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# Patient acceptability of intravitreal complement inhibitors in geographic atrophy (GA): protocol for a UK-based cross-sectional study

Christiana Dinah ,[1,2] Jamie Enoch ,[3] Arevik Ghulakhszian,[4] Mandeep Sekhon,[5] David P Crabb,[6] Deanna J Taylor[6]

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[1]Ophthalmology, London North West Healthcare NHS Trust, Harrow, UK
[2]Department of Brain Sciences, Imperial College London, London, UK
[3]City University of London, London, UK
[4]Ophthalmology Department, Central Middlesex Hospital, London, UK
[5]Population Health Research Institute, St George's University of London, London, UK
[6]Department of Optometry and Visual Science, City University, London, UK

**Correspondence to**
Christiana Dinah;
christiana.dinah@nhs.net

## ABSTRACT

**Introduction** Geographic atrophy (GA) is the advanced form of the non-neovascular ('dry') type of age-related macular degeneration (AMD). Previously untreatable, complement inhibitors delivered by regular intravitreal injections have recently been demonstrated to slow down the progression of GA lesions in phase 3 trials. One such treatment, Syfovre (pegcetacoplan), was approved by the US Food and Drug Administration in February 2023. These therapies slow down, but do not stop or reverse, the progression of GA; they may also increase the risk of developing the neovascular ('wet') type of AMD. In light of these developments, this study aims to quantify the acceptability of these new intravitreal injection treatments to patients with GA in the UK and explore factors that may influence the acceptability of these treatments.

**Methods and analysis** In this cross-sectional, non-interventional study, the primary objective is to determine the proportion of patients with GA that find regular intravitreal therapy acceptable for slowing the progression of GA. We will use a validated acceptability questionnaire in order to quantify the acceptability of new treatments among patients with GA. The correlation between acceptability and functional and structural biomarkers of GA will be established. We will also explore demographic, general health and ocular factors that may influence acceptability. 180 individuals with a diagnosis of GA will be recruited from 7 to 8 participating National Health Service trusts across the UK. Multiple regression analysis will be conducted to determine the simultaneous effects of multiple factors on patient acceptability.

**Ethics and dissemination** The study received ethical approval from the Health Research Authority on 14 March 2023 (IRAS Project ID: 324854). Findings will be disseminated through peer-reviewed publications and conference presentations to the medical retina community, as well as through dialogue with patients and macular disease charities.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This multicentric quantitative study will allow us to quantify patient acceptability of new intravitreal complement inhibitor treatments for geographic atrophy (GA) and explore correlations between patient acceptability, patient demographics and structural/functional biomarkers of GA severity.
⇒ Our acceptability questionnaire draws on a robust, prevalidated questionnaire developed from the theoretical framework of acceptability.[11 28]
⇒ The face and content validity of the acceptability questionnaire has been strengthened through consultation with an advisory group of seven patients with lived experience of GA as well as clinical experts, maximising the comprehensibility and relevance of the questionnaire.
⇒ Despite best efforts to make information for questionnaires concise and comprehensible, there is the risk of response error, whereby participants may provide inaccurate responses if they do not fully understand the questions or are experiencing questionnaire fatigue.

## INTRODUCTION

### Background and rationale

Age-related macular degeneration (AMD) is the most common cause of sight loss in the developed world.[1] In the UK, geographic atrophy (GA) is estimated to account for 26% of legal blindness, and globally, approximately 5 million people have GA in at least one eye.[2]

Patients with GA generally develop regions where the cells die in the retina. Loss of vision due to GA is irreversible, and about half of patients develop GA in both eyes within 7 years of initial diagnosis.[3]

Regular intravitreal injections (injections into the eye) are the standard of care for wet AMD and a common mode of delivery in the current pipeline of treatments for GA in clinical trials. Dysregulation of the complement cascade has been implicated in the pathogenesis of GA, and recent positive results from phase 3 clinical trials of two intravitreal complement inhibitors have paved a way for new therapies to treat GA.[4]

Findings from the DERBY and OAKS trials of pegcetacoplan have shown that at 24 months, GA lesion growth was reduced by 21% with monthly intravitreal injections

and 17% with every-other-monthly injections.[5 6] In the GATHER2 phase 3 trial of avacincaptad pegol, monthly intravitreal injections significantly reduced the mean rate of GA growth over 12 months by 14.3%.[7] Indeed, in February 2023, the first-ever treatment for GA, pegcetacoplan (brand name Syfovre), was approved for use by the Food and Drug Administration (FDA) in the USA, based on reduced rates of lesion growth in the DERBY and OAKS trials.[8] In August 2023, avacincaptad pegol (brand name Izervay) was approved by the US FDA for clinical use, on the basis of reduced rates of GA growth in the GATHER1 and GATHER2 clinical trials.[9 10] Despite these promising developments, the patient perspective on these treatments—specifically whether they perceive the anticipated benefits of these treatments to outweigh the potential burdens and risks of treatment—is unknown.

