

# Post-keratoplasty Medical Management: Survey of Current Practice Patterns in the Philippines

Bobbie Marie M. Santos, MD, PhD,<sup>1</sup> George Michael N. Sosuan, MD,<sup>1</sup>  
Ivo John S. Dualan, MD<sup>1,2</sup> and Ruben Lim Bon Siong, MD<sup>1,3</sup>

<sup>1</sup>Department of Ophthalmology and Visual Sciences, Philippine General Hospital, University of the Philippines Manila, Manila, Philippines

<sup>2</sup>Eye and Vision Institute, The Medical City, Pasig City, Philippines

<sup>3</sup>Eye Institute, St. Luke's Medical Center, Quezon City, Philippines

## ABSTRACT

**Background.** Optimizing postoperative management to reduce complications and prolong graft survival after corneal transplantation is essential to reduce the demand for corneal tissue. While studies in developed countries have focused on steroid use, limited attention has been given to antibiotic prophylaxis.

**Objective.** To address this gap, we conducted a survey among corneal surgeons in the Philippines to determine the practice patterns for steroid and antibiotic use in the postoperative management of various keratoplasty types, as well as the initial strategies for managing ocular hypertension and graft rejection.

**Methods.** A cross-sectional online survey was distributed to cornea surgeons accredited by the Eye Bank Foundation of the Philippines, Inc. (EBFPI). The survey included questions regarding practice settings, postoperative steroid and antibiotic regimens, and management of ocular hypertension and graft rejection. Responses were collected through Jotform (Jotform Inc., San Francisco, CA) from September 24 to October 8, 2024, and analyzed using descriptive statistics.

**Results.** A total of 58 corneal surgeons responded (85% response rate), representing 12 regions in the Philippines. Most respondents (45%) had over 15 years of practice. All participants performed penetrating keratoplasty (PKP), followed by deep anterior lamellar keratoplasty (DALK) (33%), Descemet stripping endothelial keratoplasty (DSEK) (24%), and Descemet membrane endothelial keratoplasty (DMEK) (19%). Prednisolone acetate 1% was the preferred topical steroid across all types of keratoplasty, particularly during the first 12 months post-surgery and beyond 12 months for high-risk PKP. The frequency was tapered and maintained once to twice daily beyond 12 months. High-risk PKP received more frequent dosing and slower tapering. Standalone antibiotics were favored over fixed-dose combination antibiotic-steroid eyedrops, with levofloxacin 0.5% as the most preferred topical antibiotic. Most surgeons (55%) continued antibiotics while corneal sutures remained. Most surgeons continued antibiotics at varying frequencies beyond 12 months for PKP (60%) and until 6 months for DALK (63%). For endothelial keratoplasty (EK), antibiotics were used up to one month. For ocular hypertension, 55% of surgeons preferred starting glaucoma medications, primarily beta-adrenergic antagonists (71%). Topical steroids were the initial treatment for graft rejection in both PKP (72%) and lamellar keratoplasty (74%), with 78% of respondents preferring hourly administration.



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Corresponding author: Bobbie Marie M. Santos, MD, PhD  
Department of Ophthalmology and Visual Sciences  
Philippine General Hospital, University of the Philippines Manila  
Taft Avenue, Ermita, Manila 1000, Philippines  
Email: bmsantos1@alum.up.edu.ph  
ORCID: <https://orcid.org/0000-0002-6377-181X>

**Conclusion.** This study is the first to examine current post-keratoplasty medical management practices in the Philippines. Steroid choice was consistent with previous global surveys, with frequency increasing with rejection risk associated with the keratoplasty type; however, it exceeded the dosing trends observed in the United States. Including questions on post-keratoplasty antibiotic use in the survey provided valuable insights into the current practices. Standalone antibiotics were preferred across all keratoplasty types, with prolonged use in PKP and DALK, likely related to the infection risk from corneal sutures. The initial treatments for ocular hypertension and graft rejection were comparable to those in other

studies. The variations in treatment protocols underscore the need for local studies to evaluate outcomes associated with different regimens and highlight the importance of developing local practice guidelines for optimal post-keratoplasty care in the Philippines.

**Keywords:** *keratoplasty, steroids, antibiotics, graft rejection, ocular hypertension*

## INTRODUCTION

Keratoplasty or corneal transplantation is an important surgical procedure to manage visual impairment and blindness from corneal diseases, affecting roughly 5.5 million bilaterally and 6.2 million unilaterally worldwide.<sup>1</sup> In the Philippines, the prevalence of moderate-to-severe visual impairment and blindness due to corneal diseases in 2020 was estimated at 0.44%, affecting approximately 480,000 individuals.<sup>2</sup> The leading indications for keratoplasty locally include bullous keratopathy, infectious keratitis, corneal scars, and regrafts.<sup>3</sup> Despite this substantial burden, access to keratoplasty is limited since there has been a global shortage of corneal grafts, with only one cornea available for 70 needed.<sup>4</sup> The COVID-19 pandemic resulted in further reduction of donor tissue volumes and rates of corneal transplants due to lockdown restrictions.<sup>5</sup> In the Philippines, only 0.4 corneas are transplanted and 1.5 corneas procured annually per 100,000 individuals, reflecting insufficient supply relative to clinical demand.<sup>2</sup> Apart from encouraging tissue donation, optimizing eye banking, developing alternative materials, and maximizing use of available tissue, instituting effective postoperative management to reduce complications and prolong graft survival must be emphasized to reduce the demand for corneal tissue needed for repeat corneal transplantation.

