# A review of patient knowledge and awareness regarding the use and storage of ophthalmic drops

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## Abstract

**Background:** Ophthalmic drops are a widely used pharmaceutical form for the treatment of ocular conditions. However, patient knowledge regarding the appropriate use and storage remains inconsistent and is often suboptimal. The aim was to determine the level of patient knowledge and awareness related to the correct usage and storage of ophthalmic drops, through a literature review.

**Methods:** Relevant studies published after the year 2000 were selected for review based on the inclusion criteria, focusing on patient knowledge and storage practices related to ophthalmic drops.

**Results:** Twenty-eight studies met the inclusion criteria, with an average sample size of 315 participants. Of these, fourteen studies involved glaucoma patients, two studies included postoperative cataract patients, two studies comprised of patients with both glaucoma and ocular hypertension, and ten studies involved patients with various ocular conditions that warranted the use of ophthalmic drops. To assess instillation techniques, nine studies employed video recordings, ten used questionnaires, five incorporated both methods and four studies were observational.

The results demonstrated that eyedrop administration remains a challenge among patients, resulting in bottle contact, inaccuracy and poor hand hygiene. The provision of education significantly improved technique in short-term follow-ups with improvements noted in accuracy, reduced contamination, and increased patient adherence. Poor eyedrop technique was noted in elderly patients, patients with low health literacy and in patients undergoing long-term therapy. Forgetfulness, inattentiveness, limited prior instruction, as well as physical and visual impairment were identified as attributers to correct eyedrop administration.

**Conclusion:** Patients lack knowledge and awareness on the use and storage of ophthalmic drops. Enhancing patient education is essential to improve understanding and correct practices of ophthalmic drop administration.

**Keywords:** pharmaceutical, literature review, ophthalmic drops, usage, techniques, storage, therapeutic outcomes



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## Introduction

Visual impairment remains a global health challenge, primarily caused by conditions such as uncorrected refractive errors, cataract, glaucoma, and diabetic retinopathy, among others.[1] Of these conditions, glaucoma, associated with irreversible blindness, can be effectively managed when diagnosed early and treated appropriately, with ophthalmic drops forming part of the management strategy.[2]

Ophthalmic drops are sterile solutions or suspensions intended for topical administration into the eye. These formulations contain pharmacologically active agents such as antibiotics, mydriatics and anti-inflammatory drugs, and may also include antimicrobial preservatives as excipients to maintain microbial stability. There are many different routes of administration for pharmaceutical products, and the site of administration plays an important role in the effectiveness of medicine. The localised delivery of ophthalmic drops directly into the conjunctiva, eyelid epidermis, or cornea offers a targeted effect, making it advantageous in managing ocular conditions such as dry eye and glaucoma, as well as inflammatory conditions of the anterior segment.[3]

Despite the proven efficacy of ophthalmic drops in treating several ocular conditions, prognosis remains poor due to various contributing factors, such as patient nonadherence, perceived inconvenience, preference for oral medication, and improper administration techniques.[4] As a result, failure to correctly use ophthalmic drops may prolong these conditions, leading to permanent visual impairment.[5] Unaddressed visual impairment impacts health, social inclusion, and economic productivity, reducing educational opportunities and quality of life and increasing mortality risk.[6] Thus, reiterating the importance of early intervention and management.

Although ophthalmic drops are integral to therapeutic efficacy, studies have shown that many patients struggle to administer them appropriately.[7] Factors such as difficulty reading labels and improper administration technique can lead to misidentification of medication or the treated eye, reduced dosage, contamination, and ocular complications.[4] In addition, for ophthalmic drops to produce the required effect, they should be chemically and microbiologically stable, retaining their physical, chemical and microbial properties integrity, and microbial properties throughout their designated shelf life.[8] Exposure to high temperatures and humidity can cause instability; therefore, patient education on correct storage is vital in maintaining drug stability and preventing contamination.

Patient adherence refers to the extent to which patients' actions and behaviours align with physicians' instructions.[9] Poor compliance often results from a combination of factors including complex dosage regimes, physical barriers such as reduced manual dexterity or visual impairment as well as limited knowledge regarding ocular conditions and the importance of treatment adherence.[9] Within the framework of patient-centred care, improving compliance requires involving patients in their treatment plans and overcoming communication barriers that frequently arise between patients and healthcare providers. These barriers can adversely affect patient adherence when patients lack a complete understanding of their condition and the rationale behind the treatment intervention. Therefore, effective patient education is critical for improved compliance and treatment outcomes

## Methodology

A scoping review, approved by the Biomedical Research Ethics Committee of the University of KwaZulu-Natal (Reference number: 00006097), was undertaken to explore this topic of interest. The objective of the review was to better understand patients' knowledge and awareness regarding the appropriate use and storage of ophthalmic drops.

### *Inclusion criteria*

- All published research articles that explicitly defined knowledge and awareness of ophthalmic drop use.
- Studies that describe their sampling technique.
- Studies conducted and published between the years 2000 and 2020 were included to align with the timeframe of original project and data collection. Despite this cutoff, the included studies provide valuable insights into patient knowledge and awareness of ophthalmic drop use, which remain relevant to current clinical practice.
- Articles published in English.