Acceptability has become a key consideration in the design, evaluation and implementation of healthcare interventions.[11] If an intervention is considered acceptable, patients are more likely to adhere to treatment recommendations and to benefit from improved clinical outcomes. While intravitreal therapies are now a mainstay of ophthalmology practice with over 400 000 intravitreal injections delivered annually in the UK alone, the current indications for treatment such as wet AMD, diabetic macular oedema and retinal vein occlusions are very different to GA. Despite evidence of patients receiving intravitreal injections for wet AMD experiencing anxiety, stress and fear of burdening relatives and carers,[12–14] the vast majority of wet AMD patients are highly motivated to attend these appointments.[15] Indeed, the prevalence of sight loss due to wet AMD has significantly reduced globally since the introduction of intravitreal injections for treatment.[16 17] Factors that have been demonstrated to influence non-adherence and non-persistence to intravitreal injection in wet AMD include lower visual acuity at baseline, worsening visual acuity with treatment, distance to treatment centre and high frequency of injections.[18 19]

In contrast to wet AMD, where a loss of vision is typically sudden and treatment leads to improvements in vision, disease progression and vision loss in GA are a gradual process. In addition, there is significant heterogeneity in the progression of GA and a lack of consensus on methods to accurately predict GA lesion trajectory.[20 21] Moreover, proposed treatments for GA may slow down vision loss but will not improve vision.[5 7] There is a lack of detailed understanding of the structure-function relationship in GA in order to understand structural changes that actually have an impact on a patient's visual function and to monitor disease and determine the benefit of any intervention on the disease process.[22]

It is not yet known whether patients with GA will be similarly motivated to adhere to frequent intravitreal treatments, how often they would be willing to undergo them and what factors would make such treatments acceptable to patients with GA.

We recently conducted a pilot mixed-methods qualitative cross-sectional study with 30 individuals diagnosed with GA to understand the impact these new therapies may have from a patient's perspective.[23] We sought to identify patient-related factors, contexts and circumstances that influence acceptability. Approximately 60% of the cohort found regular intravitreal therapy for GA acceptable while recognising potential burdens and inconveniences. The key underpinning motivation for treatment for people with GA, which emerged in our study, is the high priority placed on continuation with vision-specific activities, particularly for those in worse self-reported health. The factors limiting acceptability were largely clustered around concerns about the magnitude of treatment efficacy, fear of wet AMD and side effects (and, to a lesser extent, the injection procedure itself) and logistics of regular eye clinic visits for treatment. Importantly, we noted a large rise in acceptability when injections were offered every other month compared with monthly. As every-other-monthly injections are associated with an approximately 50% reduction in increased incidence of wet AMD in the phase 3 trials,[24] this dosing regimen seems to address two of the three main factors found to limit acceptability in our pilot study. Less frequent injections may also reduce the cumulative risks of procedure-related adverse events, such as endophthalmitis.

Patient-centred care involves patients being active members and shared decision-makers in their own healthcare.[25] This necessitates patients being empowered with evidence-based information tailored to them and being supported to evaluate the potential impact of these healthcare decisions. In England, the National Institute for Health and Care Excellence (NICE) works to centrally incorporate shared decision-making into the delivery of information about care and treatment, supported by patient decision aids.[26]

The current study seeks to confirm the factors that influence patient acceptability of intravitreal complement inhibitor therapies for GA in a larger, more generalisable UK cohort. We will seek to confirm the demographic factors and treatment attributes that influence patient acceptability using a quantitative questionnaire based on the theoretical framework of acceptability (TFA)[11] and insights gained from our pilot study and expert input. We hypothesise that patients with GA with lower best-corrected visual acuity (BCVA) in their better-seeing eye would be more likely to find the current regular intravitreal therapies in late-stage development acceptable and that reduction in the frequency of injections would correlate with higher acceptability. The correlations between acceptability, patient demographics and functional and structural biomarkers of GA will also be examined. We anticipate that our results will influence future drug development, creation of shared decision-making tools (such as those developed by National Health Service (NHS) England[27]) and service design and delivery in the event these treatments are approved for use in clinics. Specifically, this study will tell us more about the specific features around intravitreal treatments that patients with GA find unacceptable, which could then be addressed at the drug development

stage or mitigated during the service delivery stage if the treatments are approved in the UK.