Graft rejection is particularly a problem in high-risk cornea, defined as deep stromal vascularization in two or more quadrants or previous graft failure due to rejection.<sup>6</sup> Lamellar keratoplasty has augmented the graft survival rate compared to full-thickness corneal transplantation or penetrating keratoplasty (PKP); however, immunologic reasons still remain a common cause of graft failure.<sup>6</sup> Topical steroids remain the top medication in routine keratoplasty postoperative regimens for graft rejection prophylaxis, but the protocols differ depending on the type of corneal transplant, available medications, and risk for rejection.<sup>7</sup> Surveys conducted previously indicated that prednisolone was the predominant topical steroid used among different keratoplasty procedures.<sup>8,9</sup> Additionally, to treat ocular hypertension after keratoplasty, a glaucoma medication in the form of a beta-adrenergic antagonist is more likely to be added instead of reducing the potency or frequency of the steroid.<sup>8</sup> Steroid use postoperatively must be further studied locally, as there is an increasing trend towards regrafting due to graft rejection or failure in the Philippines.<sup>3</sup>

Although surveys have been conducted on steroid use following keratoplasty, there is less attention to antibiotic prophylaxis, unlike that for cataract surgery.<sup>10,11</sup> The presence of suture-related problems, such as loose or broken sutures, ocular surface disease, and extended steroid use, contributes to a higher risk of post-keratoplasty infectious keratitis, which can lead to poor graft outcomes and endophthalmitis, particularly in developing countries.<sup>12-17</sup> This underscores the necessity for further research regarding antibiotic prophylaxis for keratoplasty, which is crucial in the Philippines and other Asian countries where lamellar keratoplasty techniques such as Descemet stripping endothelial keratoplasty (DSEK) and Descemet membrane endothelial keratoplasty (DMEK) are not yet the most prevalent forms of corneal transplantation.<sup>2</sup>

There are limited controlled trials and standardized protocols for postoperative keratoplasty management, and not all medications are available worldwide.<sup>7</sup> Furthermore, surveys on practice patterns for postoperative regimens for corneal transplantation are limited to developed countries, with no comparable local studies available.<sup>8,9,11</sup> A study in the Philippines may help ophthalmologists and other healthcare providers understand the postoperative management of keratoplasty performed locally. This study can also serve as an initial step in developing national guidelines for standardized postoperative medical management of keratoplasty to promote best practices, improve patient outcomes, reduce graft complications, and reduce adverse effects from medications. Therefore, we conducted an online survey to determine the current postoperative medical management practices for corneal transplantation among Philippine corneal surgeons, specifically the use of topical steroids and antibiotics across different keratoplasty types (PKP, DALK, DSEK, and DMEK), as well as the preferred initial approaches to graft rejection and ocular hypertension.

## METHODS

### Study Design

This cross-sectional study employed a voluntary, self-administered online survey, with participants selected through total sampling.

### Sample Selection

A list of ophthalmologists accredited by the Eye Bank Foundation of the Philippines, Inc. (EBFPI) as of September 2024 was obtained with permission. This group was chosen as the study population because these surgeons regularly performed keratoplasties in the Philippines and were most familiar with the survey topics. Trainees, surgeons who had not performed keratoplasty in the past 10 years, or surgeons who were not yet accredited by the EBFPI were excluded from the study. With a 95% confidence interval and 10% margin of error, the target sample size was calculated to be 41 (60% response rate).

## Survey Development

The survey consisted of four main sections: 1) five questions on participant demographics; 2) ten questions on postoperative steroid choices and administration frequency following non-high-risk optical PKP defined as first-time PKP or vascularized cornea (one quadrant or less), high-risk optical PKP defined as vascularized cornea (two or more quadrants) and/or previous graft rejection, non-high-risk, first time DALK, DSEK, and DMEK; 3) 13 questions on postoperative antibiotic choices and administration frequency following optical PKP, DALK, DSEK, and DMEK; and 4) five questions on medical management of post-keratoplasty complications, such as graft rejection (presenting with graft edema, keratic precipitates, and anterior chamber inflammation) and ocular hypertension (intraocular pressure (IOP) of more than 21 mmHg after surgery or an increase of more than 10 mmHg over the baseline IOP). The survey was adapted and modified based on the studies of Boychev et al. and Garg et al.<sup>8,10</sup> Modifications included adding the region of practice and the number of keratoplasties per year to assess surgical volume and experience. The types of medications were adjusted to include those available locally. The online survey was reviewed and validated by four specialists in External Disease and Cornea and revised based on their feedback. To minimize response fatigue and dropout bias, adaptive questioning using conditional logic was employed to simplify the survey. This allowed respondents to answer questions based on the type of keratoplasty they performed, resulting in a maximum of 33 questions and a minimum of 18 questions per respondent. The order of the questions was not randomized. To ensure completeness, responses were required for each closed-ended question, with “Not applicable (N/A)” or “Other” options provided. Participants could return to review and edit their answers. The survey was published on Jotform (Jotform Inc., San Francisco, CA), an online form builder that provided customizable features and automated response collection. Usability and functionality were tested on both mobile and laptop devices prior to dissemination.

## Data Collection

The closed survey was electronically administered through a link that was sent exclusively to the emails of eligible participants. The survey link included an informed consent sheet detailing the purpose and length of the survey, as well as information on anonymity, confidentiality, and the voluntary nature of participation. Reminders were sent to non-respondents through email and social chat groups one week after the initial email. Responses were collected from September 24 to October 8, 2024. Data were kept in a password-protected hard drive that was only accessible to the investigators, with plans for deletion after five years.

## Statistical Analysis

All completed surveys were collated, anonymized, and analyzed without subgroup analyses. Descriptive statistics,

such as frequencies and percentages, were calculated using GraphPad Prism software (version 10.3.1; Dotmatics, Boston, MA, USA).