### *Exclusion criteria*

- Studies where the definitions of knowledge and awareness were not specified.
- Studies published prior to the year 2000.
- Grey literature.
- Articles in languages other than English.

### *PCC framework*

The PCC (population, concept, context) framework was used to guide the selection of relevant studies:

- Population: Any population of any age group.
- Concept: Knowledge and awareness of ophthalmic drop usage and storage.
- Context: Peer-reviewed articles published between 2000 to 2020.

### *Search strategy and data synthesis*

A comprehensive literature review search was conducted, retrieving articles from three electronic databases: Google Scholar, PubMed and Cochrane Library. The search strategy incorporated a combination of Medical Subject Headings (MeSH) and relevant keyword**s**, including:

- Eye drops, ophthalmic solutions, eye preparations, ophthalmic drops
- Instillation, administration, usage.
- Correct use, correct administration, correct instillation
- Eye drops knowledge, compliance on eye drop usage, adherence to eye drops

### *Data organisation and screening*

- *Rayyan QCRI*, a web-based tool for systematic reviews, was used to detect duplicate records and to assist with the screening and selection of studies

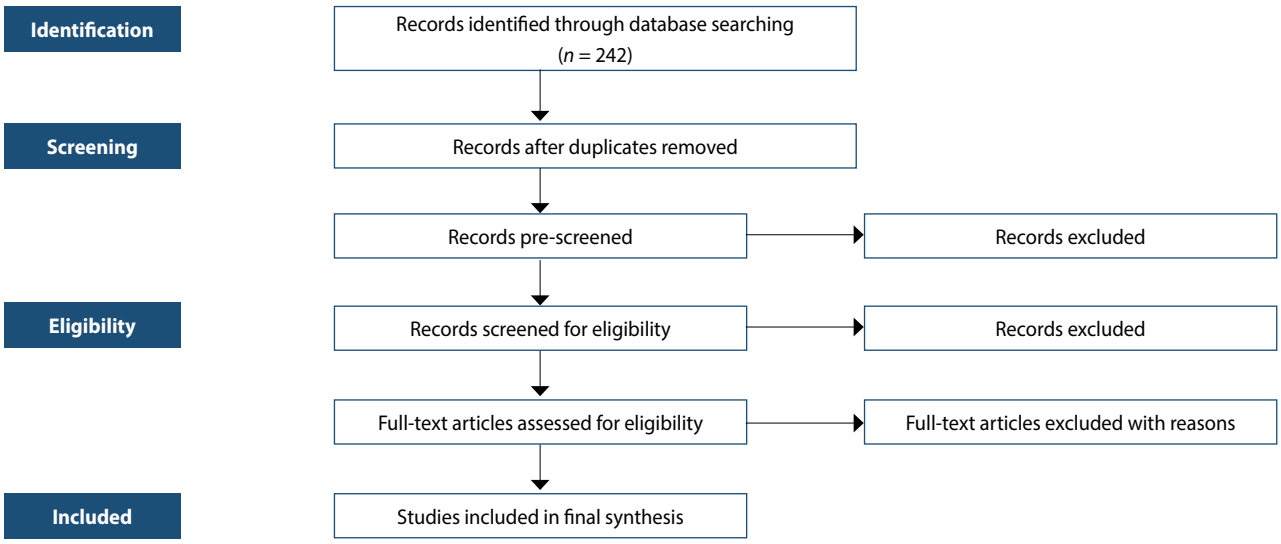


**Figure 1:** Flow diagram illustrating the selection process for inclusion of studies in the systematic review

- *Microsoft Excel* was employed to capture key article findings for analysis.

### *Data extracted from included studies*

The following information was extracted from each eligible study:

- Author identifiers
- Year of publication
- Study location
- Study design
- Sample size
- Sampling technique
- Age of study participants
- Method used to assess knowledge
- Method used to evaluate awareness

Figure 1 provides a visual representation of the literature review conducted.

From an initial pool of 242 articles retrieved using MeSH terms related to eye drops and their administration, 212 were screened. After evaluating titles and abstracts, 92 full-text articles were assessed for eligibility. Of these, only 28 studies met the inclusion criteria and were included in the final analysis (Table I).

## Results

Summary of key characteristics and findings of reviewed studies.

The included studies were conducted in clinical settings across multiple countries, with study sample sizes ranging from 26 to 5100 (mean ≈ 315). Study populations included glaucoma patients (14 studies), postoperative cataract patients (2), patients with both glaucoma and ocular hypertension (2), and individuals with other ocular conditions (10).

Techniques for assessing eyedrop instillation included video recordings (9 studies), questionnaires (10), both methods (5), and observation (4). Most studies employed a prospective cross-sectional design, with others including longitudinal and randomised components.

## Discussion

This review aimed to assess patients' knowledge and awareness regarding the correct use and storage of ophthalmic drops. Inadequate instillation technique, irrespective of treatment experience and duration, was a recurring finding across several studies.[9,13-15,24,25,32] Common challenges identified included touching the bottle tip, missing the eye, and failing to wash hands prior to drop installation.[25,32] These behaviours increase the chances of contamination and reduce treatment efficacy. Furthermore, ocular conditions deteriorate due to poor eyedrop instillation.[17] Studies outlined various factors contributing to poor instillation, including a lack of knowledge about ophthalmic drops.

