general practitioner (GP), you, your family/carer.
7. Is there anything/anyone that would make you more likely to use/not use your eyedrops as you should? (*Reinforcement domain*).
Prompt—praise from your eyecare practitioner/family or receiving negative feedback from your practitioner.
8. If you use your eyedrops correctly, how likely do you think it is that this will help you maintain your vision/stop your glaucoma from getting worse? (*Optimism domain*)
9. If you think about how you use your eyedrops each day, is there anything that makes it easier for you, anything that makes it harder? (*Environmental context and resources domain*).
Prompts—being away on holiday, being dependent on a carer/family member to instill drops/not obtaining repeat prescriptions from pharmacy/GP in time.
10. Is there anything that you do/or could do to overcome these problems? (*Behavioral regulation domain*).
Prompt—habits/techniques or practical strategies employed.
11. Does anyone else influence your decision to take your eyedrops? (*Social influences domain*).
Prompt—family members/carers/support groups/healthcare professionals (HCPs).
12. Do you ever forget or deliberately not use your eyedrops? If yes, how often have you not used your eyedrops? Is there any reason that would lead to this decision? Have you forgotten to use your eyedrops in the past month? (*Memory, attention, and decision processes domain*).
Prompt—forgetting when go away on holiday, side effects using drops so purposefully do not use.

‘Thank you for your time today, I really appreciate you sharing your views and experiences. Is there anything else you would like to add that I haven't covered? Do you have any questions?’

Eye care practitioner interviews

Introduction

‘My name is _____, a researcher at City, University of London. The main purpose of this interview is to hear about your experiences managing glaucoma medication adherence in practice’.

‘I will also be interviewing patients to learn about their experiences with glaucoma medication. We will use the information from both practitioner and patient interviews to guide the development of a potential intervention to help with glaucoma medication adherence’.

'Have you read the participant information sheet that you have been provided with?'

'I will just re-cap some information. The interview should last about 45 minutes. Everything you say will be kept strictly confidential. You are free to stop participating at any time with no consequences. You do not need to answer any questions that you do not wish to. I will be audio recording the interview so that I don't have to take too many notes and can listen to what you are saying. After the interview any identifiable information, such as your name, will be removed'.

'Please feel free to be open and honest about how you feel. There are no right or wrong answers, we are keen to hear your views and learn from your experiences both positive and negative'.

'Are you happy to take part in this interview? Before we start do you have any questions?'

Complete consent form

'I'm going to start recording now'.

Demographic information

'I'd like to ask some questions about yourself first. This information will be used to describe the people who took part in our study, all your responses will be combined so you will not be identified'.

Please can you confirm:

- your gender, ethnicity, where you practice in the country—first part of postcode
- what age range you fall into (18–30, 31–45, 46–60, 61–74, 76–90, 91+)
- your job title and role within glaucoma care
- how long have you been qualified as an eye care practitioner? How long have you been involved in glaucoma care?
- do you work in hospital, community practice, or both?
- on average how many glaucoma sessional clinics a week are you involved in?
- only for nonophthalmologists—do you issue prescriptions to glaucoma patients? Are you an independent prescriber or do you issue by other means, for example, PGD?

Questions aligned with domains of Theoretical Domains Framework (TDF)

1. In practice, how do you usually assess whether a patient is taking their eyedrops as prescribed? (*Skills domain*).

Prompt—subjectively ask patient/family member about adherence, what questions would you ask, use a questionnaire, what questionnaire would you use?

Do you provide education regarding glaucoma/treatment/adherence/advice on how to instill eyedrops? How do you do this?

2. How do you classify a patient as nonadherent? Do you think nonadherence is a problem in your clinic? Why? (*Knowledge domain*)

Prompt—is missing once/twice a week/month etc., nonadherent?

3. Whose role do you think it is to ensure patients comply with their treatment? Why do you think this? (*Social/professional role and identity*)

4. How important do you feel it is to actively manage patient adherence to treatment? What influences your approach? What are the main outcomes you aim for when supporting a patient's adherence? (*Beliefs about consequences*)

5. How confident do you feel in your ability to identify if a patient is adherent or nonadherent to their medication? Why do you feel that? (*Beliefs about capabilities*)

6. When a patient is having difficulty using their eyedrops correctly, how do you determine the most appropriate adjustments to their treatment or select an alternative approach? (*Memory, attention, and decision processes domain*).

Prompt—if developing side effects, how do you manage, do you consider SLT or surgical intervention as an alternative? If a patient is struggling with dosing regimen due to hectic lifestyle, how do you amend treatment to suit patient?

7. In clinic, are there any resources, tools, or colleagues that make it easier for you to manage nonadherence? Conversely, are there any factors that make it more challenging to support patients who struggle to adhere to their treatment? (*Environmental context and resources domain*)

Prompt—dedicated glaucoma nurses, dedicated adherence clinics, educational resources, not enough time, too many patients to see, not enough staff to support smooth running of clinic.

8. How do you keep up to date/remain consistently aware of glaucoma medication adherence and its management? (*Behavioral regulation domain*).

Prompt—use of guidelines/recommendations, CPD, courses, conferences.

9. When it comes to managing patient adherence, what are your main goals or priorities in clinic? How do these goals guide your actions or interactions with patients? (*Goals*)

'Thank you for your time today, I really appreciate you sharing your views and experiences. Is there anything else you would like to add that I haven't covered? Do you have any questions?'