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Systematic Review of Educational Interventions to Improve Glaucoma Medication Adherence: an update in 2015

Paula Anne Newman-Casey, MD, MS^{1,2,3}, Megan Dayno, BS¹, and Alan L. Robin, MD¹

¹Department of Ophthalmology and Visual Sciences, University of Michigan, Ann Arbor, MI, USA

²Department of Ophthalmology, University of Maryland, Baltimore, MD, USA

³Departments of Ophthalmology & International Health, Johns Hopkins University, Baltimore, MD

Abstract

Purpose—To evaluate the current state of the research on educational interventions whose aim is to improve glaucoma medication adherence.

Methods—A systematic review of Pubmed, Embase and CINAHL was conducted to identify research studies evaluating educational interventions to improve glaucoma medication adherence. Studies were included if the intervention was described, the outcomes assessed glaucoma medication adherence, and the focus of the research was on adults with glaucoma. The search was conducted on June 2, 2015.

Results—Seventeen studies were identified that met the inclusion criteria. These included nine randomized controlled trials and eight observational studies. Eight of the studies demonstrated an impact on glaucoma medication adherence, though their outcome measures were too heterogeneous to estimate a pooled effect size..

Conclusion—The interventions that successfully improved glaucoma medication adherence used an adequate dose of face-to-face counseling to overcome barriers to health behavior change alongside education about glaucoma.

Introduction

Although multiple randomized, controlled clinical trials have demonstrated the effectiveness of glaucoma medications, glaucoma medication adherence remains a major public health problem. The Ocular Hypertension Treatment Study demonstrated that using medications to reduce intraocular pressure resulted in a 54% decrease in the rate of developing glaucoma over five years.¹ The Early Manifest Glaucoma Trial found a 50% reduction in risk of glaucomatous progression over 6 years among patients treated with trabeculoplasty and topical therapy compared to an untreated control group.²⁻³ The recently completed United Kingdom Glaucoma Treatment Study demonstrated that medical treatment reduced the risk

Corresponding author: Paula Anne Newman-Casey, University of Michigan, 1000 Wall Street, Ann Arbor, MI 48104, Phone: 734-936-9503, Fax: 734-936-2340.

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of glaucomatous progression by 44% in just two years.⁴ Together, these landmark studies highlight the importance of using glaucoma medication to reduce the burden of vision loss from glaucoma. However, despite the availability of excellent treatments for glaucoma, it remains a leading cause of blindness in the US and in the world.

A critical contributing factor to continued vision loss from glaucoma is poor medication adherence. Multiple reviews of the glaucoma adherence literature have demonstrated rather dismal rates of medication adherence, reporting a wide range of adherence levels depending on the method used to measure adherence.^{5,6,7} The most recent review of medication adherence in 2011 reported that when patients were not being directly observed using electronic medication monitors, about half (56%) had filled enough of their prescriptions to have their prescribed medication available for their continuous use. Only about one-third (31%) persisted in taking their therapy one year after it was initially prescribed without any gaps in treatment. In a study by Newman-Casey and colleagues of longer-term (four year) adherence to glaucoma medications assessing prescription refill claims data among 1,234 glaucoma patients, 48% filled less than one-third of their prescriptions.⁸ Even when people are monitored electronically and know their adherence is being assessed, approximately 20% miss doses of medication across many different medication classes.

The World Health Organization stated that improving adherence may have “a far greater impact on the health of the population than any improvement in specific medical treatments,”⁹ and the literature on glaucoma medication adherence underscores this need. Developing programs to support patients' self-management of their glaucoma is as crucial as developing new medications, and there is a growing literature describing the development and evaluation of new education programs to better support glaucoma patients' medication taking behaviors. The NIH recommends that any educational intervention aimed to improve health and well-being be based in behavioral theory, therefore, we will evaluate whether these new programs were developed using behavioral theory.

We first reviewed the nascent literature on educational interventions aimed to improve glaucoma medication adherence in 2011. We identified that successful programs were likely to include in-person counseling to collaborate to overcome patient's barriers to optimal adherence.¹⁰ In 2013, a Cochrane review was published evaluating all interventions whose purpose was to improve glaucoma medication adherence. They included randomized controlled trials (RCTs) of interventions ranging from education and counseling to simplified medication regimens to reminder devices. They identified 16 trials that met their criteria, and seven of those studies evaluated some form of patient education. Though the outcomes in this literature were too heterogeneous to calculate an overall estimate of effect, the review found that the educational interventions that were more complex because they were personalized and involved counseling were more likely to succeed.⁴⁵

Since these reviews, additional investigators have tested novel educational programs. The purpose of this systematic review is to identify and evaluate studies that have tested the impact of educational interventions on glaucoma medication adherence. Specifically, we will report the impact of each intervention on medication adherence and evaluate each study

based on its quality, the outcome measures used to assess adherence, and whether the intervention was based in behavioral theory.

Methods

Definition of Adherence

In this review, we will use the word “adherence” to describe the extent to which a patient administers his/her glaucoma medications exactly as prescribed. We will use the word “persistence” to describe the length of time over which a patient adheres to their medication. We will also describe the method by which adherence was measured.

Systematic Review Strategy

We conducted our systematic review using Pubmed, Embase and CINAHL to search the published literature available on June 2, 2015 using the following terms and medical subject headings (MeSH): “glaucoma,” and “education,” and “compliance,” or “adherence.” We used no language restrictions. We generated searches to account for synonyms of these keywords and MESH headings as follows: 1. “glaucoma” AND (“patient education as topic,” OR “health education,” OR “consumer health,” OR “patient education,” or “motivational interviewing,” or “instruction”), 2. “glaucoma” AND (“patient acceptance of healthcare,” OR “patient compliance,” OR “treatment refusal,” OR “self-efficacy,” OR “self-care,” OR “compliance,” OR “adherence,” OR “persistence,” OR “self-management.”) (Search strategy available online, Appendix 1).¹⁰

The searches generated 581 unique references. Two independent researchers (MD, PANC) evaluated the titles and abstracts of the articles to determine their eligibility for inclusion. Inclusion criteria were as follows: 1) evaluation of an educational intervention for adult patients taking glaucoma medications with a description of the educational program and 2) glaucoma medication adherence as an outcome measure. We excluded any interventions targeted towards children or juvenile glaucoma. We included observational studies along with randomized controlled trials due to the limited number of interventions that met the inclusion criteria. Seventy-four articles were initially identified as potentially relevant to this review.

