



# Assessment of Intravitreal Injection Training among U.S.-Based Ophthalmology Residents

Jacob J. Liechty, MS<sup>1</sup> Michael J. Wilkinson, MD<sup>2</sup> Esther M. Bowie, MD<sup>2</sup>

<sup>1</sup>Pennsylvania State College of Medicine, Hershey, Pennsylvania

<sup>2</sup>Department of Ophthalmology, Pennsylvania State College of Medicine, Hershey, Pennsylvania

Address for correspondence Esther M. Bowie, MD, Department of Ophthalmology, Pennsylvania State College of Medicine, 500 University Drive, Hershey, PA 17033  
(e-mail: ebowie@pennstatehealth.psu.edu).

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## Abstract

**Purpose** To describe the intravitreal injection training of ophthalmology residents in the United States in 2018.

**Design** Cross-sectional survey.

**Methods** An anonymous, 29-question, internet-based survey was emailed to 119 ophthalmology residency program directors with the instructions to forward the survey to their ophthalmology residents.

**Results** A total of 117 ophthalmology residents (7.89%) responded to the survey. The majority of residents stated that their intravitreal injection training began during their first year of ophthalmology training, PGY 2 year, (92.3%). The majority of residents performed at least 25 injections per year (78.6%). All residents use antiseptic on the conjunctiva prior to the injection, 94% use a lid speculum, and 84.6% avoided talking in the procedure room. Most injections are performed with gloves (83.8%). A minority of residents stated that they are trained to use povidone-iodine on the eyelids prior to performing an injection (45.3%). Only 6.0% of residents claimed to use postinjection antibiotic drops. Performance of bilateral, simultaneous intravitreal injections was split with nearly half of residents not being trained in this method (47.9%).

**Conclusion** Ophthalmology residents from across the country experience a variety of different injection protocols when being trained on how to perform intravitreal injections. Conjunctival antisepsis has reached a clear consensus while topics such as simultaneous, bilateral injections and eyelid antisepsis are still uncertain among the resident community.

## Keywords

- ▶ resident
- ▶ training
- ▶ intravitreal
- ▶ retina

Intravitreal injections have been commonplace in ophthalmology clinics for over a decade and yet there remains a need for standardization of protocols surrounding the administration of these injections. Having standardized protocols provides a consistent framework for medical training and improves the quality of health care delivered. It will also strengthen the medico-legal aspects of the health care provided. In 2001 there were 4,215 intravitreal injections performed across the entire United States.<sup>1</sup> Ten years later that number rose to 2.5 million and it has only continued to grow since then.<sup>2</sup> Complications, though rare, associated with intravitreal injections include endophthalmitis, retinal

tear and detachment, cataracts, and ocular hypertension.<sup>3–7</sup> Traditionally, intravitreal injections are performed by retina specialists and retina fellows; however, their prevalence in practice has led to ophthalmology residents being trained on injection techniques.<sup>8</sup> Prior studies have already reported on the practice patterns among retina specialists in several countries.<sup>9–12</sup> In 2014, Avery et al published updated recommendations for intravitreal injections which were soon followed by the American Academy of Ophthalmology (AAO) consensus statement in 2015.<sup>13,14</sup> The aim of this study is to determine the training patterns of ophthalmology residents performing intravitreal injections and to compare

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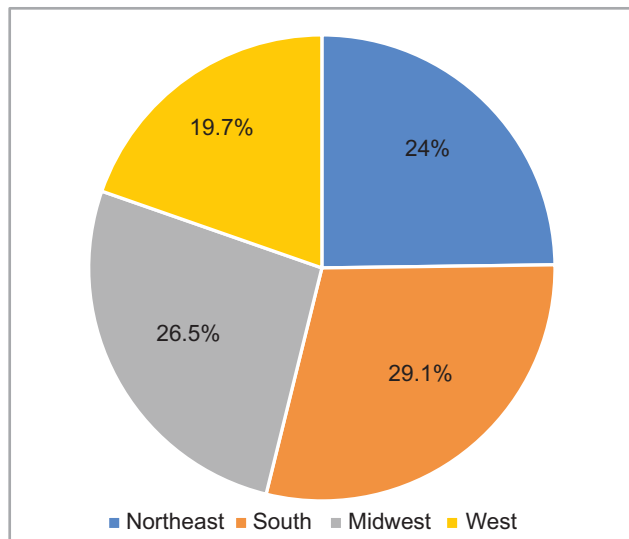
these patterns with the practice patterns of retina specialists, guidelines provided by Avery et al in 2014, and the AAO consensus statement in 2015.