Several reviewed studies focused on glaucoma patients; however, long-term therapy did not guarantee proper technique, especially among older adults who face dexterity and visual impairments.[9,12,15,16] This suggests that familiarity with the procedure, compounded by other factors, affected competency. It was further noted that improper application may persist even after years of eyedrop use.[24]

Enhanced education and communication from healthcare providers was associated with improved technique.[26] However, deficits in patients' knowledge on areas such as handwashing and checking of expiry dates were noted, often due to lack of patient education.[22]

The majority of the studies used a combination of questionnaires and video recordings to assess patients' ability to administer ophthalmic drops. Video demonstrations were deemed valuable, providing an accurate assessment of patient instillation techniques and allowing gaps to be identified.[9,18,19,28,35] Video recordings further served as an instrument to enhance patient education. Several studies indicated that education and counselling improved instillation proficiency, highlighting the importance of patient education in reducing errors and minimising adverse effects, advocating for its inclusion in clinical settings.[11-14,18,24-26]

Given these findings, it is essential that healthcare providers not only counsel patients but also demonstrate proper instillation techniques and confirm patient understanding at the point of dispensing.[12,13,26,29] In addition, patients' lack of knowledge on how and where to store ophthalmic drops also emerged as a gap.[16] This is possibly due to insufficient counselling in this area, as administration may be prioritised over storage.

## Recommendations

It is recommended that the following minimum information should be conveyed to patients to support and promote therapeutic outcomes: correct instillation technique (single drop, avoid contact with the eye or bottle tip), hand hygiene before administration, identifying the correct eye and timing of doses, checking expiry dates and discarding drops appropriately (28–30 days or per manufacturer guidelines), avoiding bottle contamination, proper storage conditions, and recognising adverse effects. Providing this information can improve patient compliance, reduce complications, and maximise the efficacy of ophthalmic therapy.

### *Limitations*

This review is not without limitations. Eyedrop administration awareness was omitted from the search strategy, and this oversight may have affected the results. Most studies focused on glaucoma patients, limiting generalisability to other ocular conditions that use ophthalmic drops. This also highlights a notable gap in literature, at the time of this study, regarding the use, knowledge and difficulties associated with ophthalmic drops in diverse patient conditions. Furthermore, the majority of the reviewed

**Table I:** Key characteristics and findings of reviewed studies

| Author(s) | Country and study location | Study design and type | Sample size and sampling method | Age and gender | Analysis method | Outcome measures | Results and conclusion | Limitations |
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| Dietlein et al.[10] | Germany: Department of Ophthalmology, University of Cologne | Prospective, observational cross-sectional | 44; consecutive sampling | 80+ years; males and females | GraphPad Prism 2; Mann–Whitney and Spearman tests; significance set at $p < 0.05$ | Patients self-administered eyedrops while being observed. Investigators recorded: ability to open the container, drop expulsion, contact with cornea/eyelid, and drops on lid/skin. | 57% successfully instilled drops into the conjunctival sac (compared to 95% and 89% in control groups A and B). Container contact with the eye occurred in 68% of the study group. Challenges were linked to reduced visual acuity and lack of prior experience. *Conclusion*: Elderly patients struggle with self-administration from single-use containers. | Small sample size due to inclusion of only patients aged 80 and above. |
| Liu et al.[11] | Ghana: Crystal Eye Clinic, Accra | Prospective, nonrandomised control group, cross-sectional | 218; selective sampling | 19+ years; males and females | Video-recorded administration scored independently by two researchers; data analysed using ANOVA ($\alpha = 0.05$) | Proficient administration defined by: (1) drop touches and remains on ocular surface; (2) bottle tip does not contact eye or adnexa; (3) only one drop is applied. | 84% of 133 educated patients achieved proficiency by day 30, compared to 59% of 49 in the non-educated group. Educated participants also reported reduced pain and irritation post cataract surgery. *Conclusion*: Patient education improves eyedrop instillation technique and post cataract surgical irritation. | Single-eye observation may not represent typical usage; observer presence could have influenced patient behaviour. |
| Naito et al.[12] | Japan: Sumitomo Besshi Hospital, Ehime Hospital, Yoshikawa Eye Clinic, Okayama Hospital | Prospective, observational, open-label, multicentre study | 163; selective sampling | 20+ years; males and females | *t*-test and Fisher's exact test for normally distributed variables; multivariable logistic regression for associations | Video-assessed success rate of eyedrop instillation in glaucoma patients and healthy volunteers; analysis of demographic and clinical predictors. | •Success rates: 38.5% in glaucoma patients, 56.5% in volunteers<br>•Average attempts: 2.7 ± 1.4 (patients), 2.3 ± 0.7 (volunteers)<br>• Bottle tip contact: 29.5% of patients, 15.3% of volunteers<br>•≥ 2 attempts: 23.1% of patients, 20.0% of volunteers<br>• Multiple drops in one attempt: 14.1% of patients, 8.2% of volunteers<br>•Single drop flow into conjunctiva: 19.2% of patients, 3.5% of volunteers<br>*Conclusion*: Glaucoma patients had poorer instillation technique compared to non-glaucoma volunteers, likely due to visual field impairment. These findings emphasise the importance of patient education in the affected population. | Only one bottle type was used and prior education on eyedrop instillation was not assessed. |
| An et al.[13] | Canada: Cataract clinics at General Justice Hospital | Prospective, consecutive, observational | 54; selective sampling | 18+ years; males and females | Odds ratios calculated using regression models | Post-surgery evaluation of patient eyedrop instillation technique via questionnaire and video recording on day one post-op. | • 22 patients (41%) waited ≥ 5 minutes between drops<br>• **92.6%** (50 patients) demonstrated improper technique via video (e.g., missing the eye, incorrect drop count, bottle tip contamination, failure to wash hands)<br>• Three patients (5.6%) instilled a stream of drops instead of a single drop<br>•20 patients reported never missing the eye; however, 7 (35%) missed under observation, and 4 (57.1%) perceived their administration as correct<br>•11 (39.3%) who believed they never touched their eye did so during observation<br>Only 11 (30.6%) of 36 who reported always washing their hands, did so under observation<br>*Conclusion*: Self-reported compliance with proper instillation technique often contradicted observed behaviour, emphasising the need for education. | • Small sample size<br>• A single postoperative observation session may not reflect long-term behaviour |