Two researchers (PANC, MD) reviewed and discussed the seventy-four articles and came to a consensus that seventeen studies met inclusion and exclusion criteria. Fifty-five of the 74 studies were not included because they did not describe an educational intervention. One educational intervention was excluded because it focused on adolescents with glaucoma. Another educational intervention in which glaucoma patients served as peer health coaches was excluded because the manuscript described the intervention but did not describe any outcome data. A hand-search of the references of each of the 17 identified articles did not reveal any additional relevant articles.

The data was abstracted from the articles using a standard data collection form by one researcher (PANC) and independently verified by a second researcher (MD). The data included the following: study type, method of assessing adherence, participants included (number, type of glaucoma), description of the educational intervention, description of the

training for the staff member delivering the intervention, use of behavioral theory (Y/N, name of theory), impact on adherence, impact on satisfaction, quality score (Jadad score for RCTs, Ottawa-Newcastle score for observational studies). The primary outcome for this systematic review is the impact of the educational intervention on adherence. The secondary outcomes included the outcome measures used to assess adherence, whether the intervention was based in behavioral theory, the impact on patient satisfaction and the overall quality of the study.

Assessment of Outcome Measures

For each study, we classified the impact of the educational intervention on adherence as our primary outcome. Due to the heterogeneity of outcome measures used, we were not able to give an overall estimate of the effect of educational interventions on glaucoma medication adherence. The gold standard for measuring medication adherence is electronic monitoring where the time and date in which the glaucoma medication bottle was used is recorded. There are two medication events monitoring systems that have been widely used. There is the MEMS (Aardex, Switzerland) “bottle-in-bottle” technique where the glaucoma medication is placed inside a larger electronic pill bottle and every time the pill bottle is opened to remove the glaucoma medication, the time and date are recorded. The other system is called the Travatan Dosing Aid, which is a device that was developed by Alcon to fit onto Travatan or Travatan/Timolol combination medications and records the time and date that the bottle of glaucoma medication is opened.¹¹ A limitation to using electronic medication monitors to assess adherence is that this type of monitoring is subject to the Hawthorne effect. The Hawthorne effect occurs when patients improve their health behavior because they know they are being monitored.¹²

Three other ways of assessing different aspects of medication adherence are 1) tabulating the number of medication refills obtained over a given period of time, 2) self-report and 3) video-taping eye drop instillation. Video-taping eye drop instillation assesses only the ability to correctly administer the eye drops, but does not assess the extent to which the person is adherent. Self-reported adherence is known to be over-estimated compared to electronically monitored data.¹³ However, using a validated instrument to measure self-reported adherence is still a valuable tool for estimating adherence. Refill adherence is a less costly method of assessing adherence than electronic monitoring and is not subject to the Hawthorne effect or to the bias of self-report. One issue with refill data is that it is oftentimes difficult to obtain complete refill records in healthcare systems in which pharmacy data is not part of a closed system. In healthcare systems in which the pharmacy is part of a single payer system such as in the health care system in England or in the Veterans Affairs system in the United States, pharmacy refill data can be a much more accurate way of measuring adherence.

Assessment of Use of Behavioral Theory

Ideas from the various behavioral theories can help shape the way our healthcare system provides support for patients to manage their health. One of the first behavioral theories developed in the 1950s, called the Health Belief Model, addressed why people did not participate in screening tests for asymptomatic diseases. Psychologists and public health experts postulated that people would make changes in their health behavior, such as

undergoing screening tests, only if the individual perceived that the severity of the disease and the chance that they were susceptible to the disease was high enough to overcome any barriers to getting the test. The Theory of Reasoned Action then added that social norms also influence people's decision to make changes in their behaviors beyond the individual risk/benefit calculation postulated by the Health Belief Model. In the 1980s, Bandura's Social Cognitive Theory brought a new level of insight into behavior change by demonstrating that a person's belief that s/he can do the behavior, called self-efficacy, plays an important role in modulating behavior change. More recently, psychologists have demonstrated that people must not only have the ability to implement a behavior change, but they must also have the intrinsic motivation to do so. The idea that motivation is central to behavior change is part of Self-Determination Theory. Motivational interviewing (MI) is a counseling style stemming from Self-Determination Theory that aims to enhance intrinsic motivation to change behavior by helping the subject identify his/her own reasons that make behavior change important. In this review, we will assess whether each educational intervention studied was developed using behavioral theory.

Quality Assessment

The researchers (PANC, MD) assessed the quality of each randomized controlled trial using a modified Jadad score for the randomized controlled trials (RCTs)¹⁴ and a modified Newcastle-Ottawa Score for the observational studies¹⁵ (Appendix 2, available online). Jadad criteria assign a score out of a possible five points based on the adequacy of randomization, the provision of an apt description of subjects lost to follow-up, and whether or not the study was double masked, meaning that neither the outcomes assessor nor the participant knew if the participant was part of the treatment arm or the control arm of the study. In this review, the two points for a masked outcomes assessment were given if adherence was measured with pharmacy refill data or electronic monitoring. If adherence was only measured with self-report, this was not considered an un-biased outcomes assessment and was not given the two points.

The modified Newcastle-Ottawa Score assigns a score out of a possible five points depending on whether the cohort studied is representative of the population of interest, how disease status is ascertained (e.g. medical record vs self-report), whether the outcomes assessor is masked to the treatment status, whether the length of follow-up is appropriate and whether there is an adequate description of any losses to follow-up. In this review, studies received a point for appropriate length of follow-up if the follow up time was ≥ 6 months. Because it is not possible to have a true “placebo” arm in a behavioral intervention, studies were given a point for a masked outcomes assessment if adherence was assessed with pharmacy refill data or with electronic monitoring. If adherence was only assessed with self-report, the point was not given. Video-taping eye drop instillation was only considered as an adjunctive measure of adherence.

Results

Descriptions of the Educational Interventions

Seventeen studies met criteria for inclusion in this review. There were nine RCTs and eight observational studies that met criteria. These studies represent work done in the United States, the United Kingdom, Finland, Holland, Sweden and China. Of the nine RCTs, four demonstrated an improvement in medication adherence after their intervention. Of the eight observational studies, four demonstrated an improvement in adherence after their intervention (Table 1).