### Study objectives

The principal objective of this study is to determine the proportion of patients with GA that find regular intravitreal therapy acceptable for slowing the progression of GA, using a quantitative questionnaire.

The secondary objectives of this study are to:

- Determine the correlation between overall patient acceptability (as determined by the adapted TFA-based quantitative questionnaire)[28] and functional and structural biomarkers of GA.
- Determine the correlation between demographic, general health and ocular factors and the overall acceptability score.
- Determine the correlation between specific items of the acceptability questionnaire and the overall acceptability score.

## METHODS AND ANALYSIS

### Study design

This is a cross-sectional, non-interventional study. Informed consent will be obtained prior to the collection of any data. Participant eligibility is determined based on BCVA and optical coherence tomography (OCT) documented as per routine standard of care.

Consenting participants will be administered a demographic questionnaire, the EuroQoL five-dimensional (EQ-5D) questionnaire and the National Eye Institute Visual Function Questionnaire 25 (NEI VFQ-25). Subsequently, the participant will be provided with a GA treatment information sheet briefly explaining GA, the new intravitreal treatments in late-stage development and the attributes of these treatments, including potential risks and benefits. (The details contained in this GA treatment information sheet are included in online supplemental appendix 1.) After this, the quantitative acceptability questionnaire will be administered (displayed in online supplemental appendix 2).

Following the questionnaires, autofluorescence will be performed.

It is important that the questionnaires and visual acuity tests are performed prior to any dilation of the participants' pupils. Therefore, autofluorescence is to be performed after the questionnaires, or the questionnaires may be administered in the above order remotely after the clinic visit if required for patient convenience, but this must be done within 28 days of the baseline visit. In this scenario, the patient would have been consented and the BCVA and retinal imaging performed in clinic as per routine clinical care.

Details regarding these distinct steps of the study are discussed below in turn. A summary of the study procedure is shown in figure 1.

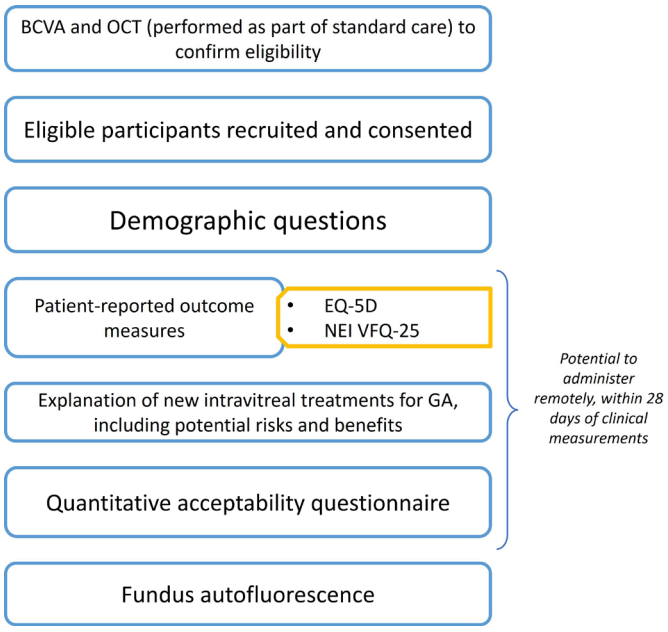


**Figure 1** Flow chart showing study procedure. BCVA, best-corrected visual acuity; EQ-5D, EuroQoL five-dimensional; GA, geographic atrophy; NEI VFQ-25, National Eye Institute Visual Function Questionnaire 25; OCT, optical coherence tomography.

### Best-corrected visual acuity (BCVA)

Many patients with GA may have good BCVA due to fovea sparing.[29] As such, BCVA may not capture the full impact of GA on a patient's visual function. BCVA will be assessed using the Early Treatment Diabetic Retinopathy Study (ETDRS) chart under routine clinic conditions as part of routine clinical care.