### Methods

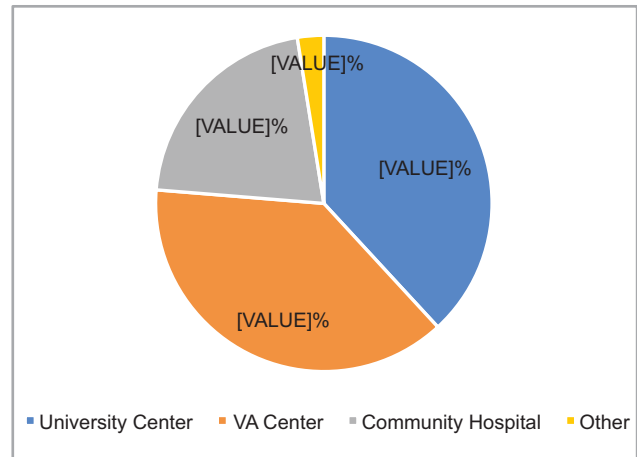
Ophthalmology residency program directors from each of the 119 ophthalmology residency training programs accredited by the Accreditation Council for Graduate Medical Education (ACGME) were contacted via email with a link to an anonymous, 29 question, internet-based survey. The questions were created by a faculty member and medical student of Penn State College of Medicine. Historical surveys in conjunction with clinical insight were used to determine the specifics of each question. The survey was created by adopting questions from prior surveys that were already validated and published.<sup>9-12</sup> The new collection of questions was then reviewed by a faculty/medical student team to assess accuracy and relevance. A complete list of the survey questions can be found in **Appendix A**. The residency directors were asked to disseminate the survey link to the residents at their respective programs. The survey link was first sent out on April 17, 2018 with two reminder emails that followed in the next month.

### Results

By June 18, 2018, 117 residents (7.89%) completed the survey. All respondents that completed the survey stated that they are trained in how to preform intravitreal injections during residency. **Fig. 1** shows the regional representation of residents. The majority of residents that responded are being trained in the South and Midwest. Most residents performed injections at a university or veterans medical center (**Fig. 2**). One-hundred and eight (92.3%) residents stated that they began performing injections during their PGY 2 year. Only seven (6.0%) and two (1.7%) residents stated that they did not begin performing injections until the PGY 3 and PGY 4 years,



**Fig. 1** Regional representation of residents.

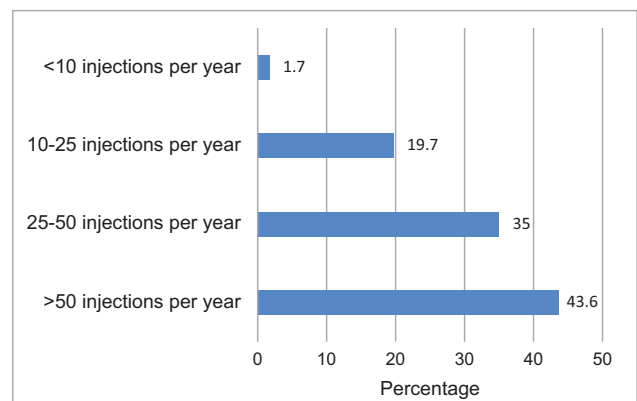


**Fig. 2** Breakdown of resident training environments.

respectively. The majority of residents (43.6%) performed greater than 50 injections per year. Thirty five percent performed 25 to 50 injections per year, 19.7% performed 10 to 25 injections per year, and 1.7% performed less than 10 injections per year (**Fig. 3**).