Randomized Controlled Trials—Among the RCTs that demonstrated a significant improvement in medication adherence after their educational intervention, one was in the US, two were in the United Kingdom and one took place in Sweden. In the US, Okeke and colleagues¹⁶ evaluated a program that included a ten minute educational video about glaucoma followed by individual discussions with the study coordinator to address barriers people had to adherence and identify strategies to integrate glaucoma medications into the daily routine. The study coordinator taught patients how to keep a medication log. She also called patients to remind them to take their medications weekly and then bi-weekly for three months. Patients also had an audible alert set on the electronic medication monitor as a reminder to take their medication. Okeke and colleagues included 66 non-adherent glaucoma patients, defined as those who took <75% of their doses of Travatan during electronic medication monitoring using the Travatan Dosing Aid. The intervention group had a significant improvement in adherence over baseline compared to the control group (54%-73% compared to 46% to 51%, $p<0.001$) at six months using electronic medication monitors.

In the UK, Gray and colleagues¹⁷ randomized 127 newly diagnosed patients with ocular hypertension or open angle glaucoma from a single eye hospital in England to a personalized individual healthcare assessment in addition to standard care or standard care with an ophthalmologist. The intervention began with a 75 minute counseling session with a glaucoma nurse to design a one year personalized follow-up plan. The session assessed and then addressed gaps in glaucoma knowledge, pre-existing beliefs, and the ability to manage an eye drop regimen. The nurse observed the patient instilling eye drops and then taught proper technique. Nurses collaborated with the patients to form a concrete plan of how to incorporate the eye drop regimen into the patient's daily routine. The same nurse met with each patient approximately five times throughout the year for approximately 15 minutes, either in-person or over the phone, to go over information about glaucoma, provide feedback about adherence and address any other concerns that arose. The number and length of follow-up visits was tailored according to each person's needs. All patients could call the nurse between visits for additional support.

Adherence was significantly higher in the intervention group (70% vs. 43%, $p=.002$) twelve months after the year-long intervention as measured with prescription refill data. There were significant differences in secondary outcomes as well. Intervention patients believed they had more control over influencing their glaucoma ($p<.001$), had a stronger belief in the necessity of drops ($p<.001$), and were more knowledgeable about glaucoma ($p<.001$). While

there was no significant difference in mean IOP (17.0 mmHg vs. 17.1 mmHg, $p=0.79$), there was a significant difference in IOP fluctuation. Control patients had more IOP fluctuation than the intervention patients (2.7 ± 1.5 mmHg vs 3.4 ± 1.5 mmHg, $p=0.013$), and intraocular pressure fluctuation is a risk factor for glaucomatous progression.¹⁸ About one-third (21/64) of intervention arm patients had changes in clinical management, including a change in the medical or surgical management of glaucoma, compared to one-half (32/63) of control arm patients ($p=0.036$).

Another randomized intervention in the UK that had more moderate success was that studied by Sheppard and colleagues,¹⁹ who evaluated a nurse-led education program compared to standard care with a physician among 73 glaucoma patients. The visit with the nurse was 15 minutes compared to the 10-minute physician visit. Half of the time with the nurse was spent educating the patient about their glaucoma type, their test results and addressing issues with adherence. Patients received educational brochures after their nurse visit. Significantly fewer patients in the nurse-led group reported problems with adherence ($p=0.04$).

An older randomized intervention evaluated by Norell in 1979²⁰ took place in Sweden and included 73 patients with high-tension glaucoma on pilocarpine three times daily. He evaluated the effect of a slideshow and leaflet about glaucoma and its treatment, followed by a counseling session with a research assistant to discuss any questions that might have come up after seeing the presentation and address any issues patients were having with their medications. The research assistant also worked with each patient to create a plan to match the timing of their glaucoma drops to activities in their daily routine. The intervention group had $9\% \pm 6.1\%$ fewer missed doses of pilocarpine than the control group ($p=0.0004$) as measured with custom made electronic medication monitors.

Five RCTs demonstrated no improvement in medication adherence after the educational intervention. Cate and colleagues²¹ evaluated a behavior change counseling program for 208 glaucoma patients in the UK. The counseling included glaucoma education and motivational support from trained para-professional staff, called “glaucoma support assistants” (GSAs). Para-professional staff went through seven hours of training in glaucoma and its treatment, barriers to adherence, and brief motivational-interviewing (MI) techniques. Brief motivational interviewing is an adaptation of MI for the busy health care setting, with sessions lasting between 5-30 minutes instead of the traditional 30-60 minutes. In this intervention, the GSA met with patients three times over eight months while the control group received standard care with a physician. Each GSA's counseling technique was assessed for fidelity to brief-MI techniques using standard measures. There was no statistically significant difference in the proportion of individuals with 80% adherence with 62.5% in the control group and 66.7% in the intervention group ($p = 0.63$) as measured with electronic medication monitors (the Travatan Dosing Aid).

Becker and colleagues²² evaluated the effects of multiple interventions on glaucoma medication adherence among 805 glaucoma patients taking Travoprost or Travoprost/Timolol in Holland over six months. They evaluated patient education, a reminder device and an eye drop guide. Patient education consisted of a 15-minute video explaining glaucoma and its treatment. There was no significant difference in adherence between

patients receiving education and those who did not (electronic medication monitoring revealed 18.4% non-adherent vs. 21.4% non-adherent, $p=0.52$). However, significantly more participants were non-adherent who received the drop guider, (24.4% non-adherent with the drop guider, 15.7% non-adherent with no drop guider, $p=0.0018$). This data suggests that the device, the TravAlert®-Eyot® drop guider, though meant to make eye drop instillation easier, may have instead made it more difficult, thereby reducing adherence.

Glanz and colleagues²³ evaluated a tailored, automated, telephone-based health communication intervention among 312 non-adherent glaucoma patients from two clinics in the Southeastern United States. Patients were approximately 90% African-American. They defined patients as non-adherent if they had poor self-reported adherence to either glaucoma medications or clinic appointments in the past year. They measured adherence during the study period from patient self-report, chart review of refill adherence, physician assessment of medication adherence and appointment adherence. All patients were interviewed by telephone four times throughout the study period to assess adherence. During the first interview and last interview, all patients were asked about facilitators and barriers to adherence including glaucoma knowledge, health literacy, self-efficacy, outcomes, expectancies, quality of life and social support.

The program used interactive voice recognition software to create tailored telephone calls that included a salutation, a review of the patient's medication regimen, tips to address particular barriers to adherence, general glaucoma information and then a synopsis of the call with a reminder to take medications. The messages were tailored on the information gathered in the interview. Participants in the intervention received 12 phone calls over a nine-month period and received printed materials one week after each phone call. While there was no significant difference in adherence between the control group and intervention group, both groups improved substantially through their participation in the study (refill adherence increased from 1.6% to 29.8% in the intervention group compared to 6.2% to 31.0% in the control group, $p = 0.09$).