### Fundus autofluorescence (FAF)

Fundus autofluorescence (FAF) is an imaging technique used to determine the retinal area affected by GA. By blue-light or green-light fundus FAF, areas of GA appear as well-demarcated areas of decreased signal intensity.[30] The high-contrast discrimination of atrophic versus non-atrophic areas by FAF has provided a reproducible method for accurate quantification of lesion area, and this method has been adopted in various clinical trials.[31] Autofluorescence is performed as part of routine clinical care.

### Spectral domain OCT (SD-OCT)

Spectral domain OCT (SD-OCT) is the current reference standard for diagnosing and monitoring progression in GA.[32] It captures the cross-sectional morphology of retinal structures and allows a detailed assessment of anatomical layers affected by the disease.[33] The distance to the fovea and foveal involvement is easily measured with SD-OCT; these measures influence the impact of GA on visual function (with foveal involvement, rather than GA progression, more highly correlated with visual acuity)[34] and thus may correlate with acceptability of regular intravitreal injections. SD-OCT is performed as part of routine clinical care.

### EuroQoL five-dimensional (EQ-5D)

The EQ-5D is a validated 5-item questionnaire, widely used for assessing the health-related quality of life. It is based on five health dimensions that can be used to describe the patient's generic health state from their own perspective.[35] The five dimensions are mobility, self-care, usual activities, pain/discomfort and anxiety/depression.

### National Eye Institute Visual Function Questionnaire 25 (NEI VFQ-25)

The NEI VFQ-25 is a validated 25-item questionnaire assessing how vision impairment influences functional vision and multiple dimensions of vision-related quality of life, with evidence of robust psychometric properties.[36] It is the most commonly used patient-reported outcome measure in retinal research and trials and has been shown to correlate with visual function and structural biomarkers, especially of the better-seeing eye.[37] The NEI VFQ-25 has been demonstrated in large clinical trials in patients with GA to be a reliable and valid cross-sectional measure of the impact of GA on patient visual function and vision-related quality of life.[38]

### Quantitative, TFA-based acceptability questionnaire

TFA was developed in response to recommendations that acceptability should be assessed in the design, evaluation and implementation phases of healthcare interventions.[11] TFA consists of seven component constructs (affective attitude, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness and self-efficacy) that can help to identify characteristics of interventions that may be improved. Using this robust framework, a validated generic TFA-based quantitative questionnaire was developed as an adaptable tool to measure acceptability across various healthcare interventions.[28]

We have adapted the prevalidated generic TFA quantitative questionnaire using insights from our pilot mixed-methods study,[23] our patient advisory group, expert clinical opinion and a literature review.

### Patient and public involvement statement

A patient advisory group composed of seven individuals with lived experience of GA has been involved since the beginning of the Acceptability of Geographic Atrophy INjections study.[39]

Specifically in terms of the present study, the first draft of the adapted quantitative TFA-based questionnaire has been discussed with our patient advisory group. This feedback was incorporated and shared with eight further patients living with GA and one lay member of the public to assess for comprehension, comprehensibility and relevance (face validity). Concurrently, we obtained feedback on the study information sheet and the acceptability questionnaire from six experts who regularly manage patients with GA. The final version of the questionnaire, thus, incorporates input from patients, members of the public and medical experts. Feedback from patient advisors, thus, helped to improve the wording of the questionnaire items and responses, thus improving comprehensibility, while retaining the overall structure of the prevalidated questionnaire. Throughout this process of adapting the generic TFA questionnaire to make it more specific to GA, we drew on the concept of think-aloud studies, recommended as a method to elicit patient feedback on acceptability questionnaires.[28] The process of developing the questionnaire and testing of content validity through involvement of patients and the public is the topic of a forthcoming paper, where we will discuss in detail how input from the patient advisory group helped transform and improve the questionnaire. The patient advisory group will also be involved when writing up and developing a lay summary of the findings, as took place for the writing up of the pilot study.[23]

## Participants

### Eligibility criteria

In order to understand the impact of new therapies from the perspective of the patient, we aim to recruit 180 patients with GA from geographically dispersed regions in the UK, of whom a maximum of 100 can have wet AMD or previous intravitreal injection in their fellow eye.