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| Gao et al.[14] | China | Observational; cross-sectional | 113; selective sampling | 18+ years; males and females | Regression analysis, means and standard deviations | Demographic and clinical data of glaucoma patients were collected.<br>Video recordings were used to assess adherence to proper eyedrop instillation technique. | • 93.8% of patients maintained a > 5-minute interval between drops while 3.5% pressed the nasolacrimal duct post-instillation<br>• 48.7% correctly instilled eyedrops on first attempt<br>• Average drops used: 1.7 ± 0.8<br>• Of those correct on first try: 46% missed the eye, 7% touched the bottle tip to the conjunctiva or cornea and 24% touched eyelids or lashes<br>• Only 9.7% had prior education on proper eyedrop instillation, primarily from doctors or nurses. *Conclusion:* Poor eyedrop administration of glaucoma patients in China. | •Observer presence may have influenced patient behaviour.<br>•Administration was assessed in only one eye; however, glaucoma treatment is typically instilled bilaterally. |
| Virani et al.[15] | India: Primary Health Care centre | Interventional, prospective | 69; selective sampling | 18–80 years; males and females | *t*-test, multivariable regression; means and standard deviations | Questionnaire-based assessment of instillation difficulties.<br>Patients received assistance for 4 weeks, and thereafter, the effectiveness of the intervention was measured by IOP reduction. | •87% of patients instilled ophthalmic drops bilaterally and 13% in one eye<br>•29 patients reported subjective difficulties, with 26 reporting multiple challenges such as bottle tip contact, identifying drops, capping, extra drops, and multiple instillation<br>•Difficulties were more prevalent in patients over 60<br>•After 4 weeks of assistance: IOP decreased significantly by 1.61 mmHg (right eye) and 1.92 mmHg (left eye)<br>•Average bottle use decreased by 0.35 per person with a 16% cost saving<br>*Conclusion:* Patients above 60 years experienced challenges with eyedrop instillation, supporting the need for targeted intervention in geriatrics. | Small sample size and 12% dropout rate |
| Tsai et al.[16] | Baltimore and Fortworth | Quantitative pilot; cross-sectional | 213; selective sampling | 18+; males and females | Means, standard deviations | A two-page questionnaire was used to collect demographic data and assess knowledge, experiences, and challenges related to eyedrop use. | •Majority (82.6%) reported self-administered eyedrops, while<br>•17.4% relied on others due to vision issues (25%), manual dexterity problems (25%), or difficulty dispensing a single drop (25%)<br>• Those who self-administered mainly did so while sitting (37.8%) or standing (36.4%), often in the bedroom or bathroom without a mirror<br>• Only 36.4% always washed their hands before use and 5% reported touching the dropper tip to the eye.<br>• Most used both hands and 11.2% disliked applying drops<br>•45.4% stored eyedrops in the bedroom, 23.9% in the bathroom, 19% in the kitchen, and 12.2% in the refrigerator<br>*Conclusion:* The importance of patient education and follow-up visits was highlighted to ensure proper eyedrop administration. | Results relied on patients' honesty in response to the questionnaire. |
| Hennessey et al.[17] | United States of America: Private subspecialty retina /glaucoma practice | Prospective, observational, cross-sectional | 409; consecutive sampling | >18 years; males and females | Multivariate logistic regression. | Patients completed a questionnaire, received 5mL of artificial tears to instil and were observed via recordings. | •Approximately one-third of both groups failed to place a drop on the ocular surface.<br>• Retina patients used multiple drops, touched the eye more frequently, and made more attempts than glaucoma patients, who were slightly more successful at instilling a single drop.<br>•Despite 80% of participants reporting no difficulty, 29-35% missed their eye. *Conclusion:* Correct eyedrop technique is crucial, and physicians should regularly counsel patients. The study demonstrated that poor instillation techniques occur even among experienced patients. | •Results may be influenced by the study's prospective design<br>•Possible self-reporting bias, particularly among patients with poor vision, who had questionnaires read to them.<br>•Variation in visual impairment levels was not accounted for in the analysis. |