## Ethical Considerations

The study was approved by the University of the Philippines Manila Research Ethics Board (UPMREB 2024-0486-01). Necessary permissions were obtained from the heads of the Philippine Cornea Society, Inc. (PCSI) and EBFPI before the questionnaire was distributed. Anonymity and confidentiality were ensured to reduce social desirability bias. Participants were required to check a box to indicate their consent before they started the survey. No personal information was collected, except for the email address, to confirm that there were no multiple entries from the same individual. There were no incentives for participating in the study.

## RESULTS

### Participant Demographics

There were 58 respondents who completed the survey out of 68 eligible ophthalmologists, resulting in a response rate of 85%. The participants came from 12 regions in the Philippines, with the majority (59%, 34/58) practicing in the National Capital Region. In terms of practice type, all 58 respondents were involved in private practice, followed by academic (66%, 38/58) and government settings (55%, 32/58). Most participants had been practicing corneal transplantation for more than 15 years (45%, 26/58). Most surgeons performed fewer than five keratoplasties annually (57%, 33/58). The most common keratoplasty technique was PKP, which was performed by all surgeons, followed by DALK (33%, 19/58), DSEK (24%, 14/58), and DMEK (19%, 11/58). The demographic characteristics of the participants are summarized in Table 1.

### Post-keratoplasty Steroid Eye Drops

This study examined the preferred topical steroids and tapering regimens for various types of corneal transplant procedures. Prednisolone acetate 1% was the most prescribed topical steroid across all types of keratoplasty, particularly during the first 12 months post-surgery and beyond 12 months for high-risk PKP (Table 2). As the postoperative period progressed, the use of prednisolone decreased for all keratoplasty types. After the sixth month following surgery, other steroids, such as dexamethasone 0.1%, loteprednol 0.5%, and fluorometholone 0.1%, were used more frequently. For non-high-risk PKP and lamellar keratoplasties, surgeons tended to prescribe soft steroids after the first postoperative year, with loteprednol being preferred over fluorometholone.

The preferred frequency of steroid eye drop administration demonstrated increasing variability over time (Table 3). Steroid application was more frequent in the early postoperative period for all keratoplasty types. During the first

**Table 1.** Participant Demographics

| Characteristics                                         | n (%)    |
|---------------------------------------------------------|----------|
| <b>Region of practice</b>                               |          |
| National Capital Region (NCR)                           | 34 (59)  |
| Region IVA (Calabarzon)                                 | 6 (10)   |
| Region III (Central Luzon)                              | 4 (7)    |
| Region VII (Central Visayas)                            | 4 (7)    |
| Cordillera Administrative Region (CAR)                  | 2 (3)    |
| Region X (Northern Mindanao)                            | 2 (3)    |
| Region I (Ilocos Region)                                | 1 (2)    |
| Region II (Cagayan Valley)                              | 1 (2)    |
| Region VI (Western Visayas)                             | 1 (2)    |
| Region VIII (Eastern Visayas)                           | 1 (2)    |
| Region XI (Davao Region)                                | 1 (2)    |
| Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) | 1 (2)    |
| <b>Type of practice</b>                                 |          |
| Private                                                 | 58 (100) |
| Academic                                                | 38 (66)  |
| Government                                              | 32 (55)  |
| <b>Duration of practice (years)</b>                     |          |
| Less than 5                                             | 10 (17)  |
| 6 to 10                                                 | 15 (26)  |
| 11 to 15                                                | 7 (12)   |
| More than 15                                            | 26 (45)  |
| <b>Cornea transplant procedures</b>                     |          |
| Penetrating keratoplasty (PKP)                          | 58 (100) |
| Deep anterior lamellar keratoplasty (DALK)              | 19 (33)  |
| Descemet stripping endothelial keratoplasty (DSEK)      | 14 (24)  |
| Descemet membrane endothelial keratoplasty (DMEK)       | 11 (19)  |
| <b>Average number of keratoplasties/year</b>            |          |
| Less than 5                                             | 33 (57)  |
| 6 to 10                                                 | 17 (29)  |
| 11 to 15                                                | 4 (7)    |
| More than 15                                            | 4 (7)    |

month, steroids were administered eight times daily for PKP and DSEK, four to six times daily for DALK, and six to eight times daily for DMEK. Between the first and 12<sup>th</sup> months, high-risk PKP cases tended to have more frequent dosing and slower tapering (six times, then four times daily), whereas non-high-risk PKP and lamellar keratoplasties had less frequent dosing and faster tapering (four times, then three times daily). Topical steroid usage continued beyond the 12<sup>th</sup> postoperative month, with both non-high-risk and high-risk PKP maintained at twice daily, whereas lamellar keratoplasties were more commonly prescribed once daily.

### Post-keratoplasty Antibiotic Eye Drops

The survey also included questions regarding the preferred topical antibiotics and their administration frequency. Respondents preferred standalone antibiotic eye-drops over fixed-dose combination (FDC) antibiotic-steroid formulations. Fluoroquinolones were the most popular standalone antibiotics across all keratoplasty types, with

levofloxacin 0.5% being the most preferred, followed by moxifloxacin 0.5% and tobramycin 0.3% (Table 4). Among the FDC eyedrops, moxifloxacin-dexamethasone was the most preferred, followed by tobramycin-dexamethasone, tobramycin-loteprednol, and levofloxacin-dexamethasone (Table 5). In the case of PKP, there was an observed trend towards increased use of tobramycin-loteprednol eyedrops after the 6<sup>th</sup> month.

Antibiotics were predominantly used in the early postoperative period and were gradually reduced based on the keratoplasty technique (Table 6). Similar to steroid use, the variability in the frequency of antibiotic administration, especially for PKP and DALK, increased over time. During the first month, antibiotic use was more intensive initially, with frequencies ranging from four to eight times daily for PKP, four to six times daily for DSEK, and four times daily for both DALK and DMEK. In the case of PKP, the majority of respondents (60%, 35/58) extended antibiotic use beyond 12 months, with more surgeons prescribing antibiotics four times daily (21%, 12/58). For DALK, most surgeons prescribed antibiotics for up to six months (63%, 12/19), with more surgeons prescribing at four times daily (32%, 6/19). This pattern was consistent with the practice of more than half of the surgeons (55%, 32/58) who maintained antibiotics while corneal sutures remained in place. Most surgeons who performed DSEK (79%, 11/14) and DMEK (73%, 8/11) maintained antibiotics for up to a month postoperatively.

