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The American Glaucoma Society 100

Articles with Significant Impact on Clinical Glaucoma Care

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Purpose: To identify 100 articles with significant impact on the clinical care of patients with glaucoma.

Design: Cross-sectional study.

Participants: A total of 108 members of the American Glaucoma Society (AGS) in the original survey and 63 in the follow-up survey.

Methods: The 100 most frequently cited English-language original articles relevant to glaucoma were identified via a Scopus search. The American Academy of Ophthalmology (AAO) Preferred Practice Pattern Glaucoma Panel selected an additional 100 articles including newer and "classic" papers. An anonymous survey including the list of 200 articles was distributed to the AGS membership. Survey participants were asked to rate the impact of each article on the clinical care of glaucoma patients using a 4-point Likert scale. Survey respondents were able to provide "write-in" suggestions for the AGS 100. A subsequent anonymous follow-up survey was distributed asking participants to use the same Likert scale to rate 31 "write-in" articles suggested in the original survey. The AGS 100 was created by ranking the top 100 articles based on mean Likert scores from the original and follow-up surveys.

Main Outcome Measures: Original English-language articles that have influenced the clinical care of patients with glaucoma.

Results: The mean ± standard deviation Likert score of articles included in the AGS 100 was 2.9 ± 0.3 (range, 2.47−3.69). The median citation number was 345 (range, 11−2426). Publication year ranged from 1965 to 2020. Articles were published in 14 journals, the most common of which were *Ophthalmology* (42%), *American Journal of Ophthalmology* (21%), and *Archives of Ophthalmology* (20%). Forty-eight articles were derived from randomized clinical trials.

Conclusions: The AGS 100 is a collection of articles judged to have significant clinical impact on glaucoma care. The list will serve as an online educational resource for ophthalmologists in training and in practice. *Ophthalmology Glaucoma 2021;■:1−11 © 2021 by the American Academy of Ophthalmology*

Supplemental material available at www.ophthalmologyglaucoma.org.

The practice of evidence-based ophthalmology requires an ability to critically appraise the peer-reviewed literature and apply study findings to patient care. Such skills are typically developed through journal clubs and other didactic sessions during ophthalmology residency and fellowship training. The Accreditation Council for Graduate Medical Education and Association of University Professors of Ophthalmology Fellowship Compliance Committee emphasize education in evidence-based medicine as a central component of ophthalmology training.[1,2] The American Academy of Ophthalmology (AAO) Basic and Clinical Science Course is a 13-volume standard reference text for ophthalmology trainees and practitioners, and undergoes regular revision to incorporate the most current scientific evidence. Beyond this, however, residency and fellowship programs vary widely in the didactic curricula and supplemental resources used to prepare trainees to practice evidence-based ophthalmology.

The purpose of the American Glaucoma Society (AGS) 100 project was to identify 100 original articles that were highly impactful on the clinical care of patients with glaucoma. The list is intended to be an educational resource for ophthalmologists both in training and in practice. The AGS 100 was published on the AGS website in November 2020.[3]

Methods

The AGS 100 was developed using a 3-part methodology consisting of a bibliometric analysis, an expert panel, and 2 surveys of the AGS membership. The University of Miami Institutional Review Board ruled that approval was not required for this study. This study adhered to the tenets of the Declaration of Helsinki. All participants provided informed consent.

On February 10, 2020, a search of the peer-reviewed literature was conducted using Scopus (Elsevier, Amsterdam, Netherlands), an online article and citation database, by entering the term

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"glaucoma" into the field "Article title, Abstract, Keywords." Search results were limited to original articles (i.e., excluded review articles, book chapters, letters, and editorials) written in the English language, which yielded 54 607 results. Search results were then sorted in descending order by number of citations and independently analyzed by 2 of the study authors (S.J.G. and K.V.) to identify the 100 most frequently cited articles directly relevant to the topic of glaucoma.

Second, 100 additional articles were identified and reviewed by the AAO Preferred Practice Pattern (PPP) Glaucoma Panel, whose 7 members were responsible for revising and updating the glaucoma PPP guidelines with the latest scientific evidence. "Classic" and more recently published papers were selected, with care to avoid duplicating topics that were already well represented within the Scopus search results. Panel members were not permitted to nominate articles that were co-authored by any member of the PPP committee.

Third, after receiving approval from the AGS Research Committee, the list of 200 articles was included in an anonymous SurveyMonkey survey of the AGS membership posted on April 22, 2020 (Appendix A, available at www.ophthalmologyglaucoma.org). The AGS membership consists of ophthalmologists who have completed fellowship training in glaucoma. Participants were first asked whether they primarily practice in an academic or private setting and how many years ago they completed their glaucoma fellowship training. Respondents were then asked to rate the impact of each article on the clinical care of glaucoma patients using a 4-point Likert scale as follows: minimal impact (1 point), moderate impact (2 points), high impact (3 points), and very high impact (4 points). Survey respondents were able to indicate that they were not familiar with a given article rather than assigning it a numerical score and were provided the option to suggest "write-in" responses if they thought that any impactful papers were not represented among the 200 articles in the survey. The order of articles was randomized in each survey to avoid biasing respondents in favor of the most frequently cited articles. The original survey remained open for 8 weeks.