### Inclusion criteria

Inclusion criteria are as follows: (1) ≥60 years of age; (2) diagnosis of GA in either one or both eyes; (3) GA lesion of at least 0.5 disc area in size, as measured on FAF; (4) visual acuity ≥24 in ETDRS letters or 6/96.

### Exclusion criteria

- Macular disease in either eye due to causes other than AMD (eg, diabetic macular oedema and Stargardt disease).
- Previously treated wet AMD or retinal pigment epithelium rip in GA eye (this aligns with the exclusion of GA eyes previously treated for wet AMD in phase 3 trials such as DERBY/OAKS and GATHER2).
- Any concurrent ocular or intraocular condition that could contribute to central visual impairment.
- Significant systemic disease or medication known to affect central visual function (eg, high doses of hydroxychloroquine and associated with retinal toxicity).[40]
- Unable to understand, process or retain information to understand consent process and instructions for study tests.

### Recruitment

180 individuals with GA will be identified from the GA patient database at 10 geographically dispersed participating NHS trusts across the UK (in Wales, South England, North England and West of England).

Individuals identified to be eligible will be approached in clinic by their consultant ophthalmologist or a member of the clinical team, who will explain the background, aims and nature of the project and provide further information about the project in a participant information sheet (PIS) in an accessible format. Potentially eligible participants who have previously given consent to contact

Table 1 Table showing sample size calculation (based on an approximate acceptability of 60% in favour of geographic atrophy (GA) injections, as found in the pilot study)[23]

| % willing to have regular therapy | Margin of error (%) | Sample size | |
|---|---|---|---|
| | | Initial calculation | With 10% withdrawal |
| 60% | ±5% | 369 | 410 |
| 60% | ±6% | 256 | 285 |
| 60% | ±7% | 188 | 209 |
| 60% | ±7.5% | 164 | 182 |
| 60% | ±8% | 144 | 160 |
| 60% | ±9% | 114 | 127 |
| 60% | ±10% | 92 | 103 |

for research can be approached by the research team by telephone, and if willing to consider participating, the PIS can be sent by post. There will be an opportunity to discuss the study before consent is obtained in the clinic, and it will be made clear that the individual is free to withdraw from the study at any point.

### Sample size

We hypothesise that intravitreal complement inhibitor therapy will be acceptable to most people with GA despite potential drawbacks. The primary analysis will be to calculate the proportion of people with GA who will be willing to have regular intravitreal complement inhibitor therapy for GA. Based on our pilot data, these treatments were acceptable to 60% of participants (95% CI ±19), in a sample size of 30. With 164 participants, the prevalence can be estimated with a 95% confidence level and 7.5% width, for example expected to be between 52.5% and 67.5%. The formula of sample size calculation is based on a study reported by Dupont and Plummer.[41] We will allow for less than 10% withdrawal rate and therefore round up the required sample size to 180. Our sample size calculation is displayed in table 1. Consecutive patients with GA who meet the criteria will be invited to participate.

### Outcome measures

The primary outcome measure for this study will be the proportion of patients that find regular (ie, either monthly or every-other-month) intravitreal injections for GA acceptable.

Secondary outcome measures will be (1) the correlation between acceptability of intravitreal complement inhibitor therapy for GA with demographic factors, general health and ocular factors, including BCVA, GA area and fovea-centre involvement, and (2) the correlation between acceptability and vision-related quality of life as measured by the NEI VFQ-25.

### Data analysis

We will perform descriptive analyses to calculate means and proportions for demographic and GA characteristics. We will also investigate the correlation between overall acceptability and patient demographics and clinical profiles (including the previous experience of intravitreal injections for wet AMD in the fellow eye). Furthermore, we will explore correlations between overall acceptability and functional biomarkers and structural biomarkers of GA, including BCVA, area of GA, nearest edge of GA to the fovea centre point and unifocal or multifocal GA. In addition, we will analyse the relationship between various acceptability questionnaire items and overall acceptability, using Pearson product-moment correlations and Spearman's rank correlations (ie, we will correlate the subscale scores within the acceptability questionnaire to the total acceptability score to see if any component construct is a particularly strong predictor of overall acceptability). We will do the same with the NEI VFQ-25 (ie, correlate NEI VFQ-25 subscale scores with the total acceptability score and the global NEI VFQ-25 score with total acceptability score). We will conduct regression analyses to determine the simultaneous effects of multiple factors on patient acceptability.