### Preferred Initial Approach for Ocular Hypertension after Keratoplasty

In the initial treatment of ocular hypertension following keratoplasty, more than half of the respondents (55%, 32/58) favored the addition of glaucoma medication. The next approach was switching to an alternative steroid type, with ester steroids such as loteprednol (24%, 14/58) preferred over ketone steroids such as fluorometholone (10%, 6/58). A small proportion of respondents (10%, 6/58) opted for decreasing the steroid frequency. Regarding the preferred glaucoma medication for post-keratoplasty ocular hypertension, most participants (71%, 41/58) chose to begin monotherapy with beta-adrenergic antagonists, such as timolol. This was followed by adrenergic agonists (16%, 9/58), prostaglandin analogs (5%, 3/58), and oral carbonic anhydrase inhibitors (5%, 3/58). A small number of surgeons (3%, 2/58) initiated treatment with fixed-dose combination eyedrops, such as brimonidine/timolol.

### Preferred Initial Approach for Graft Rejection

Topical steroids were the preferred choice for the initial treatment of graft rejection in both penetrating keratoplasty (PKP) and lamellar keratoplasty, with 72% (42/58) and 74% (25/34) of respondents favoring this option, respectively. Subconjunctival steroid administration ranked second, preferred by 19% (11/58) for PKP and 18% (6/34) for lamellar keratoplasty. Systemic steroids were less commonly

**Table 2.** Frequency Distribution of Preferred Steroid Eye Drops among Corneal Surgeons for Post-keratoplasty Management

| Postoperative time (months)        | Topical steroid, n (%) |               |             |                 |        |
|------------------------------------|------------------------|---------------|-------------|-----------------|--------|
|                                    | Prednisolone           | Dexamethasone | Loteprednol | Fluorometholone | N/A    |
| <b>PKP (non-high risk), n = 58</b> |                        |               |             |                 |        |
| 1                                  | 57 (98)                | -             | -           | -               | 1 (2)  |
| 2 to 3                             | 48 (83)                | 6 (10)        | 3 (5)       | 1 (2)           | -      |
| 4 to 6                             | 33 (57)                | 11 (19)       | 9 (16)      | 4 (7)           | 1 (2)  |
| 7 to 12                            | 21 (36)                | 11 (19)       | 16 (28)     | 8 (14)          | 2 (3)  |
| More than 12                       | 16 (28)                | 8 (14)        | 19 (33)     | 12 (20)         | 3 (5)  |
| <b>PKP (high risk), n = 58</b>     |                        |               |             |                 |        |
| 1                                  | 57 (98)                | -             | -           | -               | 1 (2)  |
| 2 to 3                             | 52 (90)                | 3 (5)         | 2 (3)       | -               | 1 (2)  |
| 4 to 6                             | 46 (79)                | 8 (14)        | 3 (5)       | 1 (2)           | -      |
| 7 to 12                            | 32 (55)                | 11 (19)       | 9 (16)      | 4 (7)           | 2 (3)  |
| More than 12                       | 23 (40)                | 12 (21)       | 16 (28)     | 6 (10)          | 1 (2)  |
| <b>DALK, n = 19</b>                |                        |               |             |                 |        |
| 1                                  | 19 (100)               | -             | -           | -               | -      |
| 2 to 3                             | 14 (74)                | 2 (11)        | 1 (5)       | 2 (11)          | -      |
| 4 to 6                             | 8 (42)                 | 3 (16)        | 5 (26)      | 2 (11)          | 1 (5)  |
| 7 to 12                            | 6 (32)                 | 2 (11)        | 6 (32)      | 3 (16)          | 2 (11) |
| More than 12                       | 3 (16)                 | 3 (16)        | 7 (37)      | 2 (11)          | 4 (21) |
| <b>DSEK, n = 14</b>                |                        |               |             |                 |        |
| 1                                  | 14 (100)               | -             | -           | -               | -      |
| 2 to 3                             | 12 (86)                | -             | 1 (7)       | 1 (7)           | -      |
| 4 to 6                             | 8 (57)                 | 3 (21)        | 1 (7)       | 1 (7)           | 1 (7)  |
| 7 to 12                            | 6 (43)                 | 3 (21)        | 2 (14)      | 2 (14)          | 1 (7)  |
| More than 12                       | 3 (21)                 | 2 (14)        | 5 (36)      | 3 (21)          | 1 (7)  |
| <b>DMEK, n = 11</b>                |                        |               |             |                 |        |
| 1                                  | 11 (100)               | -             | -           | -               | -      |
| 2 to 3                             | 8 (73)                 | 1 (9)         | 1 (9)       | 1 (9)           | -      |
| 4 to 6                             | 6 (55)                 | 1 (9)         | 2 (18)      | 2 (18)          | -      |
| 7 to 12                            | 6 (55)                 | 1 (9)         | 2 (18)      | 2 (18)          | -      |
| More than 12                       | 3 (27)                 | 1 (9)         | 4 (36)      | 3 (27)          | -      |

PKP = penetrating keratoplasty, DALK = deep anterior lamellar keratoplasty, DSEK = Descemet stripping endothelial keratoplasty, DMEK = Descemet membrane endothelial keratoplasty

prescribed, with only 9% of surgeons opting for this method in both PKP (5/58) and lamellar keratoplasty (3/34) cases. When considering the frequency of topical steroid application, the majority of surgeons (78%, 35/45) preferred hourly administration. Less common frequencies included eight times daily (20%, 9/45) and six times daily (2%, 1/45).