On July 1, 2020, a similarly designed, anonymous follow-up survey was conducted of the AGS membership that included the 31 "write-in" responses derived from the original survey (Appendix B, available at www.ophthalmologyglaucoma.org). Participants rated each article using the same 4-point Likert scale and were provided the option of indicating that they were not familiar with a given article. The order of articles was again randomized in each survey, and the follow-up survey remained open for 8 weeks. Finally, the AGS 100 was created by ranking the top 100 articles based on mean Likert-scale scores from the initial and follow-up surveys of the AGS membership. The number of citations for each article was updated using Scopus on August 29, 2020.

Results

The AGS had 1489 members at the time of survey distribution. A total of 108 (7.3%) members responded to the original survey, and 63 (4.2%) members participated in the follow-up survey. Seventy-two (66.7%) participants in the original survey practiced in an academic setting, and 36 (33.3%) participants were in private practice. Most survey respondents completed their glaucoma fellowship training either greater than 20 years ago (43; 39.8%) or less than 5 years ago (30; 27.8%).

Table 1 lists the AGS 100 in descending order of mean Likert-scale scores.[4-103] Eighty-eight articles were derived from the original survey of the AGS membership, and 12 were "write-in" responses from the original survey that were subsequently included and rated in the follow-up survey. The mean ± standard deviation Likert score was 2.9 ± 0.3 (range, 2.47−3.69). The median and mean ± standard deviation number of citations were 345 and 482.0 ± 466.2, respectively (range, 11−2426). The year of publication ranged from 1965 to 2020. The number of articles published by decade is shown in Figure 1.

Articles were published in 14 journals (Table 2).[104] The most common journals were *Ophthalmology* (42 articles), *American Journal of Ophthalmology* (21 articles), and *Archives of Ophthalmology* (20 articles).

Forty-eight articles were derived from randomized clinical trials. More than 1 publication from a single randomized clinical trial were selected for the Advanced Glaucoma Intervention Study (AGIS; 5 articles); Ahmed Baerveldt Comparison Study (2 articles); Ahmed Versus Baerveldt Study (2 articles); Collaborative Initial Glaucoma Treatment Study (CIGTS; 3 articles); Collaborative Normal Tension Glaucoma Study (CNTGS; 3 articles); Early Manifest Glaucoma Trial (EMGT; 4 articles); European Glaucoma Prevention Study (EGPS; 2 articles); Fluorouracil Filtering Surgery Study (3 articles); Ocular Hypertension Treatment Study (OHTS; 6 articles); and Tube Versus Trabeculectomy (TVT) Study (2 articles).

In addition to landmark randomized clinical trials, frequently represented topics in the AGS 100 were epidemiology (including prevalence of glaucoma and glaucoma-related blindness), diagnostic evaluation (including perimetry and OCT of the retinal nerve fiber layer), pathophysiology, and medical, laser, and surgical therapy. Epidemiological studies were well represented in the AGS 100 and included 3 articles each from the Baltimore Eye Survey and the Barbados Eye Study, 2 large population-based studies. Prevalence studies from regions outside of North America were assigned lower Likert scores by survey participants and therefore excluded from the AGS 100. Studies of genetics and experimental models of glaucoma pathophysiology were largely deemed to be of minimal clinical impact by survey respondents. Only 1 article in the AGS 100 related to childhood glaucoma, and none specifically discussed such secondary glaucomas as pseudoexfoliation glaucoma and neovascular glaucoma.

Discussion

A scholarly approach to patient care is fundamental during ophthalmology training and clinical practice. Competence in the critical analysis of scientific evidence is essential not only in its application to patient care but also to the peer review of manuscripts submitted for publication. The AGS 100 is a "living" online document that serves as a supplemental educational resource to ophthalmology trainees and those already in practice to facilitate the practice of evidence-based medicine. The Accreditation Council for Graduate Medical Education Ophthalmology Milestones, which were implemented in 2015, require ophthalmology residents to demonstrate the practice of evidence-based medicine as part of the Practice-based Learning and Improvement Core Competency.[105] The Association of University Professors of Ophthalmology Fellowship Compliance Committee requires that glaucoma fellows participate in a minimum of 4 journal clubs per academic year and encourages their involvement in the peer-review process.[2] Training programs can refer to the AGS 100 to select articles for journal clubs and other

Table 1. American Glaucoma Society 100: Articles with Significant Impact on Clinical Glaucoma Care

