AGS Mission Statement

The mission of the American Glaucoma Society is to promote excellence in the care of patients with glaucoma and preserve or enhance vision by supporting glaucoma specialists and scientists through the advancement of education and research.

The American Glaucoma Society thanks

Aerie Pharmaceuticals

Alcon

Bausch + Lomb

For supporting the educational portions of the 25th Annual Meeting.
Letter of Welcome

Welcome to lovely Coronado, California, where we gather for the 25th Annual Meeting of the American Glaucoma Society!

Your Program Committee members, Christopher Girkin, Steve Gedde, David Friedman, Michele Lim, Joseph Caprioli, Brian Francis, Felipe Medeiros, Janey Wiggs, and Neeru Gupta, have worked diligently to bring you an outstanding conference covering many different facets of our field. We were fortunate to receive a large number of abstract submissions this year, and our programming emphasizes both quality and quantity in a balance of papers, posters, and symposia. Based on AGS member responses to online surveys about the meeting, we have maintained a successful mix of symposia, free papers, and discussion time. The total number of platform papers has remained steady, and the number of poster presentations has been expanded. We will continue to use the Audience Response System that was successfully introduced at the 2012 Annual Meeting.

The honoree for the 2015 AGS Annual Meeting is David Epstein, of Durham, North Carolina. David’s spouse, Susan, and son Michael will be present to accept this honor on his behalf. The AGS Lecture (Friday afternoon) will be presented by Paul Lee, formerly of Duke University and now located in Ann Arbor, Michigan, at the University of Michigan, Kellogg Eye Center. The 16th AGS Clinician-Scientist Lecture, on Saturday morning, will be presented by Claude Burgoyne, of Portland, Oregon. The recipient of the 2015 AGS President’s Award is M. Roy Wilson, of Detroit, Michigan. The Sixth Annual AGS Glaucoma Surgery Day Lecturer is Ike Ahmed, of Ontario, Canada. The recipient of the AGS Innovator Award is Tony Molteno, of Dunedin, New Zealand, and the International Recognition awardee is Anders Heijl, of Sweden. Don Budenz, of Chapel Hill, North Carolina, is the recipient of the AGS Humanitarian Award.

This year, the meeting will hit the ground running with a special joint symposium with the North American Neuro-Ophthalmology Society (NANOS) scheduled on Thursday morning, followed by AGS-featured symposia and paper presentations in the afternoon. On Thursday evening, just prior to the opening reception, please join us for a special guest lecturer. Following the guest lecture, we will gather to network and mingle with our friends and colleagues and to meet new AGS members and guests during the Welcome Reception, which will be held at the Sundeck of the Hotel del Coronado.

Friday morning will begin with a sunrise yoga session, followed by the Sixth annual AGS Glaucoma Surgery Day, organized by Brian Francis and Michele Lim. Surgery Day is devoted to novel and traditional approaches to glaucoma surgery. We will kick off Surgery Day by honoring our Surgery Day Lecturer, Ike Ahmed, who will be presenting his lecture first thing in the morning. The day will follow suit with an exciting program that will include surgery symposia, surgery paper presentations, and the surgical video presentation.

On Saturday morning, plan to join us for the AGS Fun Run/Walk, where you can move at your own pace and enjoy the backdrop of the Pacific Ocean. Poster sessions and oral presentations will follow, beginning with free paper sessions, symposium, and the Clinician-Scientist Lecture, presented by Claude Burgoyne.
As in past years, we start early on Sunday morning, beginning at 7 AM, with eight concurrent Breakfast Roundtable Discussions that will allow small group interaction in a casual setting: MIGS 1, Maximizing Use of an Electronic Health Record in a Glaucoma Practice, MIGS 2, My Top Two Disasters, New Developments in OCT Imaging for Glaucoma: Update on the Macula, Management of Tube Complications, The Prevention of Complications from Trabeculectomy, and Would My Patient Benefit from Genetic Testing? We will end this year’s meeting with two concurrent workshops that have been very well received for many years: (1) Super Bowl of Grand Rounds and (2) Conquering Coding and ICD-10, Avoiding PQRS, and VBM Penalties.

The 25th AGS Annual Meeting promises to be educationally, socially, and personally rewarding for all attendees. We look forward to seeing you at the Hotel del Coronado!

David S. Greenfield, MD
President

Christopher A. Girkin, MD, MSPH
Program Chair
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Leadership and Program Committee

Board of Directors
David S. Greenfield, MD – President
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L. Jay Katz, MD – Treasurer
Thomas W. Samuelson, MD – Councilor to AAO
Dale K. Heuer, MD – Member-at-Large
Marlene R. Moster, MD – Member-at-Large
Joshua D. Stein, MD, MS – Member-at-Large
Louis R. Pasquale, MD – Research Chair
Shan C. Lin, MD – Patient Care Chair /
Nominating Committee Chair
James D. Brandt, MD – Education and Communication Chair
Donald L. Budenz, MD, MPH – Bylaws & Strategic Planning Chair
Christopher A. Girkin, MD, MSPH – Program Chair
Jeffrey M. Liebmann, MD – Past President 2011-2012
Kuldev Singh, MD, MPH – Past President 2013-2014

Past Presidents
George L. Spaeth, MD: 1986-1988
Richard J. Simmons, MD: 1989-1990
Allan E. Kolker, MD: 1993-1994
M. Bruce Shields, MD: 1995-1996
Richard A. Lewis, MD: 2001-2002
Richard P. Wilson, MD: 2003-2004
Gregory L. Skuta, MD: 2005-2006
Robert N. Weinreb, MD: 2007-2008
Theodore Krupin, MD: 2009-2010
Jeffrey M. Liebmann, MD: 2011-2012
Kuldev Singh, MD, MPH: 2013-2014

Program Committee
Christopher A. Girkin, MD, MSPH – Chair
Steven J. Gedde, MD – Vice Chair
Brian A. Francis, MD – Surgery Day Co-chair
Michele C. Lim, MD – Surgery Day Co-chair
Joseph A. Caprioli, MD
David S. Friedman, MD, MPH, PhD
Neeru Gupta, MD, PhD, MBA – ex-Officio
Felipe A. Medeiros, MD, PhD
Janey L. Wiggs, MD, PhD

Goal of the AGS Annual Meeting
The goal of this meeting is to provide members and guests of the American Glaucoma Society a professionally stimulating forum in which they can exchange information and ideas regarding the diagnosis and treatment of glaucoma and present new developments in glaucoma research.