Lim and colleagues¹² evaluated the impact of monthly automated phone call reminders and scripted education on glaucoma medication adherence among 80 glaucoma patients on monotherapy with a prostaglandin analogue in an academic center in California. Intervention group patients underwent a 20-30 minute scripted education session with a research assistant at 3 months, and then their adherence was measured for two more months. There was no significant improvement in medication adherence as measured by electronic medication monitors (baseline adherence 81.5% to 81.5% after the intervention in the control group vs 82.7% to 73.2% in the intervention group, $p = 0.7$).

Muir and colleagues²⁴ evaluated the impact of an educational intervention tailored to health literacy on glaucoma medication adherence among 127 patients from the Veterans Administration Medical Center in North Carolina. Patients watched a video about glaucoma developed at either a 4th, 7th or 10th grade reading level. Patients whose health literacy was <10th grade reading level reviewed eye diagrams about glaucoma and its treatment with the research assistant while those with better health literacy received the American Academy of Ophthalmology brochure about glaucoma. The research assistant taught proper eye drop

instillation technique to all patients. Though there was no overall improvement in adherence (Days Without Medication 63 ± 198 , intervention group vs 65 ± 198 , control group, $p=0.7$), there was a trend towards a more significant impact among those with lower health literacy (Effect size 0.36, 0.18 and 0.07 for those with poor, marginal and adequate health literacy, respectively).

Observational Studies—Among the observational studies of interventions that demonstrated a significant improvement in adherence, two took place in the US and one took place in the UK. Lunnela and colleagues²⁵ study showed a trend towards improved adherence that was not statistically significant, and this study took place in Finland. Dreer and colleagues,²⁶ (in Alabama, conducted a pilot study to assess the feasibility and preliminary effectiveness of a health promotion program designed to improve glaucoma medication adherence among fourteen African American patients with glaucoma who were <75% adherent to therapy. The program attempted to improve adherence using 3 approaches: 1) patient education 2) motivational interviewing (MI), and 3) problem solving training (PST). The program focused on African-Americans because African-Americans are at higher risk of developing glaucoma and at higher risk for poor medication adherence compared to Caucasians.²⁷ The intervention was delivered by a health educator, a licensed clinical psychologist, who met with patients individually in the glaucoma clinic. Each patient participated in four weekly sessions tailored to his/her barriers and facilitators to glaucoma medication adherence. The first session took place in-person in the clinic, and the additional three sessions took place over the phone. The total amount of time spent counseling patients was not described. The patients also received written program materials. Baseline adherence was measured using the TDA for prostaglandin medications only during a one-month run-in period prior to the intervention. Medication adherence increased significantly from an average of 46% before the program to 62% after the program ($p=0.03$).

Cook²⁸ led a study in Colorado to assess the feasibility of using motivational interviewing to improve glaucoma medication adherence among eight patients with glaucoma who were 80% adherent to their medications. The patients participated in three 30-45 minute in-person counseling sessions and three 5-10 minute phone calls over a 6 month period with a glaucoma technician trained in motivational interviewing. The glaucoma technician underwent six hours of training by a behavioral psychologist and completed 5.5 hours of self-study in motivational interviewing using a standard manual. The psychologist observed the technician while he was counseling patients to assess his fidelity to the counseling technique. The glaucoma technician discussed barriers to adherence and explored how each patient might identify motivating factors to overcome these barriers and improve their adherence. Adherence improved significantly after these counseling sessions ($p=0.03$, as measured by electronic medication monitors).

Rendell²⁹ assessed the impact of two different educational interventions on glaucoma patients' beliefs about adherence in 100 glaucoma patients in the UK. In the first intervention, patients were shown how glaucoma affects a model eye and in the second intervention, the patients took apart the model eye and were encouraged to ask questions about glaucoma's effects on the eye. All participants received brochures about risk factors for glaucoma. Though there were no differences in effect between these two educational

methods, all study participants had improved post-intervention knowledge scores ($p<0.001$) and an improvement in knowledge was significantly correlated with an improved belief about adherence ($p<0.001$).

Lunnela and colleagues²⁵ conducted a case-control study of web-based glaucoma education among glaucoma patients in Finland. Patients in the intervention group ($n=34$) received an email with two kinds of website links, one that provided high quality general information about glaucoma and its management and another that provided more personalized information about glaucoma management based on patients' survey responses. For example, if a patient answered that they had trouble with adherence to medical care they were given links about glaucoma medications. Patients in the control group ($n=51$) filled out surveys regarding their adherence behaviors and then received standard care from their ophthalmologist. Patients were 76% adherent at baseline, and though there was a trend towards improved self-reported adherence 6 months after the intervention, it did not reach statistical significance.

Richardson and colleagues³⁰ conducted a quasi-experimental pre-post analysis of a group based education program for patients in England on monotherapy for open-angle glaucoma or ocular hypertension and measured its effect on adherence. A glaucoma trained nurse lead a 2.5 hour group based education session that allowed time for patients to describe their experience with glaucoma and ask questions. Although adherence did not improve from its 85% pre-intervention level ($p=0.9$) at either one month or three months after the intervention, when adherence was evaluated on a per-person basis, 58% of participants (11/19) improved their adherence after the intervention according to electronic medication monitoring.

Chen and colleagues³¹ evaluated the impact of participation in the Shanghai Glaucoma Club on self-reported medication adherence among 615 glaucoma patients. The Shanghai Glaucoma Club meets every two months for lectures by ophthalmologists and provides an informal setting for patients and ophthalmologists to meet to learn more about glaucoma. Though there was a trend towards better adherence among those who participated in the club, it was not significant ($p=0.08$).

McVeigh and Vakros³² assessed the efficacy of the Eye Drop Chart in improving patients' glaucoma medication adherence using a pre-post design among 25 patients with glaucoma or ocular hypertension in the UK. The Eye Drop Chart is an audio-visual reminder system for glaucoma medications. It consists of a chart denoting the medication, the instillation times, and which eyes need treatment. Next to this medication schedule, there are instructions about how to properly instill eye drops. There is a small hole in which to place each medication below the chart. There was no significant difference in self-reported adherence before and after using the Eye Drop Chart (80% vs 92%, $p=0.47$).

Blondeau and colleagues³³ measured persistence with glaucoma medication for two years before and one year after a group education session. The sessions consisted of a power point presentation about glaucoma by a glaucoma nurse. Family members were invited to the session. The nurse observed each participant instill eye drops during the session. After the

session, the nurse called each patient at 1, 4 and 10 months to address any questions and encourage adherence. Baseline persistence was 78.9% in this sample population as measured by prescription refill data, and was not significantly changed after the education sessions ($p>0.05$). Of note, when the investigators compared those 342 patients who attended the session to 1,187 patients who opted not to attend the session, they found that those who attended were 6% more persistent with their medications than those who did not, a significant finding ($p<0.05$).