Rank	Article	Likert Score	Citations	Comments
1	Kass MA, Heuer DK, Higginbotham EJ, et al., Ocular Hypertension Treatment Study Group. The Ocular Hypertension Treatment Study: a randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma. *Arch Ophthalmol*. 2002;120:701-713.[4]	3.69	2426	RCT
2	Gordon MO, Beiser JA, Brandt JD, et al., Ocular Hypertension Treatment Study Group. The Ocular Hypertension Treatment Study: baseline factors that predict the onset of primary open-angle glaucoma. *Arch Ophthalmol*. 2002;120:714-720.[5]	3.67	1780	RCT
3	Brandt JD, Beiser JA, Kass MA, Gordon MO. Ocular Hypertension Treatment Study Group. Central corneal thickness in the Ocular Hypertension Treatment Study (OHTS). *Ophthalmology*. 2001;108:1779-1788.[6]	3.66	471	RCT
4	The Advanced Glaucoma Intervention Study (AGIS): 7. The relationship between control of intraocular pressure and visual field deterioration. The AGIS Investigators. *Am J Ophthalmol*. 2000;130:429-440.[7]	3.65	1951	RCT
5	Gedde SJ, Schiffman JC, Feuer WJ, et al., Tube Versus Trabeculectomy Study Group. Treatment outcomes in the Tube Versus Trabeculectomy (TVT) Study after five years of follow-up. *Am J Ophthalmol*. 2012;153:789-803.[8]	3.60	476	RCT
6	The effectiveness of intraocular pressure reduction in the treatment of normal-tension glaucoma. Collaborative Normal-Tension Glaucoma Study Group. *Am J Ophthalmol*. 1998;126:498-505.[9]	3.53	953	RCT
7	Comparison of glaucomatous progression between untreated patients with normal-tension glaucoma and patients with therapeutically reduced intraocular pressures. Collaborative Normal-Tension Glaucoma Study Group. *Am J Ophthalmol*. 1998;126:487-497.[10]	3.43	1134	RCT
8	Heijl A, Leske MC, Bengtsson B, et al., Early Manifest Glaucoma Trial Group. Reduction of intraocular pressure and glaucoma progression: results from the Early Manifest Glaucoma Trial. *Arch Ophthalmol*. 2002;120:1268-1279.[11]	3.35	2033	RCT
9	Cairns JE. Trabeculectomy. Preliminary report of a new method. *Am J Ophthalmol*. 1968;66:673-679.[12]	3.35	726	
10	Leske MC, Heijl A, Hussein M, et al., Early Manifest Glaucoma Trial Group. Factors for glaucoma progression and the effect of treatment: The Early Manifest Glaucoma Trial. *Arch Ophthalmol*. 2003;121:48-56.[13]	3.33	1325	RCT
11	Gazzard G, Konstantakopoulou E, Garway-Heath D, et al., LiGHT Trial Study Group. Selective laser trabeculoplasty versus eye drops for first-line treatment of ocular hypertension and glaucoma (LiGHT): a multicentre randomised controlled trial. *Lancet*. 2019;393:1505-1516.[14]	3.30	50	RCT
12	Azuara-Blanco A, Burr J, Ramsay C, et al., EAGLE Study Group. Effectiveness of early lens extraction for the treatment of primary angle-closure glaucoma (EAGLE): a randomised controlled trial. *Lancet*. 2016;388:1389-1397.[15]	3.27	120	RCT
13	Zimmerman TJ, Kaufman HE. Timolol. A beta-adrenergic blocking agent for the treatment of glaucoma. *Arch Ophthalmol*. 1977;95:601-604.[16]	3.26	324	
14	Grant WM, Burke JF Jr. Why do some people go blind from glaucoma? *Ophthalmology*. 1982;89:991-998.[17]	3.24	274	
15	Gedde SJ, Herndon LW, Brandt JD, et al., Tube Versus Trabeculectomy Study Group. Postoperative complications in the Tube Versus Trabeculectomy (TVT) Study during five years of follow-up. *Am J Ophthalmol*. 2012;153:804-814.[18]	3.20	356	RCT
16	Lichter PR, Musch DC, Gillespie BW, et al., CIGTS Study Group. Interim clinical outcomes in the Collaborative Initial Glaucoma Treatment Study comparing initial treatment randomized to medications or surgery. *Ophthalmology*. 2001;108:1943-1953.[19]	3.19	805	RCT
17	Palmer SS. Mitomycin as adjunct chemotherapy with trabeculectomy. *Ophthalmology*. 1991;98:317-321.[20]	3.19	541	
18	Leske MC, Heijl A, Hyman L, et al., EMGT Group. Predictors of long-term progression in the Early Manifest Glaucoma Trial. *Ophthalmology*. 2007;114:1965-1972.[21]	3.16	813	RCT
19	Musch DC, Gillespie BW, Lichter PR, et al., CIGTS Study Investigators. Visual field progression in the Collaborative Initial Glaucoma Treatment Study: the impact of treatment and other baseline factors. *Ophthalmology*. 2009;116:200-207.[22]	3.16	225	RCT
20	Christakis PG, Zhang D, Budenz DL, et al., ABC-AVB Study Groups. Five-year pooled data analysis of the Ahmed Baerveldt Comparison Study and the Ahmed Versus Baerveldt Study. *Am J Ophthalmol*. 2017;176:118-126.[23]	3.16	44	RCT
21	Wise JB, Witter SL. Argon laser therapy for open-angle glaucoma. A pilot study. *Arch Ophthalmol*. 1979;97:319-322.[24]	3.15	404	
22	Kass MA, Gordon MO, Gao F, et al., Ocular Hypertension Treatment Study Group. Delaying treatment of ocular hypertension: The Ocular Hypertension Treatment Study. *Arch Ophthalmol*. 2010;128:276-287.[25]	3.13	88	RCT
23	Latina MA, Sibayan SA, Shin DH, et al. Q-switched 532-nm Nd:YAG laser trabeculoplasty (selective laser trabeculoplasty): a multicenter, pilot, clinical study. *Ophthalmology*. 1998;105:2082-2088.[26]	3.11	299	
24	Drance S, Anderson DR, Schulzer M, Collaborative Normal-Tension Glaucoma Study Group. Risk factors for progression of visual field abnormalities in normal-tension glaucoma. *Am J Ophthalmol*. 2001;131:699-708.[27]	3.10	504	RCT
25	Nouri-Mahdavi K, Hoffman D, Coleman AL, et al. Advanced Glaucoma Intervention Study. Predictive factors for glaucomatous visual field progression in the Advanced Glaucoma Intervention Study. *Ophthalmology*. 2004;111:1627-1635.[28]	3.10	467	RCT
26	Sommer A, Tielsch JM, Katz J, et al. Relationship between intraocular pressure and primary open angle glaucoma among White and Black Americans. The Baltimore Eye Survey. *Arch Ophthalmol*. 1991;109:1090-1095.[29]	3.07	830	

(*Continued*)

Table 1. (Continued.)