## DISCUSSION

This is the first survey in the Philippines to explore preferred practice patterns among corneal surgeons regarding the postoperative medical management of keratoplasty. The study focused on four main aspects: topical steroid use for graft rejection prevention, topical antibiotics for infection prophylaxis, initial management of ocular hypertension after corneal transplantation, and initial treatment of graft rejection. Topical corticosteroids remain the gold standard for corneal graft rejection, with prednisolone acetate 1% being the most favored across all keratoplasty types,

aligning with previously conducted surveys and supported by research highlighting its potent anti-inflammatory properties and ocular penetration.<sup>7-9</sup> The unavailability of more potent alternatives, such as difluprednate, in the Philippines influences this preference.

A declining trend in prednisolone use was observed over the postoperative course for most keratoplasty types, except for high-risk PKP cases, with a shift to loteprednol 0.5%, fluorometholone 0.1%, or dexamethasone 0.1% in FDC after the sixth month, consistent with previous surveys.<sup>8,9</sup> This shift reflects efforts to prevent ocular hypertension, as prednisolone is recognized to elevate IOP more significantly than other steroids, whereas loteprednol and fluorometholone offer comparable efficacy in preventing graft rejection.<sup>7,18-20</sup> Steroid administration was long-term and extended beyond the first year after surgery, but the frequency was gradually reduced, consistent with other studies.<sup>7,8,21</sup> However, initial steroid dosing in the Philippines was higher (six to eight times daily) than in the United States (U.S.), where lower

**Table 3.** Frequency Distribution of Preferred Topical Steroid Tapering Regimen among Corneal Surgeons for Post-keratoplasty Management

| Postoperative time (months)        | Topical steroid frequency, n (%) |         |         |         |         |         | N/A    |
|------------------------------------|----------------------------------|---------|---------|---------|---------|---------|--------|
|                                    | 8x                               | 6x      | 4x      | 3x      | 2x      | 1x      |        |
| <b>PKP (non-high risk), n = 58</b> |                                  |         |         |         |         |         |        |
| 1                                  | 28 (48)                          | 18 (31) | 11 (19) | -       | -       | -       | 1 (2)  |
| 2 to 3                             | 4 (7)                            | 19 (33) | 31 (53) | 4 (7)   | -       | -       | -      |
| 4 to 6                             | 1 (2)                            | 6 (10)  | 29 (50) | 13 (22) | 7 (12)  | 1 (2)   | 1 (2)  |
| 7 to 12                            | -                                | 1 (2)   | 15 (26) | 19 (33) | 15 (26) | 6 (10)  | 2 (3)  |
| More than 12                       | -                                | 1 (2)   | 5 (9)   | 7 (12)  | 23 (40) | 17 (29) | 5 (9)  |
| <b>PKP (high risk), n = 58</b>     |                                  |         |         |         |         |         |        |
| 1                                  | 49 (84)                          | 6 (10)  | 3 (5)   | -       | -       | -       | -      |
| 2 to 3                             | 15 (26)                          | 36 (62) | 7 (12)  | -       | -       | -       | -      |
| 4 to 6                             | 7 (12)                           | 13 (22) | 35 (60) | 2 (3)   | -       | 1 (2)   | -      |
| 7 to 12                            | -                                | 11 (19) | 22 (38) | 14 (24) | 8 (14)  | 2 (3)   | 1 (2)  |
| More than 12                       | -                                | 3 (5)   | 15 (26) | 14 (24) | 18 (31) | 7 (12)  | 1 (2)  |
| <b>DALK, n = 19</b>                |                                  |         |         |         |         |         |        |
| 1                                  | 6 (32)                           | 7 (37)  | 6 (32)  | -       | -       | -       | -      |
| 2 to 3                             | -                                | 3 (16)  | 12 (63) | 3 (16)  | 1 (5)   | -       | -      |
| 4 to 6                             | -                                | 1(5)    | 6 (32)  | 8 (42)  | 2 (11)  | 1 (5)   | 1 (5)  |
| 7 to 12                            | -                                | -       | 3 (16)  | 4 (21)  | 6 (32)  | 4 (21)  | 2 (11) |
| More than 12                       | -                                | -       | 2 (11)  | 1 (5)   | 5 (26)  | 8 (42)  | 3 (16) |
| <b>DSEK, n = 14</b>                |                                  |         |         |         |         |         |        |
| 1                                  | 6 (43)                           | 4 (29)  | 4 (29)  | -       | -       | -       | -      |
| 2 to 3                             | 1 (7)                            | 3 (21)  | 9 (64)  | -       | 1 (7)   | -       | -      |
| 4 to 6                             | -                                | 1 (7)   | 6 (43)  | 4 (29)  | 1 (7)   | 1 (7)   | 1 (7)  |
| 7 to 12                            | -                                | -       | 1 (7)   | 5 (36)  | 4 (29)  | 3 (21)  | 1 (7)  |
| More than 12                       | -                                | -       | 1 (7)   | 1 (7)   | 5 (35)  | 6 (43)  | 1 (7)  |
| <b>DMEK, n = 11</b>                |                                  |         |         |         |         |         |        |
| 1                                  | 4 (36)                           | 4 (36)  | 3 (27)  | -       | -       | -       | -      |
| 2 to 3                             | -                                | 3 (27)  | 8 (73)  | -       | -       | -       | -      |
| 4 to 6                             | -                                | 1 (9)   | 3 (27)  | 4 (36)  | 2 (18)  | 1 (9)   | -      |
| 7 to 12                            | -                                | -       | 1 (9)   | 4 (36)  | 3 (27)  | 3 (27)  | -      |
| More than 12                       | -                                | -       | 1 (9)   | -       | 4 (36)  | 6 (55)  | -      |