### Preinjection Considerations

**Table 1** shows the results of this study compared with prior studies, along with the recommendations offered by the 2014 expert panel and the 2015 AAO consensus statement.<sup>13,14</sup> The majority of residents, 91 (77.8%), routinely dilate the eye that is being injected prior to the injection. Ninety-eight (83.8%) residents wear gloves when performing injections. Of the 98 residents that wear gloves, 57 (58.2%) use sterile gloves and 41 (41.8%) use clean gloves. Ninety-nine (84.6%) residents stated that they are trained to avoid talking in the procedure room during injections. The majority of residents, 110 (94.0%) and 111 (94.9%), use an eyelid speculum and povidone-iodine preinjection on the conjunctiva, respectively. Six (5.1%) residents use sodium hypochlorite as conjunctival antiseptic instead of betadine. A small number of residents, 6.0%, use postinjection prophylactic antibiotics.



**Fig. 3** Average number of intravitreal injections performed per residency year.

**Table 1** Comparison of IVI techniques between this study and prior studies

IVI technique	U.S. residents 2018 (N = 117)	U.S. physicians 2010 <sup>9</sup>	Canadian physicians 2012 <sup>10</sup>	Recommended by 2014 guidelines <sup>13</sup>	Recommended by 2015 consensus statement <sup>14</sup>
Pupil dilation	78% (91)	–	83%	Optional	Yes
Gloves	84% (98)	58%	39%	Yes	–
Sterile drape	10% (12)	12%	9%	No	–
Mask	34% (40)	29%	–	Yes	–
Lid speculum	94% (110)	92%	91%	Optional	–
Conjunctival povidone-iodine	95% (111)	100%	100%	Yes	Yes
Conjunctival sodium hypochlorite	5% (6)	0%	0%	–	–
Periocular povidone-iodine	45% (63)	–	48%	Optional	–
Preinjection antibiotics	10% (12/)			No	No
Measured injection site	91% (106)	56%	55%	–	–
Optic nerve perfusion	77% (89)	72%	48%	Yes	Yes
Postinjection antibiotics	6% (7)	81%	20%	No	No
Bilateral IVI	52% (61)	46%	57%	Optional	–

Abbreviation: IVI, intravitreal injection.

**Injection Technique**

► **Table 2** shows ophthalmology resident injection technique preferences. Sixty-nine (59.0%) of residents are trained to prefer a superotemporal injection site while forty-eight (41.0%) are trained to inject inferotemporally. The majority of residents, 106 (90.6%), use measurements to determine the location of the injection site. Of these 106 residents, 77 (72.6%) use calipers and 26 (24.5%) use a tuberculin syringe. One-

hundred and six (90.6%) residents use a 30- and 27-gauge needle when performing injections with antivascular endothelial growth factor drugs and triamcinolone acetonide, respectively. Twenty-two (19.0%) residents stated that they are trained to consider the speed of the jet of fluid during the injection. Of these residents, 11 (50.0%) stated that they are trained to inject slowly and 11 (50.0%) stated that they are trained to inject quickly.

**Table 2** Other injection techniques taught to U.S. ophthalmology residents

IVI technique	U.S. residents 2018 (N = 117)
Clean gloves	35% (41)
Sterile gloves	49% (57)
Avoid talking	85% (99)
Superotemporal injection site	59% (69)
Inferotemporal injection site	41% (48)
Use calipers to measure injection site	66% (77)
Use TB syringe to measure injection site	22% (26)
Use other device to measure injection site	2.6% (3)
30-gauge needle for anti-VEGF injections	91% (106)
27-gauge needle for triamcinolone injections	71% (77)
Postinjection gross visual acuity	59% (69)
Postinjection optic nerve visualization	14% (16)
Postinjection IOP measurement	3.4% (4)

Abbreviations: IOP, intraocular pressure; IVI, intravitreal injection; TB, tuberculin; VEGF, vascular endothelial growth factor.

**Postinjection Considerations**

Most residents, 89 (76.7%), assess postinjection optic nerve perfusion. Of these residents, 69 (77.5%) use visual acuity and a few, 16 (18.0%) and 4 (4.5%), are trained to use visualization of the optic disc and measurement of intraocular pressure (IOP), respectively. These results are summarized in ► **Table 2**.