Rank	Article	Likert Score	Citations	Comments
27	Becker B. Intraocular pressure response to topical corticosteroids. *Invest Ophthalmol*. 1965;4:198-205.[30]	3.07	272	
28	Tielsch JM, Sommer A, Katz J, et al. Racial variations in the prevalence of primary open-angle glaucoma. The Baltimore Eye Survey. *JAMA*. 1991;266:369-374.[31]	3.06	1005	
29	Camras CB. Comparison of latanoprost and timolol in patients with ocular hypertension and glaucoma: a six-month masked, multicenter trial in the United States. The United States Latanoprost Study Group. *Ophthalmology*. 1996;103:138-147.[32]	3.05	475	RCT
30	Chen CW, Huang HT, Bair JS, Lee CC. Trabeculectomy with simultaneous topical application of mitomycin-C in refractory glaucoma. *J Ocul Pharmacol*. 1990;6:175-182.[33]	3.05	407	
31	He M, Jiang Y, Huang S, et al. Laser peripheral iridotomy for the prevention of angle closure: a single-centre, randomised controlled trial. *Lancet*. 2019;393:1609-1618.[34]	3.05	25	RCT
32	Schuman JS, Hee MR, Puliafito CA, et al. Quantification of nerve fiber layer thickness in normal and glaucomatous eyes using optical coherence tomography. *Arch Ophthalmol*. 1995;113:586-596.[35]	3.02	687	
33	Campbell DG. Pigmentary dispersion and glaucoma. A new theory. *Arch Ophthalmol*. 1979;97:1667-1672.[36]	3.02	216	
34	Heuer DK, Parrish RK, Gressel MG, et al. 5-fluorouracil and glaucoma filtering surgery. II. A pilot study. *Ophthalmology*. 1984;91:384-394.[37]	3.01	275	
35	Bengtsson B, Olsson J, Heijl A, Rootzén H. A new generation of algorithms for computerized threshold perimetry, SITA. *Acta Ophthalmol Scand*. 1997;75:368-375.[38]	3.00	273	
36	Five-year follow-up of the Fluorouracil Filtering Surgery Study. The Fluorouracil Filtering Surgery Study Group. *Am J Ophthalmol*. 1996;121:349-366.[39]	2.98	374	RCT
37	Watson P, Stjernschantz J. A six-month, randomized, double-masked study comparing latanoprost with timolol in open-angle glaucoma and ocular hypertension. The Latanoprost Study Group. *Ophthalmology*. 1996;103:126-137.[40]	2.97	408	RCT
38	Fluorouracil Filtering Surgery Study one-year follow-up. The Fluorouracil Filtering Surgery Study Group. *Am J Ophthalmol*. 1989;108:625-635.[41]	2.95	369	RCT
39	Tielsch JM, Katz J, Singh K, et al. A population-based evaluation of glaucoma screening: The Baltimore Eye Survey. *Am J Epidemiol*. 1991;134:1102-1110.[42]	2.95	334	*
40	Ocular Hypertension Treatment Study Group, European Glaucoma Prevention Study Group, Gordon MO, Torri V, Miglior S, et al. Validated prediction model for the development of primary open-angle glaucoma in individuals with ocular hypertension. *Ophthalmology*. 2007;114:10-19.[43]	2.95	199	RCT
41	Sommer A, Katz J, Quigley HA, et al. Clinically detectable nerve fiber atrophy precedes the onset of glaucomatous field loss. *Arch Ophthalmol*. 1991;109:77-83.[44]	2.94	899	