Administrative Offices
American Glaucoma Society
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San Francisco, CA 94109
415.561.8587 FAX 415.561.8531
ags@aao.org
www.americanglaucomasociety.net

Accreditation Statement
This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education through the joint providership of the American Academy of Ophthalmology and American Glaucoma Society. The American Academy of Ophthalmology is accredited by the ACCME to provide continuing medical education for physicians.

Credit Designation Statement
The American Academy of Ophthalmology designates this live activity for a maximum of 23.50 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.
AGS Foundation

Mission of the Foundation

The mission of the American Glaucoma Society Foundation is to support glaucoma research and education and to promote excellence in the care of patients with glaucoma.

The Board of Directors is charged with overseeing these efforts by identifying unmet needs, devising strategies to address them, and advancing the field through support of research, education, and training.

Each of the stakeholders in our field (patients, clinicians, scientists, industry, government and non-governmental organizations) plays a vital role; collaboration is critical for success. We strive to support and create programs that will make the difference in our field and for our patients.

Help us make a difference!

Board of Directors

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L. Jay Katz, MD – Treasurer
James D. Brandt, MD
Donald L. Budenz, MD, MPH
Christopher A. Girkin, MD, MSPH
Dale K. Heuer, MD
Jeffrey M. Liebmann, MD
Shan C. Lin, MD
Marlene R. Moster, MD
Mildred M.G. Olivier, MD
Louis R. Pasquale, MD
Thomas W. Samuelson, MD
Arthur L. Schwartz, MD
Kuldev Singh, MD, MPH
George L. Spaeth, MD
Joshua D. Stein, MD, MS
Robert N. Weinreb, MD
American Glaucoma Society (AGS) Policies

AGS 25th Annual Meeting Conflict of Interest Issues

The AGS Program Committee takes conflicts of interest very seriously and expects all AGS Members to do the same. All participants in the program have submitted a financial disclosure form which has been reviewed by the Program Chairs and Program Committee. A Conflict of Interest form is used when deemed appropriate. An example of the Conflict of Interest Resolution Form is shown below. If you have any concerns about the content or perceived conflicts of interest in the Annual Program, please bring them to the attention of the Program Committee Chair, Dr. Christopher Girkin, or Vice Chair, Dr. Steve Gedde, or the Chair of the AGS Ethics Task Force, Dr. Cynthia Mattox, as soon as possible.

Example of Financial Conflict Resolution Form

All financial conflicts of interest must be resolved. CME providers require that everyone who is in a position to control the content of an educational activity disclose all financial relationships with any commercial interest within the past 12 months. Those whose conflicts are not resolved must be disqualified.

Please select one or more that apply to resolve your conflict.

There is a conflict of interest related to the content material, and you must:

- limit the conflict to report information that is related to the conflicted without recommendations
- reference the “best available evidence in literature,” the grade or level of that evidence and identify the conclusions that the evidence supports
- step aside and allow someone else to present
- discontinue your relationship with the commercial entity

Disclosure and Resolution of Conflict of Interest Policy

AGS ensures that all leaders, volunteers, staff, or any individuals involved in planning and production of AGS activities will disclose any and all potential conflicts of interest and resolve them prior to the activity.

Procedure

The process for ensuring compliance with this policy applies a multi-step approach including prevention and monitoring/evaluation.

Identification

All individuals who are involved with planning activities must sign and submit a financial disclosure form prior to planning the activity. All financial relationships with any commercial interest must be disclosed. Individuals subject to this requirement include, but are not limited to, activity course directors and program chairs, planning committee members, faculty/speakers/presenters, authors, editors, expert reviewers, moderators, panel members, and AGS staff in position to control content. All financial disclosures must be provided through the AGS online disclosure form or in another pre-approved format.

Financial relationships must be disclosed to learners prior to the continuing education activity. Information provided in this manner includes the name of the individual, the name of the commercial interest(s), and the nature of the relationship the person has
with the commercial interest(s). If an individual has no relevant relationship, then this must also be disclosed in advance to the learning audience.

**Resolution**

All faculty and non-faculty involved with the planning or implementation of an activity who disclose a conflict of interest must resolve that conflict prior to the activity. Appropriate mechanisms for resolution will be identified by the Program Committee and can include the following:

**Non-faculty Resolution**

A non-faculty member (e.g., staff) who has an identified conflict of interest will be asked to excuse themselves from any discussion/decision-making process where the conflict of interest would come into play.

**Faculty Member Resolution**

Peer Review: A faculty member with a conflict of interest must submit his/her work to a panel for peer review. Recommendations of the panel, as it relates to conflict, must be taken. If the faculty member refuses the recommendations they will be asked to resign and a new faculty member will be appointed.

Or

Evidence Based: Material to be presented must be the best available evidence in the literature, supported by the grade or level of that evidence and by identifying the conclusions that the evidence supports.

Or

Other methods deemed appropriate by AGS.

**Refusal to Disclose**

**Non-faculty**

If a non-faculty member refuses to disclose conflicts of interest then that person will be asked to step down from the position requiring disclosure of conflicts of interest.

**Faculty Member**

If a faculty member refuses to disclose they will be replaced and not considered to present until such disclosures are made.

**Additional Information**

Additional information may be requested of faculty/non-faculty to assist in the resolution of conflict of interest. Resolution of the conflict of interest must also be disclosed to the audience in advance.

**Off-Label Disclosure**

In addition, all faculty members are required to disclose to learners off-label and/or investigational use of a product and any limitations on the information presented, including preliminary data, anecdotal evidence, or unsupported opinion.

**Evaluation/Monitoring for Bias**

CME activity participants are surveyed about perceived commercial bias as part of the post-activity evaluation.