PKP = penetrating keratoplasty, DALK = deep anterior lamellar keratoplasty, DSEK = Descemet stripping endothelial keratoplasty, DMEK = Descemet membrane endothelial keratoplasty

initial doses (four times daily) were common, even for high-risk PKP.<sup>8</sup> Tapering in the Philippines was also more gradual across all keratoplasty types, particularly for high-risk PKP, in line with graft rejection risk. This contrasts with the U.S., where tapering was similar for both high- and low-risk PKP.<sup>8</sup> After one year, steroid maintenance in the Philippines was twice daily for PKP and once daily for lamellar keratoplasties, whereas U.S. surgeons maintained once daily dosing for all keratoplasty types.<sup>8</sup> Several factors may account for the higher steroid dosing in the Philippines. Patients may seek treatment later, resulting in more advanced conditions with increased corneal vascularization and rejection risk, requiring more aggressive use of steroids. Limited access to follow-up care may lead surgeons to prescribe higher doses to compensate for potential non-compliance. Surgeons could also be more cautious in their approach to prevent graft rejection, which could exacerbate the limited corneal supply. Evaluating emerging evidence

to establish local protocols could help standardize practices and optimize outcomes by balancing rejection prevention and the risks associated with steroid use.

This study uniquely explored preferences for antibiotic eyedrops following keratoplasty in the Philippines. The survey revealed a preference for standalone antibiotics over fixed-dose combinations with steroids. Using separate topical steroids and antibiotics would allow for more flexible dosage adjustments as complications arise during the postoperative course. Among fluoroquinolones, levofloxacin 0.5% was the preferred topical antibiotic, presumably because of its broad-spectrum coverage and high ocular tissue penetration, while avoiding corneal deposits associated with lower pH in gatifloxacin and ciprofloxacin and extended instillation of moxifloxacin.<sup>22-24</sup> Antibiotics were mainly used during the first few months postoperatively, corresponding with the epithelial healing period, and were continued by most surgeons for up to more than 12 months in PKP, six months

**Table 4.** Frequency Distribution of Preferred Standalone Antibiotic Eyedrops among Corneal Surgeons for Post-keratoplasty Management

| Postoperative time (months) | Topical standalone antibiotic, n (%) |                   |                 |                   |         |
|-----------------------------|--------------------------------------|-------------------|-----------------|-------------------|---------|
|                             | Levofloxacin 0.5%                    | Moxifloxacin 0.5% | Tobramycin 0.3% | Levofloxacin 1.5% | N/A     |
| <b>PKP, n = 58</b>          |                                      |                   |                 |                   |         |
| 1                           | 31 (53)                              | 24 (41)           | 1 (2)           | 1 (2)             | 1 (2)   |
| 2 to 3                      | 27 (47)                              | 18 (31)           | 2 (3)           | 1 (2)             | 10 (17) |
| 4 to 6                      | 22 (38)                              | 15 (26)           | 3 (5)           | -                 | 18 (31) |
| 7 to 12                     | 18 (31)                              | 13 (22)           | 3 (5)           | -                 | 24 (41) |
| More than 12                | 14 (24)                              | 10 (17)           | 4 (7)           | -                 | 30 (52) |
| <b>DALK, n = 19</b>         |                                      |                   |                 |                   |         |
| 1                           | 13 (68)                              | 6 (32)            | -               | -                 | -       |
| 2 to 3                      | 10 (53)                              | 1 (5)             | -               | -                 | 8 (42)  |
| 4 to 6                      | 7 (37)                               | -                 | -               | -                 | 12 (63) |
| 7 to 12                     | 4 (21)                               | -                 | -               | -                 | 15 (79) |
| More than 12                | 4 (21)                               | -                 | -               | -                 | 15 (79) |
| <b>DSEK, n = 14</b>         |                                      |                   |                 |                   |         |
| 1                           | 11 (79)                              | 3 (21)            | -               | -                 | 0 (0)   |
| 2 to 3                      | 6 (43)                               | -                 | -               | -                 | 8 (57)  |
| <b>DMEK, n = 11</b>         |                                      |                   |                 |                   |         |
| 1                           | 8 (73)                               | 2 (18)            | -               | 1 (9)             | -       |
| 2 to 3                      | 6 (55)                               | -                 | -               | -                 | 5 (45)  |

PKP = penetrating keratoplasty, DALK = deep anterior lamellar keratoplasty, DSEK = Descemet stripping endothelial keratoplasty, DMEK = Descemet membrane endothelial keratoplasty

**Table 5.** Frequency Distribution of Preferred Fixed-dose Combination Antibiotic-steroid Eyedrops among Corneal Surgeons for Post-keratoplasty Management