42	Mansberger SL, Gordon MO, Jampel H, et al., Ocular Hypertension Treatment Study Group. Reduction in intraocular pressure after cataract extraction: The Ocular Hypertension Treatment Study. *Ophthalmology*. 2012;119:1826-1831.[45]	2.94	147	RCT *
43	The Glaucoma Laser Trial (GLT) and glaucoma laser trial follow-up study: 7. Results. Glaucoma Laser Trial Research Group. *Am J Ophthalmol*. 1995;120:718-731.[46]	2.90	243	RCT
44	Budenz DL, Barton K, Gedde SJ, et al., Ahmed Baerveldt Comparison Study Group. Five-year treatment outcomes in the Ahmed Baerveldt Comparison Study. *Ophthalmology*. 2015;122:308-316.[47]	2.89	106	RCT *
45	Skuta GL, Beeson CC, Higginbotham EJ, et al. Intraoperative mitomycin versus postoperative 5-fluorouracil in high-risk glaucoma filtering surgery. *Ophthalmology*. 1992;99:438-444.[48]	2.87	415	RCT
46	Gedde SJ, Feuer WJ, Lim KS, et al., Primary Tube Versus Trabeculectomy Study Group. Treatment outcomes in the Primary Tube Versus Trabeculectomy Study after 3 years of follow-up. *Ophthalmology*. 2020;127:333-345.[49]	2.87	11	RCT *
47	Kitazawa Y, Kawase K, Matsushita H, Minobe M. Trabeculectomy with mitomycin. A comparative study with fluorouracil. *Arch Ophthalmol*. 1991;109:1693-1698.[50]	2.84	471	RCT
48	Bengtsson B, Leske MC, Hyman L, Heijl A, Early Manifest Glaucoma Trial Group. Fluctuation of intraocular pressure and glaucoma progression in the Early Manifest Glaucoma Trial. *Ophthalmology*. 2007;114:205-209.[51]	2.84	286	RCT
49	Toris CB, Camras CB, Yablonski ME. Effects of PhXA41, a new prostaglandin F2 alpha analog, on aqueous humor dynamics in human eyes. *Ophthalmology*. 1993;100:1297-1304.[52]	2.81	385	RCT
50	Hattenhauer MG, Johnson DH, Ing HH, et al. The probability of blindness from open-angle glaucoma. *Ophthalmology*. 1998;105:2099-2104.[53]	2.78	221	*
51	Ehlers N, Bramsen T, Sperling S. Applanation tonometry and central corneal thickness. *Acta Ophthalmol (Copenh)*. 1975;53:34-43.[54]	2.76	692	
52	Caprioli J, Coleman AL. Intraocular pressure fluctuation a risk factor for visual field progression at low intraocular pressures in the Advanced Glaucoma Intervention Study. *Ophthalmology*. 2008;115:1123-1129.[55]	2.76	297	RCT
53	Nordstrom BL, Friedman DS, Mozaffari E, et al. Persistence and adherence with topical glaucoma therapy. *Am J Ophthalmol*. 2005;140:598-606.[56]	2.76	274	
54	The Advanced Glaucoma Intervention Study (AGIS): 4. Comparison of treatment outcomes within race. Seven-year results. *Ophthalmology*. 1998;105:1146-1164.[57]	2.75	176	RCT *
55	Klein BE, Klein R, Sponsel WE, et al. Prevalence of glaucoma. The Beaver Dam Eye Study. *Ophthalmology*. 1992;99:1499-1504.[58]	2.72	748	
56	Quigley HA, Miller NR, George T. Clinical evaluation of nerve fiber layer atrophy as an indicator of glaucomatous optic nerve damage. *Arch Ophthalmol*. 1980;98:1564-1571.[59]	2.72	242	