**Diversity Policy**

The Board of Directors of the AGS recognizes that this organization is best served by representation from the broadest possible diversity of member background, experience, and professional activities setting. As a policy, the Board of Directors is committed to diverse representation on the Board and its committees and staff without regard to race, religion, national origin, sexual orientation, age, gender, or physical disability.

AGS BOD Approved – March 2010
CME Violations

When a potential violation of Accrediting Council for Continuing Medical Education (ACCME) rules occurs during a CME-generating activity at an annual AGS meeting or other AGS event, the Program Committee Chair, if he/she has not personally witnessed the violation, will initiate an investigation into the occurrence by speaking with selected members of the audience, as well as the speaker(s) charged with the violation. The Program Committee Chair may request copies of the presentation materials including slides and outlines. The program committee will review the results of the investigation. The Program Committee may require consultation with the CME-accrediting body to determine if a violation has occurred. If it is determined that a violation exists, the Program Committee Chair will communicate directly with the offender to educate him/her on the nature of the violation, review ACCME rules, and issue a warning that potential penalties for future violations may include inability to present at future meetings. Copies of all communication in this regard will be filed with the CME accrediting body.

If an individual commits a second violation, the Program Committee Chair will convene the Program Committee to review the details of both violations and to issue a recommendation to the AGS Board of Directors (BOD) regarding an appropriate penalty for the individual. The AGS BOD may accept, deny, or modify the Program Committee recommendations. The Program Committee Chair (alone or together with the AGS president) will then communicate this final decision to the offending individual.

AGS Board Approved – October 2014
# CME Financial Disclosures of Board of Directors, Program Committee, and Participants

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant/Advisor</td>
<td>C</td>
<td>Consultant fee, paid advisory boards or fees for attending a meeting (for the past 1 year)</td>
</tr>
<tr>
<td>Employee</td>
<td>E</td>
<td>Employed by a commercial entity</td>
</tr>
<tr>
<td>Lecture Fees</td>
<td>L</td>
<td>Lecture fees (honoraria), travel fees or reimbursements when speaking at the invitation of a commercial entity (for the past 1 year)</td>
</tr>
<tr>
<td>Equity Owner</td>
<td>O</td>
<td>Equity ownership/stock options of publicly or privately traded firms (excluding mutual funds) with manufacturers of commercial ophthalmic products or commercial ophthalmic services</td>
</tr>
<tr>
<td>Patents/Royalty</td>
<td>P</td>
<td>Patents and/or royalties that might be viewed as creating a potential conflict of interest</td>
</tr>
<tr>
<td>Grant Support</td>
<td>S</td>
<td>Grant support for the past 1 year (all sources) and all sources used for this project if this form is an update for a specific talk or manuscript with no time limitation</td>
</tr>
</tbody>
</table>

**Ahmed, MD, Iqbal Ike K.**  
C – Aquesys, Transcend Medical, Abbott Medical Optics, Carl Zeiss Meditec, InnFocus, Stroma, Ivantis, Alcon Laboratories, Clarity Medical Systems, Iridex, Science Based Health, Allergan, Aerie Pharmaceuticals, Croma Pharma, Envisia Therapeutics, ForSight Labs, Ade Therapeutics, Omega Ophthalmics, Ono Pharma, Glaukos, ACE Vision Group, Oculus

**Caron, PhD, Marc G.**  
C – Lundbeck

**Challa, MD, Pratap**  
S – NEI  
O – Aerie Pharmaceuticals

**Chang, MD, Robert T.**  
C – Carl Zeiss Meditec, Allergan, Transcend Medical  
P – EyeGo

**Chen, MD, Teresa**  
S – National Institutes of Health UL1  
RR 025758, Massachusetts Lions Eye Research Fund, Inc., Fidelity Charitable Fund, The American Glaucoma Society Mid-Career Award

**Chiu, OD, Gloria B.**  
C – Allergan

**Chopra, MD, Vikas**  
C – Allergan

**Coleman, MD, PhD, Anne**  
C – Allergan

**Costarides, MD, PhD, Anastasios P.**  
C – Glaukos, Inc.  
S – Allergan, Inc.

**Crichton, MD, Andrew C.**  
C – Allergan, Inc., Alcon Canada  
S – Canadian Institute for Health Research

**De Moraes, MD, MPH, C. Gustavo**  
S – Sensimed

**Demetriades, MD, PhD, Anna-Maria**  
S – Research to Prevent Blindness Career Development Award, BrightFocus Foundation National Glaucoma Research Grant

**Downs, PhD, J. Crawford**  
C – Sensimed, AG  
S – National Institutes of Health, Research to Prevent Blindness, EyeSight Foundation of Alabama

**Fechtner, MD, Robert D.**  
C – Alcon Laboratories  
S – Bausch + Lomb, Alcon Laboratories

**Feldman, MD, Robert M.**  
C – Alcon Laboratories  
S – Tomey Corporation  
L – Alcon Laboratories

**Fellman, MD, Ronald**  
C – EndoOptiks

**Flanagan, PhD, John G.**  
C – Carl Zeiss Meditec  
L – Heidelberg Engineering  
S – Optovue, Inc.  
S – Photon

**Fortune, OD, PhD, Brad**  
S – Heidelberg Engineering, GmbH

**Francis, MD, Brian**  
C – Allergan, Neomedix Corp., EndoOptiks  
S – Aquesys, Lumenis
Freedman, MD, PhD, Jeffrey
S – IOP, Inc.

Gedde, MD, Steven J.
C – Alcon, Allergan

Giaconi, MD, JoAnn A.
L – Allergan

Gibson, PhD, Daniel J.
S – Sentinel Diagnostics, Inc.