Assessment of Outcomes—The gold standard for assessment of medication adherence is electronic medication monitoring. Overall, five out of the nine RCTs used electronic medication monitoring.^{14,16,20,21,22} Two RCTs, Gray's study¹⁷ of individualized counseling with a glaucoma nurse and Muir's of education tailored to health literacy, used medication refill data. This is also a widely accepted measure of medication adherence. Sheppard's study of nurse-led glaucoma education assessed adherence by self-report, which is the least accurate method of assessment. Glanz's study²³ of automated telephone-based tailored communication used multiple outcomes including patients self-report and chart review. Review of the charts was used to ascertain pharmacy refill adherence, physician assessment of medication adherence and appointment adherence. While assessing adherence to follow-up appointments is a very important aspect of measuring adherence behavior, physician's assessment of patient's adherence levels and patient self-report are two measures that are often inaccurate. More accurate outcome measures may have changed the results of this study.

In terms of the observational studies, three used electronic medication monitoring^{26,28}, Blondeau's assessment of a nurse-led group education session used prescription refill data.³³ All of the other observational studies used various measures of self-report, and the only validated instrument was used by Lunnela's group.²⁵

Assessment of the Use of Behavioral Theory—Six out of the seventeen identified studies used behavioral theory to underpin their intervention. The majority of studies (11/17) did not use behavioral theory to underpin their educational interventions while the majority of the successful interventions (5/8) did use behavioral theory. Rendell²⁹ used adult learning theory and health motivation theory to inform their intervention, and they found a significant association between improved knowledge and improved beliefs about adherence. Glanz²³ used tailored information, and tailored, or individualized, information increases self-referential thinking, which may increase activation to change behavior. Four other interventions by Cook, Gray, Cate, and Dreer^{17,21,26,28} used some form of motivational interviewing, a counseling technique based in Self-Determination Theory. The three studies by Cook, Gray and Dreer all had a significant impact on medication adherence, and all focused on non-adherent patients while the study by Cate and colleagues focused on both adherent and non-adherent patients who were newly diagnosed with glaucoma.

Satisfaction—Over the past decade, the focus of healthcare assessment has shifted from purely based in the provision of care in a “fee for service” model to evaluating patient satisfaction as part of a “value based” reimbursement model. The Center for Medicare and Medicaid Services (CMS) measures patient satisfaction and is making it an increasingly

important aspect of reimbursement.³⁴ Of the studies discussed in this review, seven out of seventeen reported on different measures of patient satisfaction with the educational intervention. A recent literature review suggested that greater satisfaction with treatment is associated with improved adherence and persistence.³⁵

Four RCTs reported on patient satisfaction measures. Cate and colleagues²¹ reported that satisfaction with information about medications was significantly higher in the intervention group at all three time points post-intervention compared to the control arm ($p < 0.001$). In the I-SIGHT study²³ all participants said they would recommend the program to other people with glaucoma. The majority of participants (78-85%) said that the calls were interesting, personally relevant and helpful. Gray and colleagues¹⁷ found that intervention patients were significantly more likely to feel enabled to cope with, understand and manage their glaucoma than control arm patients ($p < 0.001$). Sheppard and colleagues found that patients were more satisfied with the slightly longer nurse-led education program (15 minutes) compared to standard care with a physician (10 minutes) ($p = 0.03$). Satisfaction was measured in three observational studies. McVeigh and Vakros found that 64% of participants found the EDC Eye Drop Chart useful and would recommend it to another patient. Dreer and colleagues²⁶ found that 100% of patients were very satisfied with the amount of help they received through the GOAL program, and participants felt that the sessions helped them self-manage their glaucoma more effectively. Richardson and colleagues interviewed participants and found that patients overwhelmingly enjoyed the group education sessions and found them to be helpful.

Study Quality—Overall, the RCTs were of excellent quality (Table 1). Eight out of the nine studies had a Jadad score (Appendix 1) of 5/5. The study by Sheppard from the UK of the effectiveness of nurse-led education had a Jadad score of 3/5 as they used self-report to measure adherence and had no description of the patients that were lost to follow-up. The quality of the observational studies was more variable. Two studies received an Ottawa-Newcastle score of 5/5, Blondeau's study³³ of a glaucoma nurse-led group education session and Cook's study²⁸ of motivational interviewing delivered by a trained glaucoma technician. Two studies received Ottawa-Newcastle scores of 4/5, in which they lost one point because their length of follow-up after their intervention was less than six months, but the studies were otherwise very well-designed. Dreer's study²⁶ of motivational interviewing and problem solving training for African-Americans with poor adherence to their glaucoma medications and Richardson's study of glaucoma nurse led group education both received a score of 4/5. The study of a web-based educational intervention by Lunnela and colleagues²⁵ received a 4/5 because they measured adherence using self-report only. A second limitation to this study was that there was no measure of whether or not the intervention patients actually accessed or read the web-based materials that were sent to them. The study by Rendell²⁹ evaluating different pedagogical methods of teaching about glaucoma received a score of 2/5 as did the Shanghai Glaucoma Club³¹ study as patients' glaucoma type and adherence status were ascertained by self-report. Further, these studies did not make clear how patients were diagnosed with glaucoma and evaluated adherence only at a single point in time. The evaluation of the Eye Drop Chart³² received a score of 1/5 as there was no description of how patients were selected for recruitment or who agreed to participate in the

study, and the outcome, adherence, was measured with self-report and was only measured for one month.

Discussion

Overall, studies that delivered in-person, individualized counseling were more effective in improving medication adherence than studies that did not.^{14,22,23,30,32} Scripted education sessions^{14,22} did not improve medication adherence and satisfaction was not measured with these interventions, so we do not know if patients were satisfied with this scripted information. The three interventions tested in RCTs that were really successful in improving adherence^{17,26} used an individualized approach to supporting patients' health care needs and beliefs. Gray and colleagues¹⁷ found a 39% improvement in prescription refill adherence one year after a 12-month intervention (70% vs 43%, intervention vs control group, $p=0.002$). Dreer and colleagues²⁶ found a 33% improvement in adherence after their month-long intervention (43% to 64% improvement in adherence pre- to post- intervention, $p<0.03$). Okeke and colleagues found a 35% improvement in adherence in the intervention group 6 months after their intervention compared to an 11% improvement in the control group (54% to 73% adherent pre-post the intervention compared to 46% to 51% adherent in the control group, $p<0.001$). Okeke, Dreer,²⁶ and Gray¹⁷ recognized the importance of incorporating health beliefs and motivation, individual barriers to medication adherence, and ability to properly instill eye drops into their programs. While Dreer's GOAL program²⁶ and Okeke's program targeted non-adherent patients, Gray's individualized patient care program¹⁷ targeted any newly diagnosed glaucoma or ocular hypertension patient. Both Dreer²⁶ and Gray¹⁷ based their interventions in motivational interviewing, where the aim of the intervention was to help motivate and support the patient in taking control of his/her disease.