| Postoperative time (months) | Topical fixed-dose combination antibiotic-steroid, n (%) |                              |                            |                                |         |
|-----------------------------|----------------------------------------------------------|------------------------------|----------------------------|--------------------------------|---------|
|                             | Moxifloxacin/<br>dexamethasone                           | Tobramycin/<br>dexamethasone | Tobramycin/<br>loteprednol | Levofloxacin/<br>dexamethasone | N/A     |
| PKP, n = 58                 |                                                          |                              |                            |                                |         |
| 1                           | 13 (22)                                                  | -                            | 2 (3)                      | 2 (3)                          | 41 (71) |
| 2 to 3                      | 17 (29)                                                  | 1 (2)                        | 2 (3)                      | 1 (2)                          | 37 (64) |
| 4 to 6                      | 15 (25)                                                  | 6 (10)                       | 2 (3)                      | 3 (5)                          | 32 (55) |
| 7 to 12                     | 13 (22)                                                  | 9 (16)                       | 7 (12)                     | 3 (5)                          | 26 (45) |
| More than 12                | 13 (22)                                                  | 6 (10)                       | 10 (17)                    | 3 (5)                          | 26 (45) |
| DALK, n = 19                |                                                          |                              |                            |                                |         |
| 1                           | 5 (26)                                                   | 1 (5)                        | -                          | -                              | 13 (68) |
| 2 to 3                      | 5 (26)                                                   | 1 (5)                        | 1 (5)                      | -                              | 12 (63) |
| 4 to 6                      | 3 (16)                                                   | 3 (16)                       | -                          | -                              | 13 (68) |
| 7 to 12                     | 3 (16)                                                   | 2 (11)                       | -                          | -                              | 14 (74) |
| More than 12                | 4 (21)                                                   | 2 (11)                       | -                          | -                              | 13 (68) |
| DSEK, n = 14                |                                                          |                              |                            |                                |         |
| 1                           | 4 (29)                                                   | -                            | -                          | -                              | 10 (71) |
| 2 to 3                      | 5 (36)                                                   | -                            | -                          | 1 (7)                          | 8 (57)  |
| DMEK, n = 11                |                                                          |                              |                            |                                |         |
| 1                           | 3 (27)                                                   | -                            | -                          | -                              | 8 (73)  |
| 2 to 3                      | 2 (18)                                                   | 1 (9)                        | -                          | -                              | 8 (73)  |

PKP = penetrating keratoplasty, DALK = deep anterior lamellar keratoplasty, DSEK = Descemet stripping endothelial keratoplasty, DMEK = Descemet membrane endothelial keratoplasty

**Table 6.** Frequency Distribution of Preferred Topical Antibiotic Dosing Regimens among Corneal Surgeons for Post-keratoplasty Management

| Postoperative time (months) | Topical antibiotic frequency, n (%) |         |         |         |         |        | N/A     |
|-----------------------------|-------------------------------------|---------|---------|---------|---------|--------|---------|
|                             | 8x                                  | 6x      | 4x      | 3x      | 2x      | 1x     |         |
| PKP, n = 58                 |                                     |         |         |         |         |        |         |
| 1                           | 16 (28)                             | 16 (28) | 16 (28) | -       | -       | -      | 10 (17) |
| 2 to 3                      | 3 (5)                               | 9 (16)  | 29 (50) | 2 (3)   | 1 (2)   | -      | 14 (24) |
| 4 to 6                      | -                                   | 5 (8)   | 27 (47) | 1 (2)   | 2 (3)   | 2 (3)  | 21 (36) |
| 7 to 12                     | -                                   | 1 (2)   | 14 (24) | 10 (17) | 8 (14)  | 3 (5)  | 22 (38) |
| More than 12                | -                                   | -       | 12 (21) | 6 (10)  | 10 (17) | 7 (12) | 23 (40) |
| DALK, n = 19                |                                     |         |         |         |         |        |         |
| 1                           | 5 (26)                              | 5 (26)  | 7 (37)  | -       | -       | -      | 2 (11)  |
| 2 to 3                      | -                                   | 4 (21)  | 6 (32)  | 3 (16)  | 1 (5)   | -      | 5 (26)  |
| 4 to 6                      | -                                   | -       | 6 (32)  | 3 (16)  | 2 (10)  | 1 (5)  | 7 (37)  |
| 7 to 12                     | -                                   | -       | 2 (11)  | 3 (16)  | 3 (16)  | 1 (5)  | 10 (53) |
| More than 12                | -                                   | -       | 2 (11)  | 1 (5)   | 3 (16)  | 2 (11) | 11 (58) |
| DSEK, n = 14                |                                     |         |         |         |         |        |         |
| 1                           | 1 (7)                               | 5 (36)  | 5 (36)  | -       | -       | -      | 3 (21)  |
| 2 to 3                      | -                                   | 1 (7)   | 4 (29)  | 1 (7)   | -       | -      | 8 (57)  |
| DMEK, n = 11                |                                     |         |         |         |         |        |         |
| 1                           | 2 (18)                              | 1 (9)   | 5 (45)  | -       | -       | -      | 3 (27)  |
| 2 to 3                      | -                                   | 1 (9)   | 3 (27)  | 1 (9)   | -       | -      | 6 (55)  |

PKP = penetrating keratoplasty, DALK = deep anterior lamellar keratoplasty, DSEK = Descemet stripping endothelial keratoplasty, DMEK = Descemet membrane endothelial keratoplasty

in DALK, and one month in EK procedures. In the survey, PKP and DALK cases often had longer antibiotic courses than EK, reflecting the perceived need for preventing infection in these eyes with increased risk of infection from suture-related complications, chronic steroid use, and ocular surface disease.<sup>14,17</sup> The extended courses observed in our survey also reflect higher infectious risk profiles often seen in developing countries, where infectious keratitis is a common indication for keratoplasty, and patients often have poor follow-up compliance, poor hygiene, lower level of education, and poverty.<sup>17</sup> However, prolonged antibiotic use carries potential risks, including epithelial toxicity and the development of antibiotic resistance, particularly with low-dose chronic antibiotics and increased fluoroquinolone use, prompting some experts to suggest limiting the duration of antibiotic use and instead prioritizing earlier suture removal according to vascularity and aggressive management of ocular surface disorders.<sup>14,16,25</sup> While the duration of antibiotic use tended to be prolonged, the frequency and tapering schedules varied considerably over time among the respondents, indicating a lack of standardized protocols. Currently, no formal international guidelines or peer-reviewed data define the optimal duration of antibiotic prophylaxis after keratoplasty; however, informal communication with some surgeons practicing in other countries suggests that antibiotics are commonly discontinued once epithelial healing is achieved, typically within 1 week. Lower baseline infection rates, earlier suture removal, and more reliable postoperative follow-up in developed settings may explain

why prior surveys have not emphasized antibiotic use. Although surgeons must make individual decisions regarding antibiotic use based on risk-benefit analysis, our results highlight the need for additional research to investigate the outcomes of current regimens and guide local practices.