Table 1. (Continued.)

Rank	Article	Likert Score	Citations	Comments
57	Christakis PG, Kalenak JW, Tsai JC, et al. The Ahmed Versus Baerveldt Study: five-year treatment outcomes. *Ophthalmology*. 2016;123:2093-2102.[60]	2.72	61	RCT *
58	Leske MC, Wu SY, Hennis A, et al., BESs Study Group. Risk factors for incident open-angle glaucoma: The Barbados Eye Studies. *Ophthalmology*. 2008;115:85-93.[61]	2.71	452	
59	De Moraes CG, Hood DC, Thenappan A, et al. 24-2 visual fields miss central defects shown on 10-2 tests in glaucoma suspects, ocular hypertensives, and early glaucoma. *Ophthalmology*. 2017;124:1449-1456.[62]	2.70	48	
60	Quigley HA, Addicks EM, Green WR, Maumenee AE. Optic nerve damage in human glaucoma. II. The site of injury and susceptibility to damage. *Arch Ophthalmol*. 1981;99:635-649.[63]	2.69	823	
61	Hayreh SS, Zimmerman MB, Podhajsky P, Alward WL. Nocturnal arterial hypotension and its role in optic nerve head and ocular ischemic disorders. *Am J Ophthalmol*. 1994;117:603-624.[64]	2.69	630	*
62	Bindlish R, Condon GP, Schlosser JD, et al. Efficacy and safety of mitomycin-C in primary trabeculectomy: five-year follow-up. *Ophthalmology*. 2002;109:1336-1341.[65]	2.69	245	
63	Risk factors for suprachoroidal hemorrhage after filtering surgery. The Fluorouracil Filtering Surgery Study Group. *Am J Ophthalmol*. 1992;113:501-507.[66]	2.69	60	RCT
64	Quigley HA, Dunkelberger GR, Green WR. Retinal ganglion cell atrophy correlated with automated perimetry in human eyes with glaucoma. *Am J Ophthalmol*. 1989;107:453-464.[67]	2.68	857	
65	Miglior S, Zeyen T, Pfeiffer N, et al., European Glaucoma Prevention Study (EGPS) Group. Results of the European Glaucoma Prevention Study. *Ophthalmology*. 2005;112:366-375.[68]	2.68	248	RCT
66	Quigley HA, Katz J, Derick RJ, et al. An evaluation of optic disc and nerve fiber layer examinations in monitoring progression of early glaucoma damage. *Ophthalmology*. 1992;99:19-28.[69]	2.65	465	
67	Medeiros FA, Zangwill LM, Bowd C, et al. Evaluation of retinal nerve fiber layer, optic nerve head, and macular thickness measurements for glaucoma detection using optical coherence tomography. *Am J Ophthalmol*. 2005;139:44-55.[70]	2.65	450	
68	Quigley HA. Number of people with glaucoma worldwide. *Br J Ophthalmol*. 1996;80:389-393.[71]	2.64	1829	
69	Leske MC, Connell AM, Wu SY, et al. Risk factors for open-angle glaucoma. The Barbados Eye Study. *Arch Ophthalmol*. 1995;113:918-924.[72]	2.64	513	
70	Greenfield DS, Siatkowski RM, Glaser JS, et al. The cupped disc. Who needs neuroimaging? *Ophthalmology*. 1998;105:1866-1874.[73]	2.64	79	
71	Alm A, Stjernschantz J. Effects on intraocular pressure and side effects of 0.005% latanoprost applied once daily, evening or morning. A comparison with timolol. Scandinavian Latanoprost Study Group. *Ophthalmology*. 1995;102:1743-1752.[74]	2.63	493	RCT
72	Heijl A, Lindgren A, Lindgren G. Test-retest variability in glaucomatous visual fields. *Am J Ophthalmol*. 1989;108:130-135.[75]	2.63	299	
73	Tham YC, Li X, Wong TY, et al. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. *Ophthalmology*. 2014;121:2081-2090.[76]	2.62	1547	
74	Greenfield DS, Suñer IJ, Miller MP, et al. Endophthalmitis after filtering surgery with mitomycin. *Arch Ophthalmol*. 1996;114:943-949.[77]	2.61	308	
75	Khaw PT, Chiang M, Shah P, et al. Enhanced trabeculectomy: The Moorfields Safer Surgery System. *Dev Ophthalmol*. 2017;59:15-35.[78]	2.61	14	
76	Leibowitz HM, Krueger DE, Maunder LR, et al. The Framingham Eye Study monograph: An ophthalmological and epidemiological study of cataract, glaucoma, diabetic retinopathy, macular degeneration, and visual acuity in a general population of 2631 adults, 1973-1975. *Surv Ophthalmol*. 1980;24(Suppl):335-610.[79]	2.59	787	
77	Anderson DR. Trabeculotomy compared to goniotomy for glaucoma in children. *Ophthalmology*. 1983;90:805-806.[80]	2.59	117	
78	Hayreh SS. Blood supply of the optic nerve head and its role in optic atrophy, glaucoma, and oedema of the optic disc. *Br J Ophthalmol*. 1969;53:721-748.[81]	2.58	479	
79	Parrish RK, Palmberg P, Sheu WP, XLT Study Group. A comparison of latanoprost, bimatoprost, and travoprost in patients with elevated intraocular pressure: a 12-week, randomized, masked-evaluator multicenter study. *Am J Ophthalmol*. 2003;135:688-703.[82]	2.58	362	RCT
80	Malihi M, Moura Filho ER, Hodge DO, Sit AJ. Long-term trends in glaucoma-related blindness in Olmsted County, Minnesota. *Ophthalmology*. 2014;121:134-141.[83]	2.58	41	*
81	Samuelson TW, Katz LJ, Wells JM, et al., US iStent Study Group. Randomized evaluation of the trabecular micro-bypass stent with phacoemulsification in patients with glaucoma and cataract. *Ophthalmology*. 2011;118:459-467.[84]	2.57	256	RCT
82	Lowe RF. Aetiology of the anatomical basis for primary angle-closure glaucoma. Biometrical comparisons between normal eyes and eyes with primary angle-closure glaucoma. *Br J Ophthalmol*. 1970;54:161-169.[85]	2.55	365	
83	Pederson JE, Anderson DR. The mode of progressive disc cupping in ocular hypertension and glaucoma. *Arch Ophthalmol*. 1980;98:490-495.[86]	2.55	322	
84	Quigley HA, Addicks EM, Green WR. Optic nerve damage in human glaucoma. III. Quantitative correlation of nerve fiber loss and visual field defect in glaucoma, ischemic neuropathy, papilledema, and toxic neuropathy. *Arch Ophthalmol*. 1982;100:135-146.[87]	2.54	932	
85	Van Herick W, Shaffer RN, Schwartz A. Estimation of width of angle of anterior chamber. Incidence and significance of the narrow angle. *Am J Ophthalmol*. 1969;68:626-629.[88]	2.54	319	

(*Continued*)

Table 1. (Continued.)