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| Choy et al.[18] | Hong Kong: Ophthalmology clinic of Queen Mary Hospital and Grantham Hospital | Prospective; cross-sectional | 26 participants | > 60 years; males and females | •Prism GraphPad and SPSS reported frequencies, percentages, means and SDs<br>•Paired *t*-tests, Spearman, and point-biserial correlations<br>•Multiple linear regression to assess relationships between demographics and instillation ability | To identify risk factors for poor eyedrop technique and assess the benefits of patient education. | •Post-education score: 7.33 ± 1.27, showing a mean improvement of 1.90 ± 2.01<br>•FRAIL score was a significant predictor of technique (B = -1.087, $p = 0.003$), even after adjusting for age, sex, education, and cognitive function<br>•Females had lower baseline scores (r = -0.402) but improved significantly after education (r = 0.392).<br>*Conclusion:* Patients with poor functional status are at greater risk for poor instillation technique. However, structured education improved technique, thereby reducing contamination, wastage and maximising drug efficiency and adherence. | •As a prospective, self-controlled study, differences in demographics and questionnaire responses may affect data comparability.<br>•Small sample size limits generalisability. |
| Lampert et al.[19] | Germany: community pharmacies | Cluster-randomised; cross-sectional | 91 participants | >18 years; males and females | •Computer-generated randomisation<br>•Before–after comparisons: McNemar tests<br>•IBM SPSS Statistics V24 | The effect of motivational education on long-term eyedrop administration. | Correct administration improved over time: 6% at baseline, 35% at one month and 64% at 6 months.<br>Education methods included demonstrations, verbal and written counselling.<br>*Conclusion:* Patient education, regardless of the mode of delivery, resulted in improved eyedrop technique, emphasising the need for consistent, reinforced practices. | •Small sample size<br>• High dropout rate due to long follow-up period<br>• Potential selection bias from cluster-randomisation<br>•Use of placebo eyedrops differing from individual medications<br>•Unassessed indications for eyedrop use. |
| Gomes et al.[20] | Brazil: Hospital Federal de Bonsucesso, Rio de Janeiro | Cross-sectional | 71; consecutive sampling | 55–77 years; both males and females | •JMP, v12.0 (SAS Institute)<br>•Percentages, means and standard deviations | Observation parameters included: time to first drop after uncapping, number of drops squeezed, drop location, tip contact, whether the bottle was shaken, prior handwashing, eyelid closure ≥ 1 minute post-instillation and punctum occlusion after instillation. | •Only 28% of patients correctly instilled eyedrops without tip contact<br>•62% had bottle contact, 49% had drops land on eyelids or cheeks, 27% squeezed multiple drops<br>• Only 11% washed hands prior<br>•Slightly better performance noted in females and younger age was significantly associated with correct technique (mean 61.2 vs. 68 years, $p = 0.02$).<br>*Conclusion:* The majority of glaucoma patients struggled with correct eyedrop instillation, with younger age being the only significant factor associated with correct administration. | • Patients with motor impairments and severe visual loss (worse than hand movements) were excluded<br>•Drop instillation history relied on patient recall<br>•Eyedrop use was only observed once in a different setting, potentially affecting natural behaviour. |
| McVeigh and Vakros[21] | United Kingdom: Bath Royal United Hospital | Prospective, pilot | 25; purposive sampling | 45–90 years; both males and females | Bath Royal United Hospital, Bath | Evaluated the effectiveness of an educational drop chart (EDC) distributed with an information leaflet and two questionnaires (before and 1-month post-EDC use). | •Significant improvements noted in nine of eleven categories<br>• Hand washing increased from 64% to 92% ($p = 0.029$), shaking the bottle from 40% to 84% ($p = 0.001$), and punctal occlusion from 44% to 72% ($p = 0.015$)<br>•Discarding the bottle after 28 days rose from 68% to 92%, although not statistically significant ($p = 0.09$).<br>*Conclusion:* EDC as a promising, cost-effective tool in improving use of topical ocular medications. | Small sample size and subjectivity |
| Mohindroo et al.[22] | India: Department of Ophthalmology, Government Medical College and Hospital, Chandigarh | Cross-sectional; quantitative | 101; consecutive sampling | 18-87 years; both males and females | IBM SPSS statistical software v21 | The knowledge, attitude and practices of eyedrops instillation. | •98% knew the purpose of the medicine but only 61.4% knew appropriate storage practices<br>•Nearly 30% believed two eyedrops could be instilled consecutively and 55.4% did not consider missing a dose significant.<br>*Conclusion:* Variation in basic practices, such as handwashing and checking expiry dates before using eyedrops, indicates the need for education. | Lack of reviewing clinical charts |