We also investigated the management of frequent complications, such as ocular hypertension. This condition can develop in a significant number of patients within a year post-keratoplasty, requiring proactive treatment to prevent glaucoma.<sup>26</sup> The findings showed that the initial approach typically involved adding a glaucoma medication. Beta-adrenergic antagonists, such as timolol, were the preferred glaucoma medications, consistent with a survey conducted in the U.S.<sup>8</sup> The second most preferred option was shifting to a soft steroid, with loteprednol being favored over fluormetholone, likely due to its higher anti-inflammatory potency.<sup>7</sup> Graft rejection management was explored as it continues to be a primary reason for graft failure and cause for repeat grafting in the Philippines.<sup>3,6</sup> Philippine corneal surgeons favored hourly topical steroids as the initial treatment for rejection in both PKP and lamellar keratoplasty, consistent with findings from earlier surveys in other countries.<sup>8,9</sup> The less frequent use of subconjunctival steroids may be attributed to the heightened risk of developing secondary glaucoma.<sup>7</sup> There are limited studies on systemic steroids, with some papers showing a lack of significant improvement in rejection reversal rate compared to local steroid treatment.<sup>7,27</sup> A recent protocol proposed by Azevedo Magalhaes et al. recommends combining oral prednisone

with hourly topical steroids for acute graft rejection episodes for all types of keratoplasty.<sup>7</sup> However, the potential risks associated with systemic steroid use must be carefully evaluated against their possibly limited benefits, highlighting the need for additional research in this area.

Our study incidentally showed that PKP remained the predominant form of keratoplasty in the Philippines, in contrast to the U.S., where EK was more frequently performed.<sup>8</sup> This is consistent with a retrospective review of EBFPI postoperative reports from 2013 to 2019, which showed that the majority (92%) of corneal grafts were used for PKP, even for conditions like keratoconus and endothelial dystrophies (Dr. Elizabeth Aileen Giller, written communication, February 2025). Multiple factors may explain the low adoption of lamellar keratoplasty in the Philippines. As observed in China, the limited availability of donor tissue, lack of curricula and surgical training, and steep learning curve associated with EK are potential reasons.<sup>28</sup> Additionally, prolonged waiting times due to the scarcity of corneal tissue may have allowed some early-stage conditions to progress to stromal fibrosis. Furthermore, many patients only seek medical attention when their corneal disease has reached an advanced stage, limiting the effectiveness of lamellar techniques.

The results of this study offer significant insights into current post-keratoplasty practices in the Philippines. The observed practices in this survey appear to represent local adaptations due to contextual realities in a developing country, such as high-risk cases for rejection and infection, limited access to follow-up care, and socioeconomic barriers. These factors may drive more frequent or prolonged use of medications compared to developed settings. However, some of these practices may reflect long-standing traditions passed down through training rather than evidence-based protocols. Thus, this survey serves as a critical starting point for the reevaluation of postoperative keratoplasty care in the Philippines. In addition to these observations, our study had several strengths that enhanced its relevance. Notably, this study incorporated antibiotic prophylaxis into the survey, whereas most studies focused on steroid use, marking a new addition to the existing literature on postoperative practices in keratoplasty. The high response rate of 85% suggests a good representation of the target population. By utilizing an online format, we were able to reach a wider audience of practitioners across 12 regions. Furthermore, a large proportion of respondents had over 15 years of surgical experience, which adds credibility to the reported practice patterns.

However, there are several limitations to this study. The questionnaire did not include other immunosuppressants for graft rejection prophylaxis. The defined postoperative time intervals may not accurately reflect real-world practices, especially in the early postoperative period, where treatment may be adjusted weekly rather than monthly. The use of "N/A" in dosing regimen questions may have introduced ambiguity, as it could represent either complete discontinuation of

the medication or an approach outside the predefined administration frequency. Therefore, the exact proportion of surgeons who intentionally stopped steroids or antibiotics at specific time points could not be determined. As the data were self-reported, recall bias may have influenced the results.

Our recommendations include conducting a follow-up survey after five years to monitor changes in post-keratoplasty management practices over time, as keratoplasty techniques and medication options evolve. Research on preoperative and intraoperative strategies to prevent graft rejection and infection is also recommended. Furthermore, it would be beneficial to examine the relationship between current practice patterns and rates of graft rejection, ocular hypertension, infection, and antibiotic resistance in post-keratoplasty patients. The survey revealed some differences in management approaches among practitioners; thus, the development of local clinical practice guidelines by a technical working group would be ideal for establishing standardized protocols for post-keratoplasty management, with the goal of refining practices to optimize outcomes and minimize adverse effects from medications.

## CONCLUSION

This study provided an overview of current postoperative medical management practices for various keratoplasties in the Philippines. Prednisolone acetate 1% was the steroid of choice, similar to preferences of corneal surgeons worldwide, while levofloxacin 0.5% was the most preferred antibiotic across keratoplasty types. The frequency and duration of steroid and antibiotic eyedrop administration varied among surgeons, influenced by the specific type of corneal transplant and the associated risks of graft rejection and infection. Filipino corneal surgeons generally prescribed steroids more frequently; however, the initial treatment approaches for ocular hypertension, involving topical beta-adrenergic antagonists, and hourly topical steroids for graft rejection were similar to those of their U.S.-based counterparts. These differences in treatment protocols underscore the need for further local studies to evaluate the outcomes of different regimens and highlight the importance of developing local practice guidelines to support optimal post-keratoplasty care in the Philippines.

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All authors certified fulfillment of ICMJE authorship criteria.

## Author Disclosure

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