**Discussion**

Our study is the first to report the practice patterns of intravitreal injections among residents trained in the United States. The rate of resident-performed injections has continued to rise over the past 10 years. In 2006, a survey of program directors found that 75% of the program directors that responded were having their residents perform fewer than 10 injections prior to graduating.<sup>8</sup> Resident responders to this survey show that 78.6% are performing, on average, at least 25 of these injections each year of their training. This survey also demonstrates that there are discrepancies among the intravitreal injection training techniques of U.S.-based ophthalmology residents and retina specialists. Prior studies looked at practice patterns among retina providers but, until now, had never addressed the potential cause of these discrepancies which may lie in the training received during residency. The largest of these studies was conducted in 2010, prior to new guideline recommendations

that were published in 2014 and the 2015 AAO consensus statement.<sup>9,13,14</sup> It is important to determine whether or not these new recommendations have begun to affect the way in which ophthalmology residents are currently being trained.

### Preinjection Considerations

Ninety-one (77.8%) residents stated that they are trained to routinely dilate the eye that is to be injected. This number is consistent with reports from Canadian physicians in 2012.<sup>11</sup> The 2014 guidelines suggested this may be optional and the 2015 AAO consensus statement suggested using mydriatics before injections.<sup>13,14</sup> There is no clear consensus on whether or not patients need to be dilated. The survey did not distinguish between visits to make the diagnosis and injection visits; therefore, we are unable to determine from this study if patients were dilated for a planned injection visit. Dilation may be done as a part of the routine clinic visit to make the diagnosis, find other retina problems, as well as to examine postinjection optic nerve perfusion and complications. Our survey found that 57 (48.7%) residents are trained to use sterile gloves, which reflects a 15.7% increase when compared with providers surveyed in 2010. The use of gloves (sterile or unsterile) does not impact the overall rate of postinjection endophthalmitis.<sup>15,16</sup> Glove use may be varied based on the culture of the practice. Ninety-four percent of residents are trained to use a lid speculum which is consistent with the 2014 guidelines.<sup>13</sup> The guidelines recommend the use of some form of lid retraction if a lid speculum is not utilized.<sup>13</sup> Our study specifically asked about lid speculum use so we do not know if any other method of lid retraction was used by the remaining 6% of residents. One of the new recommendations that came with the 2014 guidelines was to either utilize a surgical face mask or minimize talking during the in-office procedures.<sup>13</sup> This recommendation is based off of the findings that endophthalmitis secondary to intravitreal injection has a disproportionately higher rate of streptococcus isolates when compared to endophthalmitis secondary to intraocular surgery.<sup>17-19</sup> This survey found that this new recommendation has been heeded as 84.6% of residents stated that they are trained to avoid talking while performing injections. The 2014 panel did not recommend the use of a sterile drape as evidence showed that its use did not affect the overall rate of postinjection endophthalmitis.<sup>13,16,20</sup> Residency training is consistent with this recommendation as only 10.3% of residents stated that they are trained to use a sterile drape. One of the most notable differences between the U.S.-based providers that were surveyed in 2010 and current U.S. residents is that 34% of providers claimed to use prophylactic, preinjection, topical antibiotics, while only 10.3% of current residents are trained to maintain this practice. This is consistent with numerous studies which found that not only did preinjection antibiotics provide no real benefit but may actually pose some harm in the form of promoting antibiotic-resistant bacteria.<sup>16,21-25</sup> This discrepancy between our survey and the 2010 U.S. provider survey is most likely because the U.S. provider survey was done before the antibiotic recommendations were changed.

### Injection Technique

This survey found that 90.6% of residents are trained to measure the distance from the limbus to the injection site with the majority of these residents (72.6%) utilizing calipers to make the measurement. This is in stark contrast to what was found when active providers were surveyed in 2010. At that time only 56% of retina specialists claimed to measure the distance between the limbus and their injection site.<sup>9</sup> It is possible that calipers are used preferentially in training because it provides a more exact measurement. Retina physicians with years of experience may no longer feel the need to measure prior to performing their injections. Another difference between providers in 2010 and current residents is the consideration of the speed of the actual injection. In 2010, 59% of surveyed physicians claimed to consider the speed at which they did their injections.<sup>9</sup> This survey found that only 19% of current residents are trained to make this same consideration. In 2010, among physicians that considered injection speed, 76% chose to inject quickly. This survey found that the speed of injection was equivocal. Guidelines in 2004 recommended injecting slowly to avoid excessive drug dispersion.<sup>26</sup> New evidence, however, indicates that injection speed makes no difference in drug dispersion.<sup>27</sup> The discrepancy in the literature may be the reason for our equivocal survey results.