Girkin, MD, PhD, Christopher A.
S – National Eye Institute, EyeSight
Foundation of Alabama, SOLX, Carl
Zeiss

Godfrey, MD, David G.
L – Alcon Laboratories

Gong, MD, PhD, Haiyan
S – NIH/NEI, The Massachusetts Lions
Eye Research Fund

Gould, Lisa F.
C – Novartis

Greenfield, MD, David S.
C – Allergan, Alcon Laboratories, Bausch
+ Lomb, Senju
S – Heidelberg Engineering, National Eye
Institute, Optovue, Carl Zeiss Meditec

Gross, MD, Ronald L.
C – Allergan, Alcon, Intelligent Retinal
Imaging Systems, Reichert
L – Allergan
S – Allergan, Alcon

Grover, MD, MPH, Davinder S.
L – Alcon Laboratories, Allergan, Tissue
Bank International

Gupta, MD, PhD, MBA, Neeru
C – Bausch + Lomb
S – Canadian Institutes of Health
Research, Glaucoma Research Society
of Canada

Gupta, MD, Sunil
C – Alcon Laboratories, Allergan
O – IRIS

Harris, MS, PhD, Alon A.
C – Biolight, Nano Retina, Science Based
Health, ONO, Isarna Therapeutics
L – Alcon, Biolight
O – AdOM. Oxymap, Nano Retina

He, PhD, Lin
E – Alcon Laboratories

Herndon, Jr., MD, Leon W.
C – Aerie Pharmaceuticals, Sight Sciences
L – Alcon, Glaukos

Hood, PhD, Donald
S – Topcon, Inc.

Huang, MD, PhD, David
P – Optovue, Inc., Carl Zeiss Meditec, Inc.

Hubatsch, MSc, Douglas
E – Alcon Laboratories

Hughes, MD, Bret A.
C – Alcon Laboratories, Allergan
S – Glaukos

Jia, PhD, Yali
P – Optovue

Johnstone, MD, Murray A.
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O – Healionics, Cascade Ophthalmics
P – Allergan

Kagemann, PhD, FARVO, Larry F.
E – Zeiss, Inc

Kahook, MD, Malik
C – Allergan, Alcon Laboratories
P – Oasis, AMO, Glaukos, ClarVista
Medical

Kardon, MD, PhD, Randy H.
C – Novartis OCTiMS Study Steering
Committee
S – NEI R00904054, R01 EY018853,
Department of Defense, TATRC,
VA Rehabilitation Research and
Development

Katz, MD, Gregory
L – Alcon Laboratories

Katz, MD, L. Jay
C – Glaukos, Mati Therapeutics, Aerie
Pharmaceuticals, Bausch + Lomb,
Inotek Corp., Alcon, ForSight
Visions Inc., Sensimed AG, Alcon
Laboratories
O – Aerie Pharmaceuticals, Mati
Therapeutics
S – Allergan, Bausch + Lomb, Aerie
Pharmaceuticals, Mati Therapeutics
L – Lumenis, Alcon Laboratories,
Allergan

Kaufman, Paul L.
C – Alcon, Allergan, Bausch + Lomb,
Johnson & Johnson, Santen, Merck,
Amakem, AGTC, Refocus, Sucampo,
Zlens
P – WARF

Khatana, MD, Anup K.
C – Iridex, Glaukos, Transcend Medical

Kinast, MD, Robert M.
S – Mobius Therapeutics, Allergan

Kopczynski, PhD, Casey
E – Aerie Pharmaceuticals

Kuchtey, MD, PhD, Rachel
S – American Glaucoma Society,
National Eye Institute

Lee, MD, David A.
L – Alcon Laboratories, Merck

Lee, MD, Olivia L.
C – Allergan
S – Allergan

Levy, OD, MSc, Brian
E – Aerie

Lewis, MD, Richard A.
C – Aerie, Alcon, Allergan, Aquesys,
AVS, Envisia, Glaukos, Ivantis,
Ocu leve, PolyActiva, ViSci, Zeiss

Liang, MD, Susan
S – Allergan, Alcon Laboratories,
Transcend Medical

Liebhmann, MD, Jeffrey M.
C – Sensimed, Inc., SOLX, Inc., Valeant
Pharmaceuticals, Alcon, Bausch
+ Lomb, Reichert, Inc., Alcon
Laboratories, Diopysis, Inc., Merz
Pharmaceuticals
O – Sustained Nano Systems, LLC
S – National Eye Institute, New York
Glaucoma Research Institute,
Heidelberg Engineering, Sensimed,
Inc., Optovue, Inc., Topcon, Inc.,
Diopysis, Inc., Bausch + Lomb,
Allergan

Liu, PhD, John
C – Bausch + Lomb

Mansberger, MD, MPH, Steve L.
C – Vision5, New World Medical,
Valeant Pharmaceuticals, Santen,
Envisia, Alcon Laboratories, Glaukos
S – MOBIUS, Merck, Allergan
<table>
<thead>
<tr>
<th>Name</th>
<th>Disclosures</th>
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<tbody>
<tr>
<td>Mansouri, MD MPH, Kaweh</td>
<td>C – Sensimed AG, Switzerland</td>
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<td>Mattox, MD, Cynthia</td>
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<td>S – NIH</td>
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<td>C – New World Medical, Allergan</td>
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<td>C – Allergan, Alcon Laboratories</td>
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<td>Park, MD, Sung Chul</td>
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<td>Petrie, MD, Renée</td>
<td>S – Other</td>
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<td>Piltz-Seymour, MD, Jody R.</td>
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<td>C – Alcon Laboratories, Allergan, Glaukos, Transcend Medical, Iridex Corporation, Reichert, Endo Optiks</td>
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<td>Radhakrishnan, MD, Sunita</td>
<td>C – Netra Systems</td>
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<td>Ramulu, MD, MHS, PhD, Pradeep</td>
<td>S – Research to Prevent Blindness, National Eye Institute</td>
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<td>Serle, MD, Janet B.</td>
<td>C – Aerie, Ono, Forest</td>
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<td>Shemyani, MD, Arsham</td>
<td>C – AqueSys</td>
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<tr>
<td>Shindler, MD, PhD, Kenneth S.</td>
<td>S – NIH, RPB, F M Kirby Foundation</td>
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<td>Simon-Zoula, PhD, Sonja</td>
<td>E – Sensimed</td>
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<td>Singh, MD, MPH, Kuldev</td>
<td>C – Alcon Laboratories, Transcend Medical, Ivantis, Aerie, InnFocus, Allergan, Bausch + Lomb, Santen, ForSight Vision 5</td>
</tr>
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<td>Smith, MD, Oluwatosin U.</td>
<td>C – Transcend Medical, Allergan, Glaukos, Santen</td>
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<td>SooHoo, MD, Jeffrey R.</td>
<td>S – Alcon Laboratories, Glaukos, Bausch + Lomb, Regeneron</td>
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<td>Spaeth, MD, George L.</td>
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<td>Stamper, MD, Robert L.</td>
<td>C – SightScience, Inc, Transcend Medical</td>
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<td>Stiles, MD, Michael</td>
<td>S – Glaukos</td>
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<td>Sun, MD, PhD, Yang</td>
<td>S – NIH</td>
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<td>Tanaka, MD, George H.</td>
<td>L – Alcon Laboratories, Allergan</td>
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<td>Tatham, FRCOphth, Andrew J.</td>
<td>S – Heidelberg Engineering</td>
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<tr>
<td>Toris, PhD, Carol B.</td>
<td>S – Bausch + Lomb, Allergan, GSK, Nicox</td>
</tr>
</tbody>
</table>
Tsai, MD, MBA, James C.
C – Aerie Pharmaceuticals, Amakem