It was interesting that the study by Cate and colleagues²¹ that also used individualized, in-person counseling based in motivational interviewing did not show an effect on adherence. We hypothesize that the lack of an effect on adherence could be due to the limited time the counselor was able to spend with each patient (approximately 52 minutes over eight months). In the two effective interventions,^{17,26} much more time was spent counseling each patient. Okeke did not report the total number of time spent counseling the patients. In the study by Gray and colleagues¹⁷ participants spent approximately 150 minutes in counseling with the glaucoma nurse over the year. In GOAL²⁶ participants spent about 210 minutes in counseling over the month. Interestingly, in the study by Glanz and colleagues²³ the entire cohort of patients' adherence improved. All patients in this study were interviewed by the study team extensively for approximately 120 minutes over nine months about their social situation and barriers to optimal medication adherence, and so this in itself could have served as a type of "intervention" that improved adherence in both groups. The amount of counseling in these interventions is within the 106 ± 92.4 minutes of motivational-interviewing based counseling that a recent meta-analysis found had a significant impact on health behavior change.³⁶ Though it would make implementation easier, it may not be possible to build rapport with patients and collaborate to overcome barriers to improving medication adherence in brief counseling sessions.

A recent study demonstrated the importance of addressing medication adherence through education. Sleath and colleagues video-taped 279 visits in glaucoma patients whose adherence was subsequently monitored with electronic medication monitors for 2 months to examine the relationship between patient-provider communication and medication adherence. They found that patients only asked questions about half of the time.³⁷ Conversely, they found that providers did not educate patients about glaucoma during 37% of visits and did not educate patients about glaucoma medication during 26% of visits even though they knew they were being video-taped.³⁸ This means that patients are not asking and providers are not volunteering information. Sleath and colleagues found that more education occurred during a visit when glaucoma patients were newly prescribed a medication. About 60% of physicians educated newly diagnosed patients about their diagnosis and the goals of treatment. However, even with newly diagnosed patients, only 39% of physicians discussed adherence and only 26% taught eye drop instillation.³⁴ Though their study revealed that the education physicians are providing to glaucoma patients is quite poor, they found that when physicians did provide education about how to instill eye drops, this was associated with significantly improved medication adherence.³⁹ These findings highlight the importance of improving glaucoma patient education.

Patient education programs could potentially be enhanced by harnessing technological innovations such as automated reminders and tailored education alongside individualized in-person counseling. Boland and colleagues found that automated daily reminder phone calls or text messages improved medication adherence from 54% to 73% before and after the intervention compared to 62% to 67% in the control group ($p < 0.05$).⁴⁰ Of note, only 5% (2/38) of patients in the control group elected to receive text messages. Current glaucoma patients may not prefer communication via text message,⁴¹ though this may change as future generations of glaucoma patients become more tech savvy. Additionally, half of the patients in the study were lost to follow-up, which underscores the need for concomitant in-person support to complement the support that automated technologies can lend.

Technology can also be used to tailor, or individualize, educational information. Tailored interventions delivered by web, smartphone or tablet have significantly improved clinical outcomes in diverse chronic conditions.^{42,43,44} For example, while 2-5% of patients quit smoking on their own, and physician advice increased rates by 1-3%,⁴⁵ web-based tailored patient testimonials describing how they overcame the same barriers to quitting that the patients had resulted in quit rates five times higher (39.9%).⁴⁶ Utilizing electronic health technologies to provide individualized education could provide a mechanism through which to support paraprofessional staff in the provision of high-quality, accurate personalized information for glaucoma patients.

One limitation in the assessment of adherence in four^{14,21,22,26} out of the five RCTs that utilized electronic medication monitors is that only adherence to prostaglandin analogues was measured. The studies by Okeke, Cate,²¹ and Beckers²² all used the Travatan Dosing Aid to monitor adherence, and that tool can only measure adherence to travatan or travatan/timolol combination medications. In the two studies that used electronic medication that were bottle agnostic (MEMS),¹⁴ only adherence to prostaglandin analogues was measured. In both studies, patients were only included if they were on monotherapy with a

prostaglandin analogue. Monitoring only the prostaglandin analogues or patients on monotherapy could bias the study population and make it less generalizable, as adherence to monotherapy is higher than to a regimen with multiple glaucoma medications.^{47,48,49} Future work should include an evaluation of patients taking multiple medications and should measure adherence to all prescribed glaucoma medications.

Four studies used pharmacy refill data^{17,23,24,33} to objectively measure adherence, and those studies were able to capture a broader picture of patients' adherence to their medications than those using electronic monitoring of a single medication. The study by Gray and colleagues¹⁷ took place in the UK while the studies by Glanz²³ and Muir²⁴ took place in the US and the study by Blondeau³³ took place in Canada. The caveat to using prescription refill data as a measure of adherence is that unless the data is from a single-payer closed-pharmacy system such as in the UK¹⁷ or Canada,³³ it is difficult to be certain that all refills are being captured from the large number of potential pharmacies at which a patient may have filled a script. Thus using prescription refill data from local pharmacies to measure adherence, such as in the I-SIGHT study,²³ will decrease the signal to noise ratio of the measurement, leading to a less accurate classification of adherence status.

Though the two-year study by Gray and colleagues¹⁷ demonstrated a significant improvement in intermediary clinical outcomes, a decrease in intraocular pressure fluctuation and a decrease in changes in clinical management, there has not yet been an assessment of the impact of improved adherence on visual field progression. The length of time and the number of subjects required to evaluate the impact of improving medication adherence on visual field progression has prohibited this assessment. In future work, researchers developing successful educational programs could collaborate to test the effect of in-person individualized education on medication adherence, intraocular pressure and glaucomatous progression.