Rank	Article	Likert Score	Citations	Comments
86	Samuelson TW, Chang DF, Marquis R, et al., HORIZON Investigators. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology*. 2019;126:29-37.[89]	2.54	31	RCT
87	Leske MC, Connell AM, Schachat AP, Hyman L. The Barbados Eye Study. Prevalence of open angle glaucoma. *Arch Ophthalmol*. 1994;112:821-829.[90]	2.53	497	
88	Varma R, Ying-Lai M, Francis BA, et al., Los Angeles Latino Eye Study Group. Prevalence of open-angle glaucoma and ocular hypertension in Latinos: The Los Angeles Latino Eye Study. *Ophthalmology*. 2004;111:1439-1448.[91]	2.53	296	
89	Singh K, Mehta K, Shaikh NM, et al. Trabeculectomy with intraoperative mitomycin C versus 5-fluorouracil. Prospective randomized clinical trial. *Ophthalmology*. 2000;107:2305-2309.[92]	2.53	141	RCT *
90	Chen PP, Lin SC, Junk AK, et al. The effect of phacoemulsification on intraocular pressure in glaucoma patients: a report by the American Academy of Ophthalmology. *Ophthalmology*. 2015;122:1294-1307.[93]	2.53	95	*
91	Asrani S, Zeimer R, Wilensky J, et al. Large diurnal fluctuations in intraocular pressure are an independent risk factor in patients with glaucoma. *J Glaucoma*. 2000;9:134-142.[94]	2.52	643	
92	Advanced Glaucoma Intervention Study. 2. Visual field test scoring and reliability. *Ophthalmology*. 1994;101:1445-1455.[95]	2.51	380	RCT
93	Armaly MF, Krueger DE, Maunder L, et al. Biostatistical analysis of the collaborative glaucoma study. I. Summary report of the risk factors for glaucomatous visual-field defects. *Arch Ophthalmol*. 1980;98:2163-2171.[96]	2.51	280	
94	Argus WA. Ocular hypertension and central corneal thickness. *Ophthalmology*. 1995;102:1810-1812.[97]	2.51	247	*
95	Samuelson TW, Sarkisian SR Jr, Lubeck DM, et al., iStent inject Study Group. Prospective, randomized, controlled pivotal trial of an ab interno implanted trabecular micro-bypass in primary open-angle glaucoma and cataract: two-year results. *Ophthalmology*. 2019;126:811-821.[98]	2.51	22	RCT
96	Musch DC, Gillespie BW, Palmberg PF, et al. Visual field improvement in the Collaborative Initial Glaucoma Treatment Study. *Am J Ophthalmol*. 2014;158:96-104.[99]	2.50	23	RCT
97	Liu JH, Zhang X, Kripke DF, Weinreb RN. Twenty-four-hour intraocular pressure pattern associated with early glaucomatous changes. *Invest Ophthalmol Vis Sci*. 2003;44:1586-1590.[100]	2.49	306	
98	Serle JB, Katz LJ, McLaurin E, et al., ROCKET-1 and ROCKET-2 Study Groups. Two Phase 3 clinical trials comparing the safety and efficacy of netarsudil to timolol in patients with elevated intraocular pressure: Rho Kinase Elevated IOP Treatment Trial 1 and 2 (ROCKET-1 and ROCKET-2). *Am J Ophthalmol*. 2018;186:116-127.[101]	2.48	50	RCT
99	Stone EM, Fingert JH, Alward WL, et al. Identification of a gene that causes primary open angle glaucoma. *Science*. 1997;275:668-670.[102]	2.47	1150	
100	Migdal C, Gregory W, Hitchings R. Long-term functional outcome after early surgery compared with laser and medicine in open-angle glaucoma. *Ophthalmology*. 1994;101:1651-1656.[103]	2.47	291	RCT

RCT = randomized clinical trial.
*Article was a "write-in" response in the original survey that was subsequently rated in the follow-up survey.

didactics. In addition, landmark study results are among the topics tested in the Ophthalmic Knowledge Assessment Program, American Board of Ophthalmology Written Qualifying Exam, and American Board of Ophthalmology Continuing Certification program.[106] The latter includes subspecialty-specific Knowledge Assessment and Article-Based Learning modules,[106] but these are limited in scope. Practicing ophthalmologists can use the AGS 100 to augment their required maintenance of certification activities.

In 1988, Eddy and Billings[107] described a lack of adequate evidence supporting the effectiveness of medical treatment for glaucoma in their report to the National Leadership Commission on Health Care. The following decade witnessed a burgeoning of multicenter randomized clinical trials within the glaucoma community, and this is reflected in the large number of AGS 100 articles published in the 1990s (Fig 1). Well-designed, prospective, randomized clinical trials provide the highest level of scientific evidence. The randomization process is intended to eliminate bias, creating treatment groups that differ only by the intervention performed. Since the 1990s, landmark glaucoma trials have produced valuable evidence regarding the benefit of intraocular pressure reduction with medications, laser therapy, and surgery, and the AGS 100 reflects their significant influence on clinical practice. In our surveys of the AGS membership, respondents selected more than 1 paper from each of 10 randomized clinical trials (i.e., AGIS, Ahmed Baerveldt Comparison, Ahmed Versus Baerveldt, CIGTS, CNTGS, EMGT, EGPS, Fluorouracil Filtering Surgery Study, OHTS, and TVT), and in many cases provided "write-in" suggestions for publications from trials that were already represented in the original survey.

Nonetheless, randomized clinical trials do not always influence clinical practice patterns, as has been observed in several peer surveys.[108-110] Panarelli et al[110] surveyed the AGS membership in 2012 and observed wide variability in the reported clinical impact of 8 landmark glaucoma trials, all of which are represented within the AGS 100 (OHTS, CNTGS, AGIS, TVT, EMGT, CIGTS, Glaucoma Laser Trial, EGPS). While a large percentage of survey participants agreed that OHTS (94.4%) and CNTGS (84.5%) significantly impacted their clinical practice, a smaller proportion reported a significant impact from the CIGTS (52.9%) and Glaucoma Laser Trial (49.8%). The clinical impact of more recent

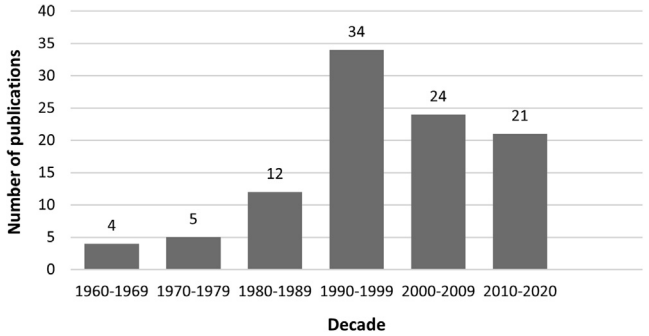

Figure 1. The number of publications included in the American Glaucoma Society (AGS) 100 by decade.