### Postinjection Technique

This survey found that 76.7% of residents are trained to assess postinjection optic nerve perfusion. This is similar to the 72% of practicing retina specialists that assess postinjection optic nerve perfusion in 2010.<sup>9</sup> It is difficult to directly compare the methods for assessing optic nerve perfusion between 2010 and now because in 2010 the respondents were offered a choice that combined more than one method whereas this survey only allowed respondents to select one choice. In spite of that, it is fairly certain that measuring IOP to assess optic nerve perfusion is less common now than it was then. Only 4.5% of residents stated that they are trained to utilize this method of assessment, while 15% of retinal specialists selected this as their sole method of assessment in 2010.<sup>9</sup> The new 2014 guidelines suggest that IOP should be checked prior to administration of an injection but give no recommendation on IOP versus gross visual acuity for postinjection assessment.<sup>13</sup> The use of postinjection prophylactic antibiotics is another area where new guidelines have made a clear impact. The 2010 survey of U.S.-based retinal specialists found that 81% used postinjection antibiotics. This survey found that only 6.0% of residents are being trained to continue this practice. The 2014 guidelines reflect this shift in practice and no longer recommend postinjection antibiotics, citing strong evidence from the DRCR Network LRT trials.<sup>15</sup> One area that still remains divided is the practice of performing same-day, bilateral injections. This survey found that 52.1% of residents are being trained to perform simultaneous, bilateral injections. In 2010, the rate among practicing physicians was reported as 46%.<sup>9</sup> The new guidelines do not take a strong stance against this practice but do make sure to offer certain

precautions. They recommend that each eye be treated as its own separate procedure and that, when possible, different lots of medications should be used for each eye.<sup>13</sup> It has been shown that bilateral injections can be done in a safe manner that provides convenience for both the patient and the physician.<sup>28</sup>

Limitations of this study include difficulty in assessing how many residents received the survey because our method of delivery depended on the residency Program Director or Coordinator sending the survey to the ophthalmology residents. If we assume that all residents received the survey then our response rate is low. While our survey utilized previously validated questions, it was not newly validated for the resident population. A future study would benefit from a validation process that takes into consideration potential differences between the interpretations of questions by residents and attending physicians. Current practice patterns of U.S.-trained ophthalmology residents are reported in this study and it is clear that practice patterns have shifted between physicians in 2010 and residents in 2018. It is still unclear if these changes only exist in the vacuum of academic centers or if these changes have made their way to the retina community at large. Future improvements would seek to expand the response rate as well as to survey retina fellows at the beginning of their fellowship training and then again after 5 years of being in practice on their own. Ultimately, the ideal study would include residents, fellows, and physicians who have been in practice for several years. This would allow for the capture of practice patterns at the same time, and under the same set of guidelines, but across a myriad of different career points.

## Conclusion

Unfortunately, there are no prior studies that assess residency training patterns that our data can be directly compared with.

The only reference points currently available are the past trends of practicing retina specialists. While this is not a direct comparison, it is the best comparison that can be drawn. It is our belief that large differences between how residents are currently trained and how physicians previously practiced can be attributed to changing guidelines. Finally, this study provides a much needed baseline to assess trends in residency training for intravitreal injections.

### Funding

None.

### Conflict of Interest

None declared.