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| Ribeiro et al.[23] | Brazil: Instituto de Olhos de Maceió, Alagoas | Cross-sectional; quantitative | 237 participants | Males and females | Chi-square test, $p \leq 0.05$ | Questionnaire divided into three parts: demographics, glaucoma details, number of eyedrops used, education and self-rated vision<br>• Morisky Adherence Scale (MMAS-8<br>• Adherence behaviours using a 5-point Likert scale | •Adherence to glaucoma drops was 54%<br>•Age and number of drops ($p = 0.02$ and 0.03 respectively) and vision quality ($p < 0,001$) significantly influenced inappropriate use<br>•Forgetfulness was the most common reason in both adherent (23%) and non-adherent (76.15%) groups.<br>*Conclusion:* Over half of patients were non-adherent, forgetfulness and visual limitations were key contributing factors. | Excluded patients who missed appointments in the last 3 months and those not enrolled in the Glaucoma Project. |
| Alfawzan et al.[24] | Saudi Arabia: Buraidah Central Hospital | Prospective, cross-sectional | 643; randomly selected | 18–35 years, both males and females | SPSS software; Chi-square test $p \leq 0.05$ | The questionnaire had three sections: demographics, eyedrop administration and storage behaviours, and the role of pharmacists in improving compliance. | •Majority (82.5%) avoided bottle tip contact and 90.8% applied ointment after eyedrops, while 30.6% allowed less than 5 minutes between treatments. 30.5% waited 5–10 minutes.<br>• 32.5 % reported always washing their hands before instillation, with 29.6% washing occasionally.<br>*Conclusion*: All patients reporting incorrect eyedrop use indicated the need for counselling to ensure effective treatment. | •Observation was not done to verify self-reported data<br>•Inclusion extended to only individuals who had access to social networking, which may not affect the broader population. |
| Gupta et al.[25] | India: Tertiary eye care facility | Observational; cross-sectional | 70 participants | 35–70 years | Means and standard deviations | Patients' ability to instil a single eyedrop at home, the time taken, accuracy and container contamination were evaluated. | • 63% had primary angle-closure and 37% primary open-angle glaucoma<br>•Mean time to instil the first drop ranged from 8.7 to 23.5 seconds.<br>•Only ~50% could squeeze a single drop, and 53 patients touched the bottle tip to the eye or eyelids, risking contamination<br>• Drops missed the eye in 22 patients, with some misdirecting multiple drops<br>• Only 6 patients correctly instilled a single drop into the conjunctival sac.<br>*Conclusion*: Overall, 90% failed to instil drops properly, emphasising the need for education to improve adherence to medication. | •Socioeconomic status and literacy levels were not assessed.<br>•Patients with physical impediments were excluded. |
| Tatham et al.[26] | United Kingdom: University Hospital Leicester | Observational; cross-sectional | 85 participants | 50–90 years | •Means and standard deviations at different time points<br>•Histograms: Shapiro-Wilk test<br>•Wilcoxon rank-sum test<br>•Univariable logistic regression | The outcome was scored from 1 (worst) to 4 (best), based on the patient's ability to instil a single eyedrop. | • The average patient age was 71.6 ± 11.6 years.<br>•65.7% had poor technique (scores 1–2), including missed eyes, touching the bottle tip contact.<br>• 81.2% recalled being shown how to instil drops by an ophthalmic professional.<br>•Patients taking two or more medications often instil drops without appropriate intervals<br>•Difficulty ratings varied with 34 patients rating difficulty 1/10, 18 rated 2/10 and 13 3/10. Only 9 patients rated eyedrop difficulty a 5.<br>•No significant differences were found based on gender, ethnicity, education, or visual acuity. Age was strongly linked to poorer instillation technique.<br>*Conclusion:* There was a clear relationship between patient education and correct eyedrop instillation. Education should be a routine part of glaucoma care. | •Potential patient recall bias.<br>•Clinic setting and observation may have altered patient behaviour.<br>•Handedness was not assessed, which could impact technique.<br>•The role of compliance aids was not evaluated, which could support instillation accuracy. |