Expert Commentary

Approximately half of the identified educational interventions (4/9) that were tested in randomized controlled trials have had a substantial impact on improving medication adherence. The attributes that the successful interventions shared were individualizing the counseling provided, providing the majority of the counseling in-person as opposed to over the telephone, and having an adequate amount of time to spend with the patients to address each person's needs. More interventions were effective if they focused on addressing the needs of non-adherent patients. Seven out of seventeen studies measured patient satisfaction, and all seven demonstrated that patients appreciated the extra support offered by the intervention. It will be important to create and evaluate standardized approaches to improving support for glaucoma patient self-management that can be widely scaled in the future. It will also be important to standardize our outcome measures and use metrics such as prescription refill data and/or electronic medication monitoring that are more reliable than self-report to get a better sense of which interventions should be implemented and tested more broadly.

Five year view

The development of educational programs that can be widely scaled will help ophthalmologists incorporate improved support for glaucoma patients' self-management into clinical practice. There is a need to simultaneously develop programs to train providers to become glaucoma health educators. Decisions will need to be made as to whether ophthalmologists should be providing this additional education and counseling or trained para-professional staff should be trained as glaucoma health counselors. Ultimately, a team based approach to providing glaucoma care might provide the best support for patients where physicians and para-professional staff work together to create and carry out an individualized education plan for each patient. A team-based approach could help patients identify why it is important to them to take control of their glaucoma, make a plan for how they can do so, and provide adequate follow-up resources to help patients implement the plan.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key issues

- In this systematic review, we found that approximately half of the seventeen educational interventions had an impact on glaucoma medication adherence, and the successful interventions were more likely to include a counseling session with a health educator.
- The majority of studies (11/17) did not use behavioral theory to underpin their educational interventions while the majority of the successful interventions (5/8) did use behavioral theory. It will be important to use successful behavioral theories in designing interventions in the future.
- Studies were very heterogeneous in terms of their method of evaluating adherence; future research should use objective methods of measuring adherence such as medication refill data and electronic medication monitoring.
- The only study that provided longer term support and longer term follow-up (2 years) showed a positive impact on adherence. As adherence is a life-long issue, additional studies evaluating the long term impact of counseling and education on disease management are needed.

Table 1

Summary of Educational Interventions to Improve Glaucoma Medication Adherence

Partial Title (Year)	Author	Study Type	Adherence Measurement	Patients	Intervention Type	Impact of Intervention	Study Quality
Interventions improve poor adherence (2009)	Okeke and colleagues ¹⁶	Randomized Controlled Trial	Electronic monitoring	Total: 66 Glaucoma diagnosis: <ul style="list-style-type: none">• POAG• ACG• GS• OHTN	Educational: <ul style="list-style-type: none">• Video• In-person counseling• Reminder phone calls	Intervention improved adherence (54% pre-intervention to 73% post-intervention, p<0.001) compared to those receiving standard care (46% to 51%, p<0.001).	Jadad score 5/5
Effectiveness of a nurse-led glaucoma monitoring clinic (2003)	Sheppard and colleagues ¹⁹	Randomized Controlled Trial	Self-report	Total: 73 Glaucoma diagnosis: <ul style="list-style-type: none">• POAG• NTG• OHTN• PXG• GS with stable vision, fields and IOP for 1 year & 2 glaucoma meds	10-minute standard visit with ophthalmologist or 15-minute ophthalmic nurse-led semi-structured educational session	Both groups had improved adherence compared to baseline (p=0.004). Significantly fewer patients in the nurse-led group reported problems with adherence (p=0.04) and patient satisfaction scores were higher in the nurse-led group (p=0.03).	Jadad score 3/5
Improving medication compliance (1979)	Norell ²⁰	Randomized Controlled Trial	Electronic monitoring	Total: 73 Glaucoma diagnosis: POAG with elevated IOP, vision & on pilocarpine tid 20/60	Educational with ophthalmic assistant: <ul style="list-style-type: none">• Slideshow and leaflet• Counseling session• Patient and counselor created plan to match timing of glaucoma drops to a daily activity	The intervention group had 9 ± 6.1% fewer missed doses of pilocarpine (p=0.0004) compared with those receiving standard care.	Jadad score 5/5
The influence of health literacy level on an educational intervention (2012)	Muir and colleagues ²⁴	Randomized Controlled Trial	Veterans Affairs pharmacy refill data	Total: 127 Glaucoma diagnosis: (N) <ul style="list-style-type: none">• POAG (84)• NTG (7)• PDG (1)	Video about glaucoma and its treatment tailored on health literacy level	No significant impact on adherence. There was a trend towards improved adherence in the groups of patients with 4th and 7th grade health literacy levels.	Jadad score 5/5

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Partial Title (Year)	Author	Study Type	Adherence Measurement	Patients	Intervention Type	Impact of Intervention	Study Quality
				<ul style="list-style-type: none">• Combined mechanism glaucoma (2)• GS (6)			
Feasibility of motivational interviewing delivered by a glaucoma educator (2010)	Cook and colleagues ²⁸	Observational study	Electronic monitoring	Total: 8 Glaucoma diagnosis: POAG prescribed glaucoma medication monotherapy	135 minutes of motivational - interviewing based counseling over 6 months	A pre-post analysis demonstrated a significant (p=0.03) improvement in adherence compared to baseline levels.	Ottowa-Newcastle score 5/5
Effect of health education (2000)	Rendell ²⁹	Observational study	Self-report	Total: 100 Glaucoma diagnosis: POAG	Educational: didactic or participatory method showing how glaucoma affects a model eye	No significant difference in medication adherence between the groups.Both groups had significantly higher post-test knowledge scores than pre-test knowledge scores (p<0.0001), and this was correlated with an improved belief about medication adherence (p<0.0001).	Ottowa-Newcastle score 2/5
Role of Glaucoma Club on patients' knowledge (2009)	Chen and colleagues (Shanghai Glaucoma Club) ³¹	Observational study	Self-report	Total: 615301 members, 314 non-membersSelf-Reported Glaucoma Diagnosis (N Club members/ N non-club members): <ul style="list-style-type: none">• POAG (147/110)• ACG (134/135)• GS (18/62)• Unsure (2/7)	Member of Shanghai Glaucoma Club compared to non-member	There was a trend toward improved self-reported adherence among club members (p=0.08).	Ottowa-Newcastle score 2/5
A 2 hour information session (2011)	Blondeau and colleagues ³³	Observational study	Pharmacy refill data	Total: 342 Glaucoma diagnosis: not specified	Educational: <ul style="list-style-type: none">• Two-hour educational session• eye drop instillation instruction• The glaucoma nurse contacted the patients three times over the next ten months to address any concerns and encourage adherence	Persistence was unchanged when refill data from two years prior to the intervention was compared to refill data from one year after the intervention. Patients who elected to attend the intervention were 6% more persistent than a random sample of 1187 glaucoma patients from the same ophthalmology practice (p<0.05).	Ottowa-Newcastle score 5/5
Improving adherence to glaucoma medication: a	Cate and colleagues ²¹	Randomized Controlled Trial	Electronic monitoring	Total: 208Glaucoma diagnosis (N control / N intervention):	Behavior change counseling (BCC) intervention: education and motivational support from	No significant differences were observed (p=0.47) at eight months.No statistically significant difference in the	Jadad score 5/5