Turati Acosta, MD, Mauricio
C – New Light, Alcon Laboratories
L – Alcon Laboratories, Sophia

Vittitow, PhD, Jason
E – Bausch + Lomb

Vold, MD, Steven
C – Wavecet Vision, TrueVision Systems, Iridex

Walsh, MD, MPH, Molly M.
C – Synteract
E – Retroject, Inc.
P – Retroject, Inc.

Weinreb, MD, Robert N.
C – Topcon, Alcon Laboratories, Reichert, Zeiss-Meditec, Allergan, Aries, Valeant Pharmaceuticals, Aquesy, Bausch + Lomb

Wen, MD, Joanne
S – Research to Prevent Blindness

Wiggs, MD, PhD, Janey L.
C – Genentech
S – NIH, March of Dimes

Williams, MD, Ruth D.
C – Allergan

WuDunn, MD, PhD, Darrell
S – Mati Therapeutics, Aerie Pharmaceuticals, InnFocus

Yuodelis, MD, PhD, Yeni H.
C – Bausch + Lomb
S – Glaucoma Research Society of Canada, Canadian Institute of Health Research

Zangwill, PhD, Linda
S – Heidelberg Engineering
P – Carl Zeiss Meditec

No Financial Relationships to Disclose
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Al-Hashimi, MD, Saba
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Alhadeff, MD, Paula A.
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Crandall, MD, Alan S.
Cui, MD, PhD, Qi

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DeBarber, PhD, Andrea
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Evangelista, MD, Charisma
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Jasien, MD, Jessica
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Jiménez-Roman, MD, Jesus
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Kedar, MD, Sachin
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Khodadadeh, MD, Sarah
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Lee, MD, JD, Paul P.
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Li, PhD, Xilong
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Lin, MD, Shan
Lin, MD, Shuai-Chun
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Liu, MD, Ji
Liu, MD, Liang
Liu, BA, Yingna
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Simavli, MD, Huseyn
Skaat, MD, Alon
Skytt, MSc, PhD, Dorte M.
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Sodhi, MD, Avneet
Sponsel, MD, William
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Suhr, MD, Abraham
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Swamy, MD, MPH, Ramya
Swenor, MPH, PhD, Bonnielin K.
Sy, MD, Aileen
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Tange, PhD, Chikako
Taniguchi, MD, Elise
Tehrani, MD, PhD, Shandiz
Theventhiran, MD, Alex
Toeteberg-Harms, MD, FEBO, Marc
Trese, MA, Matthew
Trobe, PhD, FRCSC, MBCh, Graham

E.
Tsikata, PhD, Edem
Tudor, PhD, Gail E.
Turalba, MD, Angela V.
Van Oyen, PhD, Mark
Van Tassel, MD, Sarah
Varma, MD, Rohit
Vazquez, MD, PhD, Luis
Vicchrilli, Sue
Villarreal, MD, Guadalupe
Villarreal Berain, BS, Analaura
Vinod, MD, Kateki
Vithana, PhD, Eranga
Waisbourd, MD, Michael
Wall, MD, Michael

Wang, BS, Diane
Wang, MD, PhD, Lin
Wang, BS, Linda
Wang, PhD, Ruikang
Wang, BA, Samantha
Wang, BMSc, Wendy (Wan)
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Wellik, MD, Sarah
Werner, MD, Mark A.
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Whitson, BS, Emily R.

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Williams, MD, Alice
Winkler, MD, Kathryn
Winkler, BS, Nelson
Winter, MD, Aaron
Wong, MD, PhD, Tien Yin
Woolson, MPH, Sandra
Xu, BS, Chaoying
Yang, PhD, Hongli
Yarovoy, MD, Dmitry
Yu, PhD, Fei
Zhang, PhD, Xinbo
Zhao, MS, Jing
Zhou, PhD, Zhehai
Meeting Information

Notification
A written, printed, or electronic notice of any annual or special meeting of the Members, stating the time, place, and purposes thereof, shall be sent to each Member by the Secretary, or, in the case of his/her death, absence, incapacity or refusal, by a person designated by the Board of Directors, at least sixty (60) days before the date of the meeting by leaving such notice with the Members or at his/her residence or usual place of business, by mailing the same, postage prepaid, directed to him/her at his/her address at last recorded on the books of the Society, or by electronic communication (e-mail) directed to an electronic address provided by the Member. Notice of a meeting need not be given to a Member if such Member, or his/her attorney thereunto duly authorized, waives such notice by a writing filed with the records of the meeting.

Meeting Objectives
After attending this program, participants should be able to:

- Describe recent medical advances in the diagnosis, management, and treatment of glaucoma in the United States and the world.
- Discuss different diagnostic and prognostic tools and new clinical research and advances in glaucoma in order to provide the best possible treatment options and care to patients.
- Critically evaluate/explain new and traditional types of glaucoma surgery.
- Examine and discuss advances in glaucoma science and implications for glaucoma therapy.

CME Credit

Accreditation Statement
This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education through the joint providership of the American Academy of Ophthalmology and American Glaucoma Society. The American Academy of Ophthalmology is accredited by the ACCME to provide continuing medical education for physicians.