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| Sakiyalak et al.[27] | Thailand: Faculty of Medicine, Sariraj Hospital, Mahidol University | Cross-over design, randomised | 59 participants | > 18 years; both males and females | •Means, standard deviations at different time points<br>• *p*-values<br>•Eyedrop guide<br>•Univariate and multivariate analysis of risk factors for instillation failure, summarised with EDGs | Patient's instillation ability, time taken, technique used, amount of drug delivered, and spillages were assessed via video recording | •Out of 64 glaucoma patients, 26 (40.6%) succeeded in eyedrop instillation with their usual technique<br>•Five withdrew before the week 2 visit, therefore 59 participants completed the study<br>•Success rates were 61% for EDG and 66.1% for traditional techniques, with no significant difference<br>•The number of patients unable to instil 1 drop using the EDG technique was almost double than that of the traditional method<br>•13 participants contaminated the bottle using the traditional method<br>•The EDG method took longer to instil drops.<br>*Conclusion:* No correlation between adherence and demographics, clinical factors, or glaucoma knowledge, suggesting that personalised strategies are needed to improve adherence. | •High expectations of EDG may have increased false positives and reduced statistical power.<br>•Single session video observation may not reflect routine behaviour.<br>•Investigator presence might have influenced patient comfort and instillation performance.<br>•No baseline data to verify consistency. |
| Feng et al.[28] | United States of America: Ophthalmology clinics at the University of Minnesota. | Prospective; cross-sectional | 34; selective sampling | 19–91 years; males and females | •Chi-square.<br>•Pearson's *t*-test | Assess the effectiveness of patient education using a handout and instructional video on eyedrop self-administration. | •Before teaching, 47% had never been instructed on proper eyedrop administration, among them 88% felt confident while 12% did not<br>• 9% always worried about missing a dose, 3% often and 56% sometimes worried<br>•Post-teaching, 91% felt confident and 94% correctly pulled down their lower eyelid (increase from 47%)<br>•More patients correctly instilled drops (91% vs. 59%), and behaviours like eyelid closure, digital pressure and avoiding surface contact improved after education.<br>*Conclusion*: Post instructional videos, patients showed improvement in eyedrop instillation, viewing the materials as helpful. Thus, warranting inclusion in counselling, especially for OTC drops to reduce misuse, wastage, contamination and ocular injury. | •Short study duration limits long-term retention assessment.<br>Future research should evaluate technique retention over time and reinforce education during follow-up.<br>•Small sample size |
| Saynera et al.[29] | United States of America: Ophthalmology clinics in 4 states | Prospective; cross-sectional | 279; selective sampling | > 18 years; males and females | IBM SPSS Statistics v19 with statistical significance at $p < 0.05$. | Role of communication and patient confidence/ self-efficacy in eyedrop use | • Only 40 patients received education on eyedrop use from ophthalmologists<br>•Higher education levels improved accuracy while women frequently touched the applicator to their eyes or face<br>•Severe glaucoma, female gender and low health literacy were significantly linked to poor technique<br>•Mobility impediments adversely affected accuracy<br>•African American patients were significantly less likely to contaminate the applicator.<br>*Conclusion*: Significant associations noted between gender, glaucoma severity, and question-asking with poor eyedrop technique.<br>Physicians should encourage patient questions and demonstrate eyedrop instillation.<br>Further research is needed on effective educational tools. | •Possible selection bias as reasons for non-participation was not tracked.<br>• Limited racial diversity as most non-African American patients were white.<br>•Camera issues affected the clarity of some video evaluations.<br>• Bottle variations (Systane) may have influenced technique.<br>•Performance anxiety during observation could have affected results.<br>•Prior instruction on eyedrop use was not assessed. |

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| Curtis et al.[9] | Australia: Sydney Eye Hospital | Cross-sectional | 100; selective sampling | 18–90 years; males and females | •Responses were analysed as "yes/no" or "correct/incorrect", • Chi-squared tests | Evaluate patients' knowledge and behaviours with glaucoma eyedrop therapy and the impact of interpreters or English-speaking family members on patients' understanding and compliance. | •77% knew the eyedrop names, with non-English speakers less informed<br>• 88% indicated receiving clear instructions<br>•13 patients reported difficulties with instillation<br>•Only 49% knew to close their eyes post-instillation<br>•46% missed doses, and 8 had discontinued treatment without medical advice.<br>*Conclusion*: Missed doses occurred regardless of demographics. Interpreter use did not significantly influence adherence. Older patients and those on long-term therapy had poorer knowledge, indicating a need for ongoing education by nurses. | •Only glaucoma patients included.<br>•Technique was not observed, preventing assessment of instillation practices. |
| Stone et al.[30] | United States of America | Cross-sectional | 139; selective sampling | > 18; males and females | •Video review of technique<br>•Medical record review<br>•Commercial analysis software. | Evaluate eyedrop instillation of experienced patients with ocular hypertension and glaucoma. | •92.8% reported no difficulties with eyedrop administration, and 61.9% believed they never missed the eye<br>•79.2% reported no bottle tip contact<br>•61.9% reported prior handwashing; however, observation showed only 1.7% washed hands<br>•Among those using 15-mL and 2.5-mL bottles, 21.9% and 30.8%, respectively, instilled a single drop without touching the eye.<br>*Conclusion:* Experienced patients demonstrated poor technique in instilling a single drop without bottle tip contact, indicating a discrepancy between self-reported data and practices. | •Only glaucoma patients included.<br>•41 videos from 34 patients were lost due to a technical error. |
| Kawai-Tsuboi et al.[31] | Japan Nayoro City General Hospital | Retrospective; cross-sectional | 67; consecutive sampling | 52–95 years; males and females | •Humphrey field analyser<br>•Means and standard deviation<br>•Logistic regression analysis | Evaluate eyedrop administration methods (aided or unaided), the number of drops per instillation; placement accuracy, weekly usage frequency and awareness of local side effects. | •Inaccurate eyedrop placement accuracy was significantly associated with more bottles prescribed monthly ($p = 0.008$)<br>•Patients using ≥ 2 drops per application also received more bottles, with the number of drops per instillation ($p = 0.029$) influencing prescription quantity.<br>*Conclusion:* Prescription patterns correlated with instillation technique (i.e., accuracy and drop usage), but no significant links were found between technique and demographic variables. | •Small sample size and retrospective design.<br>•Reliance on self-reported data potentially overestimated use and may not accurately reflect patient behaviour. |
| Park et al.[32] | United States of America: Chicago, Philadelphia, Tucson, AZ, Rochester. | Prospective; cross-sectional | 78; consecutive sampling | 40–85 years; males and females | •Kappa statistics<br>•3 masked graders<br>•Means | Video recordings of self-instilling artificial tears assessed efficacy (drop on ocular surface), safety (bottle tip contact) and efficiency (drops expressed). | •Efficacy: 79.5–87.2% (right eye), 74.4–87.2% (left eye).<br>•Safety: 46.2–66.7% (right eye), 57.3–74.4% (left eye) made no contact with the eye<br>•Efficiency: 64.1–76.9% (right eye), 64.1–89.7% (left eye) used one drop per instillation. *Conclusion:* Overall, 23 of 78 patients touched the bottle tip, indicating poor safety practices and a lack of knowledge that could possibly negatively affect long-term adherence. | •Use of a artificial tear bottle than patients' glaucoma medication bottles.<br>•Some videos were blurry or incomplete, limiting accurate assessment.<br>•Kappa statistics possibly underestimated the actual assessment between graders. |
| Tsumura et al.[33] | Japan: Hospitals and Clinics of Ophthalmologists Association | Prospective; longitudinal | 5100; purposive sampling | +20 years; males and females | •Logistic regression<br>•MD of Humphrey visual field analyser<br>•Means ± standard deviations | Assess difficulty awareness, instillation intervals, recent forgetfulness and timings, assistance, use of aids, preferred number of drops and preferred frequency of instillation. | •Good adherence was reported by 72.4% of subjects and 78.5% of ophthalmologists<br>•Missed instillations commonly occurred at noon (48.2%), before sleep (20.5%), evening (15.8%), and morning (14.0%).<br>*Conclusion*: Longer treatment duration, age, and the number of drops per instillation negatively affected adherence. Females showed significantly better adherence than males. | Participants were pre-selected to use fixed combination drops, introducing selection bias. |