Partial Title (Year)	Author	Study Type	Adherence Measurement	Patients	Intervention Type	Impact of Intervention	Study Quality
randomised controlled trial of a patient-centered intervention (2014)				<ul style="list-style-type: none">• POAG/NTG new patient (33/32)• POAG/NTG follow-up patient (40/37)• GS/OHTN new patient (16/15)• GS/OHTN follow-up patient (17/18)	trained para-professional staff, called “glaucoma support assistants” (GSAs)	proportion of individuals with adherence (62.5% control group, 66.7% intervention group, p=0.63),	
Adherence improvement in Dutch glaucoma patients: a randomized controlled trial (2014)	Becker and colleagues ²²	Randomized Controlled Trial	Electronic monitoring	Total: 805 Glaucoma diagnosis: POAG or OHTN (All patients taking Travoprost or Travoprost/ Timolol combination)	4 types: <ul style="list-style-type: none">• TravAlert dosing aid as a reminder device• TravAlert-Eyot® drop guider and TravAlert dosing aid• Patient education and TravAlert dosing aid• Patient education, TravAlert dosing aid and TravAlert-Eyot® drop guider	No significant difference in adherence between patients receiving education and those who did not (18.4% non-adherent, 21.4% non-adherent, p=0.52).Significantly more participants were non-adherent who received the drop guider, (24.4% non-adherent with the drop guider, 15.7% non-adherent with no drop guider, p=0.0018).	Jadad score 5/5
Impact of a Health Communication Intervention to Improve Glaucoma Treatment Adherence: Results of the I-SIGHT Trial (2012)	Glanz and colleagues ²³	Randomized Controlled Trial	Patient self-report, pharmacy refill data, chart review	Total: 312 Glaucoma diagnosis:Glaucoma (type not specified) or OHTN for at least 1 year	I-SIGHT program: tailored, automated, telephone-based health communication intervention.	Adherence increased substantially for all measures and in intervention and control group between the baseline and final visit.Refill adherence improved from 1.6% to 29.8% in the intervention group compared to 6.2% to 31.0% in the control group from the baseline study visit to the last study visit.No significant difference in adherence between control group and intervention group	Jadad score 5/5
Adherence to glaucoma medication: the effect of interventions and association with personality type (2013)	Lim and colleagues ¹⁴	Randomized Controlled Trial	Electronic dosing monitors	Total: 80Glaucoma diagnosis (N control / N intervention): <ul style="list-style-type: none">• POAG: (25/18)• NTG (10/16)• PDG (1/1)• PXG (1/1)	automated reminders and education sessions	No statistically significant improvements regarding adherence or therapeutic coverageAdherence levels in the control group began at 81.5% and ended at 81.0%. Adherence levels in the intervention group began at 82.7% and ended at 73.2%.The only difference in adherence was noted one week prior to the mid-study education visit, when the intervention group's	Jadad score 5/5

Partial Title (Year)	Author	Study Type	Adherence Measurement	Patients	Intervention Type	Impact of Intervention	Study Quality
				<ul style="list-style-type: none">OHTN (4/0)		adherence improved compared to the control group in anticipation of the visit with their physician (p=0.012).	
Individualised patient care as an adjunct to standard care for promoting adherence to ocular hypotensive therapy: an exploratory randomised controlled trial (2012)	Gray and colleagues ¹⁷	Randomized Controlled Trial	Prescription refill adherence	Total: 127 Glaucoma diagnosis: newly diagnosed with OHT or OAG	personalized individual healthcare assessment	Adherence was significantly higher in the intervention group (70% vs. 43%, p=.002) twelve months after the year-long intervention	Jadad score 5/5
The eye drop chart: a pilot study for improving administration of and compliance with topical treatments in glaucoma patients (2015)	McVeigh and Vakros ³²	Observational	Self- reported	Total: 25Glaucoma diagnosis (N): <ul style="list-style-type: none">POAG: (25)NTG (5)OHTN (1)PDG (2)ACG (1)Not specified (4)	Eye Drop Chart (EDC): audio-visual reminder system for glaucoma medications	No significant different in self-reported adherence before and after using the EDC (80% vs 92% , p =0.47).	Ottowa-Newcastle score 1/5
Glaucoma Management Optimism for African Americans Living with Glaucoma (GOAL) (2015)	Dreer and colleagues ²⁶	Observational	Electronic Monitoring with TDAClient Satisfaction Questionnaire	Total: 14 Glaucoma diagnosis: OAG on a prostaglandin analogue	1) patient education 2) motivational interviewing (MI), and 3) problem solving training (PST).	Medication adherence increased significantly (46% before program, 62% after program, p=0.03)General satisfaction increased (80% to 92%, p=.01).	Ottowa-Newcastle score 4/5
A study to assess the feasibility of undertaking a randomized controlled trial of adherence with eye drops in glaucoma patients (2013)	Richardson and colleagues ³⁰	Observational - randomized controlled trial	Self-reported: the revised Glaucoma Adherence QuestionnaireMEMS electronic monitoring technology	Total: 19 Glaucoma diagnosis: <ul style="list-style-type: none">POAGNTGOHTN	Group based education program	Adherence did not improve (p=0.9) at either one month or three months after the intervention	Ottowa-Newcastle score 4/5
Web-based intervention for improving adherence of people with glaucoma (2011)	Lunnela and colleagues ²⁵	Observational case-control trial	Self-reported adherence using the validated Adherence Chronic Disease Instrument (Finnish)	Total: 85 Glaucoma diagnosis: <ul style="list-style-type: none">Any glaucoma diagnosisExcluded those with OHTN	Emailed patients a link to web sites with content about glaucoma and its management	Adherence did not improve significantly 6 months after the intervention, though there was a trend towards improved adherence	Ottowa-Newcastle score 4/5

POAG, primary open angle glaucoma; NTG, normal tension glaucoma; PDG, pigment dispersion glaucoma; ACG, angle closure glaucoma; OHTN, ocular hypertension; GS, glaucoma suspect