Credit Designation Statement
The American Academy of Ophthalmology designates this live activity for a maximum of 23.50 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Claim your CME credits using the online form on the AGS website, www.americanglaucomasociety.net.

Display or Distribution of Materials
The AGS has retained use of the Hotel del Coronado to enable registered members and guests to participate in Society-sponsored educational and informational activities. Display or distribution of non-sponsored information or advertising in or on the property of the meeting facilities, except at exhibit tables and on the notice board, is prohibited. Violation of this policy will result in confiscation and disposal of the material. Individuals who violate this policy may be evicted from the premises.

FDA Status Disclaimer
Some material on recent developments may include information on drug or device applications that are not considered community standard, that reflect indications not included in approved FDA labeling, or that are approved for use only in restricted research settings. This information is provided as education only so physicians may be aware of alternative methods of the practice of medicine, and should not be considered
endorsement, promotion, or in any way encouragement to use such applications. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each drug or device he or she wishes to use in clinical practice, and to use these products with appropriate patient consent and in compliance with applicable law.

The AGS provides the opportunity for material to be presented for educational purposes only. The material represents the approach, ideas, statement, or opinion of the presenter and/or author, not necessarily the only or best method or procedure in every case, nor the position of the AGS. The material is not intended to replace a physician’s own judgment or give specific advice for case management. The AGS specifically disclaims any and all liability for injury or other damages of any kind for any and all claims that may arise out of the use of any technique demonstrated or described in any material by any presenter and/or author, whether such claims are asserted by a physician or any other person.

**Photographing and Taping of Exhibits and Program**

Attendees wishing to photograph or videotape an exhibit must secure permission from the exhibiting company before doing so. No portion of the scientific program or posters may be photographed, audio taped, or videotaped without the express written consent of the AGS and presenter.

**Target Audience**

The target audience for the American Glaucoma Society’s 25th Annual Meeting is glaucoma specialists, ophthalmologists, and researchers, practicing physicians, ophthalmology residents, and fellows.

**Exhibits**

Plan to visit the exhibits located in the Crown Room of the Hotel del Coronado. Exhibiting companies will showcase the newest and most innovative ophthalmic products and services.

**Spouse and Guest Hospitality**

The AGS Spouse and Guest Hospitality Room at the Hotel del Coronado will be open and available for registered spouses and guests as follows:

- **Thursday, February 26** 8:30 AM – 10:30 AM Garden Room
- **Friday, February 27** 8:30 AM – 10:30 AM Garden Room
- **Saturday, February 28** 8:30 AM – 10:30 AM Garden Room

**2016 Annual Meeting Program Submissions**

For those interested in submitting an abstract for the 2016 Annual Meeting, the online electronic submission program will be available in August 2015. Please visit the American Glaucoma Society’s website, www.americanglaucomasociety.net, to submit an online abstract by the deadline.
Registration Information

Attendance Verification
Attendees must verify their attendance to claim CME credit for attending the 25th Annual Meeting. Please refer to the CME Credit section in Meeting Information for more details.

Attendance verification letters will be available at the AGS Registration Desk, located in the Crystal Continental Foyer of the Hotel del Coronado, from Wednesday, February 25, to Sunday, March 1.

Registration Locations, Speaker Ready Station, and Hours
Registration will be located in the Crystal Continental Foyer from Wednesday, February 25, to Sunday, March 1. Any questions about the meeting, posters, and/or social functions may be answered at this location. The Speaker Ready Station, located in the Crystal Room, will be available February 25. Registered participants will receive their badge and meeting materials at the registration desk. The AGS Registration Desk and Speaker Ready Station will be open as follows:

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wednesday, February 25</td>
<td>5:00 PM – 8:00 PM</td>
<td>Crown Room</td>
</tr>
<tr>
<td>Thursday, February 26</td>
<td>6:00 AM – 6:30 PM</td>
<td>Crown Room</td>
</tr>
<tr>
<td>Friday, February 27</td>
<td>7:00 AM – 6:00 PM</td>
<td>Crown Room</td>
</tr>
<tr>
<td>Saturday, February 28</td>
<td>7:00 AM – 4:00 PM</td>
<td>Crown Room</td>
</tr>
<tr>
<td>Sunday, March 1</td>
<td>7:00 AM – 11:00 AM</td>
<td>Crown Room</td>
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</table>

Payment of Fees
The AGS accepts cash, checks payable to the AGS, MasterCard, and Visa. We do not accept American Express.

Social Events

<table>
<thead>
<tr>
<th>Day/Date/Event</th>
<th>Time</th>
<th>Location/Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday, February 26</td>
<td>7:00 AM – 8:00 AM</td>
<td>Crown Room</td>
</tr>
<tr>
<td>Continental Breakfast</td>
<td>6:30 PM – 7:00 PM</td>
<td>Ballroom</td>
</tr>
<tr>
<td>Special Guest Speaker</td>
<td>7:00 PM – 8:30 PM</td>
<td>Sundeck</td>
</tr>
<tr>
<td>Welcome Reception**</td>
<td>7:00 PM – 8:30 PM</td>
<td>Sundeck</td>
</tr>
<tr>
<td>Friday, February 27</td>
<td>6:00 AM – 6:50 AM</td>
<td>Executive Room</td>
</tr>
<tr>
<td>Morning Yoga*</td>
<td>6:30 AM – 8:00 AM</td>
<td>Crown Room</td>
</tr>
<tr>
<td>Gala Reception**</td>
<td>7:00 PM – 8:00 PM</td>
<td>Garden Patio</td>
</tr>
<tr>
<td>Gala**</td>
<td>8:00 PM – 10:00 PM</td>
<td>Ballroom</td>
</tr>
<tr>
<td>Saturday, February 28</td>
<td>6:00 AM – 6:50 AM</td>
<td>AGS Registration Desk, Crystal Continental Foyer</td>
</tr>
<tr>
<td>Fun Run/Walk*</td>
<td>7:00 AM – 8:15 AM</td>
<td>Crown Room</td>
</tr>
<tr>
<td>Sunday, March 1</td>
<td>7:00AM – 8:15AM</td>
<td>Crown Room</td>
</tr>
</tbody>
</table>

* Indicates a separate fee for participation
** Not included in free registration for Non-Members, but a ticket may be purchased
Messages
There will be a message board at the AGS Registration Desk, located in the Crystal Continental Foyer. Please check for messages.