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| Welge-Lussen et al.[34] | Germany: University Eye Clinic, Friedrich-Alexander University, Erlangen | Prospective; cross-sectional | 123; consecutive sampling | 45–88 years; males and females | •Means, standard deviations at time points T1 and T2. •Bivariant correlations •Regression models | Knowledge and self-reported adherence assessed using ARMS2 and VAS-AD | •18.5% of patients always took drops correctly according to VAS-AD.<br>•77.9% missed no doses in the prior 14 days<br>•Forgetfulness (43.8%) was the main reason for nonadherence, followed by inattentiveness (25%).<br>•One third of patients missed doses when applying more than once daily.<br>*Conclusion:* No link was found between adherence and demographic, clinical characteristics, or glaucoma knowledge data. Individualised strategies are recommended to improve adherence. | •Potential social desirability bias in self-reports.<br>•Small sample size.<br>•Short interval between T1 and T2.<br>•Lack of data on environmental, social, and medication factors.<br>•No control group was included. |
| Lazcano-Gomez et al.[35] | Mexico: Prevent Blindness Association (APEC Hospital de la Ceguera) | Prospective; cross-sectional | 45; consecutive sampling | 25–86; males and females | •SPSS software<br>•Means, standard deviation and percentages | Patients on glaucoma treatment for ≥ 6 months were video-recorded instilling eyedrops, educated on proper technique, and reassessed post-education. | •Before education, patients squeezed 1.9±0.9 drops (0.9±0.7 reached the eye), with 64.4% touching ocular tissues, 61% had bottle tip contact and 66.7% instilled one drop<br>•Post education, patients squeezed 1.2±0.5 drops (1.2±0.4 reached the eye), with 82% instilling one drop.<br>*Conclusion:* A single educational session improved both the efficiency and accuracy of instillation. | •Small sample size.<br>•Brief follow-up (only 30 minutes post-education) limiting understanding of long-term retention and technique. |
| Hein et al.[36] | United States of America: Duke Eye Centre and the Durham VA Medical Centre | Prospective cohort; cross-sectional | 137; consecutive sampling | Not specified | SAS 9.4 | Patients rated their confidence in eyedrop instillation, followed by observing the administration. | •Among 117 confident participants, only 95 used the correct technique<br>•Of 18 not confident, 11 used the correct technique<br>•Overall, 78% demonstrated correct eyedrop instillation.<br>*Conclusion*: Self-reports and confidence levels do not confirm correct installation; therefore, direct observation is necessary. | The confidence question was vague and may have led to misinterpretation, failing to reflect patient ability accurately. |

studies were conducted in developed countries with higher literacy levels, which may not accurately reflect the difficulties faced in developing countries. In addition, most studies examined eyedrop instillation with limited focus on storage practices. Only one study specifically addressed both knowledge of eyedrop usage and storage, highlighting the scarcity of evidence in this area. Consequently, eyedrop storage practices are relatively understudied, and their impact on treatment outcomes remains unclear, representing an important knowledge gap that warrants further investigation.

## Conclusion

This literature review confirmed that patients lack sufficient knowledge on eyedrop administration, while evidence regarding storage practices is limited. Where available, gaps were noted in essential practices such as handwashing, checking of expiry dates, discarding drops after 28–30 days depending on manufacturer guidelines, avoiding bottle contamination, and accurate instillation of a single drop. Poorly executed eye-drop instillation techniques adversely affected treatment adherence. An evident gap exists between patient education and knowledge on proper administration, warranting improvement in healthcare communication and information dissemination in clinical settings. Strengthening patient education is critical for achieving proficiency and ensuring safe practices necessary for compliance and treatment efficiency.

### *Conflict of interest*

The authors declare no conflict of interest.


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### *Ethical approval*

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