randomized clinical trials represented in the AGS 100 (such as those supporting initial treatment with selective laser trabeculoplasty for ocular hypertension and primary open-angle glaucoma[14] and early lens extraction for primary angle-closure glaucoma[15]) remains to be seen. Many barriers to translating the results of randomized clinical trials into clinical practice exist.[109-114] These include the complexity of study findings,[109] variations in the quality of study design and implementation,[113] and misinterpretation and misapplication of study findings.[112-114]

Our 3-part methodology had several strengths. Bibliometric analyses offer a historical perspective on the evolution of research topics within a particular medical field and on progress made with regard to our understanding of the pathophysiology, diagnostic evaluation, and treatment of a given disease. In bibliometrics, the citation number serves as a proxy for an article's influence within the scientific community and is used to calculate the impact factor for journals. We used an expert panel (the AAO PPP Glaucoma Panel) to identify newer publications lacking sufficient longevity to accrue many citations as well as "classic" papers that may not be cited as frequently because their conclusions are now considered standard knowledge (i.e., the phenomenon of obliteration by incorporation[115]). Finally, surveying the AGS membership allowed us to develop a list that represents the glaucoma community at large. Use of a Likert-scale design improved the psychometric validity of our surveys and enabled quantitative analysis of results. We offered survey respondents the option of indicating that they were not acquainted with a given article to avoid having participants assign lower ratings to unfamiliar articles.

Table 2. Journals Represented in the American Glaucoma Society 100

Journal	No. of Articles	Impact Factor[104]
Ophthalmology	42	8.470
American Journal of Ophthalmology	21	4.013
Archives of Ophthalmology	20	6.198*
British Journal of Ophthalmology	3	3.611
Lancet	3	60.390
Acta Ophthalmologica	2	3.362
Investigative Ophthalmology & Visual Science	2	3.470
American Journal of Epidemiology	1	4.526
Developments in Ophthalmology	1	†
Journal of Glaucoma	1	1.992
Journal of Ocular Pharmacology	1	1.961
Journal of the American Medical Association	1	45.540
Science	1	41.846
Survey of Ophthalmology	1	4.195

Impact factors are derived from the 2019 Web of Science Journal Citation Reports database.[104]
*Impact factor is provided for *JAMA Ophthalmology* (formerly *Archives of Ophthalmology*).
†*Developments in Ophthalmology* is not listed in the Web of Science Journal Citation Reports.

Our study also has several limitations. The number of citations accumulated by a given article does not reflect the quality of study design or implementation. Bibliometric analyses do not identify the newer literature, a limitation that we sought to address by involving an expert panel and including a "write-in" response option within our original survey of the AGS membership. Despite this, we may not have successfully identified all current topics of interest. An expert panel may introduce potential bias based on the significance each member attaches to a particular research topic. We attempted to limit such bias by disallowing expert panelists from nominating publications authored by any panel member. Interestingly, 5 articles[45,47,49,92,93] co-authored by an expert panelist were nominated by the AGS membership via the "write-in" option in our original survey, and subsequently received a sufficiently high mean Likert score in our follow-up survey to be included in the AGS 100. However, our strategy to limit bias from the expert panel may have resulted in the exclusion of other clinically impactful articles published by members of the PPP Glaucoma Panel. Although we intended the AGS 100 to reflect the consensus of the AGS membership, we received a low response rate to both of our surveys. The upgrade to the AGS website in 2019 (i.e., the transition from the AGSnet Listserv to the Open Forum) altered the mechanism by which AGS members accessed online posts, including our survey announcements. This may have contributed to the low response rate from AGS members. In addition, the AGS membership consists of glaucoma fellowship-trained ophthalmologists but is not inclusive of the entire community of ophthalmologists who provide care to patients with glaucoma. The anonymous nature of our survey did not permit comparison of AGS members who did and did not participate to assess for nonresponse bias. Additionally, respondents may have recommended their own publications in their "write-in" responses, which led us to distribute a follow-up Likert scale survey to rate those suggestions more objectively. We specifically aimed to identify articles with the greatest clinical impact, and our results therefore may not represent topics (e.g., genetics) that are important to the field of glaucoma but not directly relevant to clinical practice. Our methodology may have undervalued topics, such as perimetry, for which no single article has been seminal.

In conclusion, the AGS 100 represents an amalgamation of clinically impactful articles generated from a bibliometric analysis, expert panel, and surveys of the AGS membership. The list includes frequently cited as well as newer and "classic" papers spanning 6 decades of progress in glaucoma research and innovation. Our initial

list will undergo periodic revisions and updates in the future to reflect the most current literature and consensus of the growing AGS membership. We hope the AGS 100 will serve as a valuable educational resource for ophthalmologists and trainees to support the practice of evidence-based ophthalmology.

Footnotes and Disclosures

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Data collection: Vinod, Gedde, Ramulu

Analysis and interpretation: Vinod, Gedde, Ramulu

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Abbreviations and Acronyms:

AAO = American Academy of Ophthalmology; **AGIS** = Advanced Glaucoma Intervention Study; **AGS** = American Glaucoma Society; **CIGTS** = Collaborative Initial Glaucoma Treatment Study; **CNTGS** = Collaborative Normal Tension Glaucoma Study; **EGPS** = European Glaucoma Prevention Study; **EMGT** = Early Manifest Glaucoma Trial; **OHTS** = Ocular Hypertension Treatment Study; **PPP** = Preferred Practice Pattern; **RCT** = randomized clinical trial; **TVT** = Tube Versus Trabeculectomy.

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