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## Appendix A

### Assessment of Intravitreal Injection Training Among US Based Ophthalmology Residents

Which area of the country is your residency program located in?	<input type="radio"/> Northeast <input type="radio"/> South <input type="radio"/> Midwest <input type="radio"/> West
Do you, as a resident, perform intravitreal injections?	<input type="radio"/> Yes <input type="radio"/> No
Where do you perform intravitreal injections?	<input type="checkbox"/> University Center <input type="checkbox"/> Veterans Medical Center <input type="checkbox"/> Community Center <input type="checkbox"/> Other
Other:	_____
What year of residency do you start doing injections?	<input type="radio"/> PGY 2 <input type="radio"/> PGY 3 <input type="radio"/> PGY 4
On average, how many intravitreal injections do you perform each year as a resident?	<input type="radio"/> < 10 <input type="radio"/> 10-25 <input type="radio"/> 25-50 <input type="radio"/> >50
Are you trained to routinely dilate the eye that is being injected prior to the injection?	<input type="radio"/> Yes <input type="radio"/> No
Are you trained to wear gloves when performing intravitreal injections?	<input type="radio"/> Yes <input type="radio"/> No
What types of gloves do you use?	<input type="radio"/> Clean gloves <input type="radio"/> Sterile gloves
Are you trained to use a sterile drape when performing intravitreal injections?	<input type="radio"/> Yes <input type="radio"/> No
Are you trained to use a surgical face mask when performing intravitreal injections?	<input type="radio"/> Yes <input type="radio"/> No
Are you trained to avoid talking in the procedure room during an intravitreal injection?	<input type="radio"/> Yes <input type="radio"/> No
Are you trained to use an eyelid speculum when performing intravitreal injections?	<input type="radio"/> Yes <input type="radio"/> No
Are you trained to use povidone-iodine pre-injection on the conjunctiva?	<input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Other antiseptic is used
Other antiseptic used:	_____

Appendix A (Continued)

Are you trained to use povidone-iodine on the eye lids?	<input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Other antiseptic is used
Other antiseptic used:	_____
Are you trained to use prophylactic topical antibiotics prior to injection?	<input type="radio"/> Yes <input type="radio"/> No
In what way are you trained to use pre-injection topical antibiotics?	<input type="radio"/> Multiday course <input type="radio"/> Immediately prior to injection
Which anesthetic are you trained to use?	<input type="radio"/> Topical only (eg Proparacaine/tetracaine) <input type="radio"/> Pledget (eg lidocaine) <input type="radio"/> Gel (eg lidocaine) <input type="radio"/> Subconjunctival <input type="radio"/> Other
Other anesthetic used:	_____
Which site are you trained to prefer for your injection location?	<input type="radio"/> Superotemporal <input type="radio"/> Inferotemporal <input type="radio"/> Inferonasal <input type="radio"/> Superonasal
Are you trained to measure the distance from the limbus to the injection site?	<input type="radio"/> Yes <input type="radio"/> No
How are you trained to measure the distance from the limbus to the injection site?	<input type="radio"/> Calipers <input type="radio"/> Tuberculin syringe <input type="radio"/> Other
Other type of measuring device:	_____
Are you trained to consider the speed of the jet of fluid during the injection?	<input type="radio"/> Yes <input type="radio"/> No
At what speed are you trained to inject the fluid?	<input type="radio"/> Slowly <input type="radio"/> Quickly
Which gauge of needle are you trained to use for the injection of Anti-VEGF drugs?	<input type="radio"/> 27-gauge <input type="radio"/> 30-gauge <input type="radio"/> 31-gauge <input type="radio"/> Other
Other gauge of needle used:	_____
Which gauge of needle are you trained to use for the injection of triamcinolone acetonide?	<input type="radio"/> 27-gauge <input type="radio"/> 30-gauge <input type="radio"/> 31-gauge
Are you trained to assess post-injection optic nerve perfusion?	<input type="radio"/> Yes <input type="radio"/> No
How are you trained to assess post-injection optic nerve perfusion?	<input type="radio"/> Gross visual acuity exam (finger count or hand motion) <input type="radio"/> Visualization of the optic disc <input type="radio"/> Measurement of intraocular pressure
Are you trained to use post-injection prophylactic topical antibiotics?	<input type="radio"/> Yes <input type="radio"/> No
How long are you trained to use post-injection prophylactic topical antibiotics?	<input type="radio"/> 1-3 days <input type="radio"/> 4-7 days <input type="radio"/> Greater than 7 days
Are you trained to perform bilateral simultaneous intravitreal injections?	<input type="radio"/> Yes <input type="radio"/> No