Posters
Posters will be displayed in the Coronet Room throughout the entire meeting. Please check the Poster Schedule (p. 107) for listings.

Exhibitors
Exhibitors must check in at the AGS Registration Desk to pick up their packet and badge(s). One registration packet is provided per exhibiting company.

Registration Amenities
AGS Member/Non-member registration includes printed materials, giveaway item/s, daily continental breakfasts and breaks, Welcome Reception, and the Gala Reception & Dinner.

Spouse/Personal Guest registration includes all social events: use of the Spouse/Guest Hospitality Room, daily continental breakfasts, Welcome Reception, Gala Reception & Dinner, and the special guest lecture.
## Schedule at a Glance

**WEDNESDAY, FEBRUARY 25TH**

<table>
<thead>
<tr>
<th>TIME</th>
<th>EVENT</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:00 PM – 8:00 PM</td>
<td>Registration &amp; Exhibitor Check-In</td>
<td>AGS Registration Desk</td>
</tr>
</tbody>
</table>

**THURSDAY, FEBRUARY 26TH – AGS & NANOS JOINT SYMPOSIUM**

<table>
<thead>
<tr>
<th>TIME</th>
<th>EVENT</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00 AM – 6:30 AM</td>
<td>Registration</td>
<td>AGS Registration Desk</td>
</tr>
<tr>
<td>6:00 AM – 7:00 AM</td>
<td>Poster Set-up (1-37)</td>
<td>Coronet</td>
</tr>
<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Breakfast – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>7:00 AM – 3:50 PM</td>
<td>Exhibit Hall Viewing</td>
<td>Crown</td>
</tr>
<tr>
<td>7:00 AM – 5:00 PM</td>
<td>Poster Viewing (1-37)</td>
<td>Coronet</td>
</tr>
<tr>
<td>8:30 AM – 10:30 AM</td>
<td>Spouse Guest Hospitality Room</td>
<td>Garden Room</td>
</tr>
<tr>
<td>9:30 AM – 10:15 AM</td>
<td>Concierge Visit to Hospitality Room</td>
<td>Garden Room</td>
</tr>
<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Poster Session with Authors: Optic Nerve (1-37)</td>
<td>Coronet</td>
</tr>
<tr>
<td>8:00 AM – 8:05 AM</td>
<td>Welcome and Introduction</td>
<td>Ballroom</td>
</tr>
<tr>
<td>8:05 AM – 9:42 AM</td>
<td>Section 1 – Glaucoma: The Other Optic Neuropathy</td>
<td>Ballroom</td>
</tr>
<tr>
<td>9:42 AM – 10:12 AM</td>
<td>Morning Tea – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>10:12 AM – 11:17 AM</td>
<td>Section 2 – Clinical Differences Between Glaucoma and Other Optic Neuropathies</td>
<td>Ballroom</td>
</tr>
<tr>
<td>11:17 AM – 12:32 PM</td>
<td>Section 3 – The Neurology of Glaucoma</td>
<td>Ballroom</td>
</tr>
<tr>
<td>12:32 PM – 2:00 PM</td>
<td>Lunch – on your own</td>
<td></td>
</tr>
<tr>
<td>2:00 PM – 3:00 PM</td>
<td>Symposium 1 – The Pathogenesis of Optic Neuropathy: Glaucoma vs. the Rest</td>
<td>Ballroom</td>
</tr>
<tr>
<td>3:00 PM – 3:30 PM</td>
<td>Break – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>3:30 PM – 4:30 PM</td>
<td>Paper Presentations 1-5</td>
<td>Ballroom</td>
</tr>
<tr>
<td>4:30 PM – 5:30 PM</td>
<td>Symposium 2 – Optic Nerve Imaging: New Parameters and Techniques</td>
<td>Ballroom</td>
</tr>
<tr>
<td>5:00 PM – 5:45 PM</td>
<td>Poster Tear Down (1-37)</td>
<td>Coronet</td>
</tr>
<tr>
<td>5:45 PM – 6:30 PM</td>
<td>Poster Set-up (38-84)</td>
<td>Coronet</td>
</tr>
<tr>
<td>6:30 PM – 7:00 PM</td>
<td>Special Guest Speaker</td>
<td>Ballroom</td>
</tr>
<tr>
<td>7:00 PM – 8:30 PM</td>
<td>Welcome Reception</td>
<td>Sundeck</td>
</tr>
</tbody>
</table>

**FRIDAY, FEBRUARY 27TH – SURGERY DAY**

<table>
<thead>
<tr>
<th>TIME</th>
<th>EVENT</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00 AM – 6:50 AM</td>
<td>Morning Yoga</td>
<td>Executive Room</td>
</tr>
<tr>
<td>6:30 AM – 8:00 AM</td>
<td>Continental Breakfast – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>7:00 AM – 6:00 PM</td>
<td>Registration</td>
<td>AGS Registration Desk</td>
</tr>
<tr>
<td>7:00 AM – 4:30 PM</td>
<td>Exhibitor Viewing</td>
<td>Crown</td>
</tr>
<tr>
<td>7:00 AM – 5:00 PM</td>
<td>Poster Viewing (38-84)</td>
<td>Coronet</td>
</tr>
</tbody>
</table>