## ETHICS AND DISSEMINATION

### Ethical considerations

The study received a favourable opinion from the Proportionate Review Subcommittee of the NHS South Central-Berkshire Research Ethics Committee on 7 March 2023 (REC reference: 23/PR/0192). Full ethical approval from the Health Research Authority was granted on 14 March 2023 (IRAS Project ID: 324854).

The project will meet the requirements and principles set by General Data Protection Regulations 2018 and the European Medicines Agency (Good Clinical Practice guidelines). The study will be conducted in accordance with the recommendations for physicians involved in research on human subjects adopted by the 18th World Medical Assembly, Helsinki 1964 (including later revisions), and any other relevant ethical guidance. Any subsequent changes to the study conduct, design or management will be notified to original approving R&D department and any other relevant regulatory authority via a substantial amendment.

The investigator will preserve the confidentiality of participants taking part in the study and will work in accordance with the Caldicott Principles, Data Protection Act 2018 and any relevant NHS trust organisational policies. Data for each patient will be entered on electronic case record forms on Qualtrics, which is a secure electronic database licensed to the sponsor. All data will be anonymised with no patient identifiers. Unique identifiers will be used, and the key for pseudoanonymisation shall be stored on a hospital server at the local site, with access only available to study investigators. Christiana Dinah (chief investigator) will act as the guardian of the data received at the sponsor site. Data will be stored for 5 years after the study completion date.

### Dissemination and planned outputs

The researchers will publish outputs from this work in high-impact peer-reviewed publications in ophthalmology

and health service research journals. The results will also be presented at conferences including the Royal College of Ophthalmology Annual Congress, EURETINA and the Association for Research in Vision and Ophthalmology and the College of Optometrists conferences.

With the data derived from WP1 and WP2, we will create a patient decision aid to support shared decision-making for patients with GA in England. In the longer term, we will conduct further validating assessments to confirm responsiveness and suitability for use as a secondary endpoint in future GA trials. As this is not a clinical trial, the trial will not be registered on a database; however, a summary will be publicly available on the Health Research Authority website.

Participants may opt to receive a summary of the research findings at the conclusion of the study. A lay summary document will be compiled with input from our patient advisory group, describing the findings in lay terms.

All findings from the study will be made available to the medical community and to the GA patient community via the Macular Society, the Royal National Institute of Blind People and other eye care charities.

All researchers who have been involved in the project will have authorship of the paper and responsibility for the review and dissemination of the results. The Strengthening the Reporting of Observational Studies in Epidemiology checklist for cross-sectional studies will be used when reporting study results.[42]

The output of this programme of work has the potential to influence the development of patient education material for intravitreal complement inhibitors in the management of GA, shared decision-making tools for GA management, service design and delivery of these treatments and future evolution of these treatments for GA.

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**Contributors** Authors CD, DJT, JE, AG, MS and DPC designed the study and study protocol. CD and DJT acquired funding for the study. CD wrote the protocol for submission to the Health Research Authority, which JE adapted into this manuscript. All authors provided critical comment, revision and feedback on the manuscript and take responsibility for the manuscript content. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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**Competing interests** JE, AG and MS declare that they have no competing interests. CD has served on advisory boards for Novartis, AbbVie, Ora Clinical, Roche and Apellis. CD is on the scientific advisory board for Ora Clinical, has received speaker fees from Roche and Novartis and holds a research grant from Apellis. DPC reports grants from Roche, grants and personal fees from Santen, grants and personal fees from Apellis, grants from Allergan, personal fees from Thea, personal fees from Bayer and personal fees from Centervue, outside the submitted work. DPC receives funding from the Innovative Medicines Initiative 2 Joint Undertaking under grant 116076 (Macustar). This joint undertaking receives support from the European Union's Horizon 2020 research and innovation programme and European Federation of Pharmaceutical Industries and Associations (EFPIA). The communication reflects the author's view and that neither IMI nor the European Union, EFPIA or any associated partners are responsible for any use that may be made of the information contained there. DJT holds a research grant from Apellis. The authors report no other conflicts of interest in this work. The conflicts of interest reported will not influence the data collection, analysis and reporting of research findings.

**Patient and public involvement** Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

**Patient consent for publication** Not applicable.

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**ORCID iDs**
Christiana Dinah http://orcid.org/0000-0002-0815-4771
Jamie Enoch http://orcid.org/0000-0002-4614-6676

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