* CME credits for Thursday morning sessions 1 through 3 will be provided by NANOS.
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 AM – 10:30 AM</td>
<td>Spouse/Guest Hospitality Room</td>
<td>Garden Room</td>
</tr>
<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Poster Session with Authors: Surgery (38-84)</td>
<td>Crown</td>
</tr>
<tr>
<td>8:00 AM – 8:02 AM</td>
<td>Announcements and Housekeeping</td>
<td>Ballroom</td>
</tr>
<tr>
<td>8:02 AM – 8:35 AM</td>
<td>Glaucoma Surgery Day Lecturer – MIGS 2.0</td>
<td>Ballroom</td>
</tr>
<tr>
<td>8:35 AM – 9:30 AM</td>
<td>Surgery Day Section 1 – MIGS</td>
<td>Ballroom</td>
</tr>
<tr>
<td>10:47 AM – 11:42 AM</td>
<td>Surgery Day Section 3 – Paper Presentations 6-10</td>
<td>Ballroom</td>
</tr>
<tr>
<td>11:42 AM – 11:44 AM</td>
<td>Announcements – Transition to Business Meeting</td>
<td></td>
</tr>
<tr>
<td>11:44 AM – 12:04 PM</td>
<td>AGS Annual Business Meeting</td>
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<tr>
<td>12:04 PM – 12:14 PM</td>
<td>Group Photo</td>
<td>TBD</td>
</tr>
<tr>
<td>12:14 PM – 1:35 PM</td>
<td>Lunch – on your own</td>
<td></td>
</tr>
<tr>
<td>1:35 PM – 2:35 PM</td>
<td>Surgery Day Section 4 – Glaucoma Training: At Home and Abroad</td>
<td>Ballroom</td>
</tr>
<tr>
<td>2:35 PM – 3:30 PM</td>
<td>Surgery Day Section 5 – Congenital and Secondary Glaucomas: The Science and the Surgeries</td>
<td>Ballroom</td>
</tr>
<tr>
<td>3:30 PM – 3:50 PM</td>
<td>Break – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>3:50 PM – 3:53 PM</td>
<td>Eye Care America Video Presentation</td>
<td>Ballroom</td>
</tr>
<tr>
<td>3:53 PM – 4:23 PM</td>
<td>AGS Lecturer – Paying it Forward: New Opportunities for Translational Research and Personalized Care</td>
<td>Ballroom</td>
</tr>
<tr>
<td>4:23 PM – 4:28 PM</td>
<td>Introduction of Innovator Award</td>
<td>Ballroom</td>
</tr>
<tr>
<td>4:28 PM – 5:33 PM</td>
<td>Surgery Day Section 6 – Tweaks of the Trade: Trab and Tube</td>
<td>Ballroom</td>
</tr>
<tr>
<td>5:33 PM – 6:05 PM</td>
<td>Surgery Day Section 7: Surgical Videos</td>
<td>Ballroom</td>
</tr>
<tr>
<td>5:30 PM – 6:00PM</td>
<td>Poster Tear-Down (38-84)</td>
<td>Coronet</td>
</tr>
<tr>
<td>6:00 PM – 6:30 PM</td>
<td>Poster Set-up (85-124)</td>
<td>Coronet</td>
</tr>
<tr>
<td>7:00 PM – 8:00 PM</td>
<td>Gala Reception</td>
<td>Garden Patio</td>
</tr>
<tr>
<td>8:00 PM – 10:00 PM</td>
<td>Gala Banquet and Dinner</td>
<td>Ballroom</td>
</tr>
<tr>
<td>10:00 PM – 11:00 PM</td>
<td>Music by the FlipSide and Dancing</td>
<td>Ballroom</td>
</tr>
</tbody>
</table>

SATURDAY, FEBRUARY 28TH

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00 AM – 6:50 AM</td>
<td>Fun Run/Walk</td>
<td>Beach</td>
</tr>
<tr>
<td>7:00 AM – 8:15 AM</td>
<td>Breakfast – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>7:00 AM – 4:00 PM</td>
<td>Registration</td>
<td>AGS Registration Desk</td>
</tr>
<tr>
<td>7:00 AM – 11:00 AM</td>
<td>Exhibit Viewing</td>
<td>Crown</td>
</tr>
<tr>
<td>7:00 AM – 3:30 PM</td>
<td>Poster Viewing (85-124)</td>
<td>Coronet</td>
</tr>
<tr>
<td>8:30 AM – 10:30 AM</td>
<td>Spouse/Guest Hospitality Room</td>
<td>Garden Room</td>
</tr>
<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Poster Session with Authors: Epidemiology and Clinical Studies (85-124)</td>
<td>Coronet</td>
</tr>
<tr>
<td>8:00 AM – 8:05 AM</td>
<td>Announcements</td>
<td>Ballroom</td>
</tr>
<tr>
<td>8:05 AM – 9:05 AM</td>
<td>Paper Presentations 11-15</td>
<td>Ballroom</td>
</tr>
<tr>
<td>9:05 AM – 10:10 AM</td>
<td>Symposium 3 – Intraocular Pressure and Glaucoma – New Insights</td>
<td>Ballroom</td>
</tr>
<tr>
<td>10:10 AM – 10:30 AM</td>
<td>Break – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>10:30 AM – 11:30 AM</td>
<td>Paper Presentations 16-20</td>
<td>Ballroom</td>
</tr>
<tr>
<td>Time</td>
<td>Event</td>
<td>Location</td>
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<tr>
<td>--------------</td>
<td>----------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>11:30 AM – 12:00 PM</td>
<td>Clinician-Scientist Lecture – Predicting Optic Nerve Head Susceptibility to Glaucoma</td>
<td>Ballroom</td>
</tr>
<tr>
<td>12:00 PM – 1:30 PM</td>
<td>Lunch – on your own</td>
<td></td>
</tr>
<tr>
<td>1:30 PM – 2:00 PM</td>
<td>Symposium 4 – Innovating the Glaucoma Practice of the Future</td>
<td>Ballroom</td>
</tr>
<tr>
<td>2:00 PM – 3:10 PM</td>
<td>Symposium 5 – Functional Impairment in Glaucoma</td>
<td>Ballroom</td>
</tr>
<tr>
<td>3:10 PM – 4:10 PM</td>
<td>Paper Presentations 21-25</td>
<td>Ballroom</td>
</tr>
<tr>
<td>1:30 PM – 4:30 PM</td>
<td>Exhibitor Tear-Down</td>
<td>Crown</td>
</tr>
<tr>
<td>3:30 PM – 4:15 PM</td>
<td>Poster Tear-Down (85-124)</td>
<td>Coronet</td>
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</table>

**SUNDAY, MARCH 1ST**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 AM – 11:00 AM</td>
<td>Registration</td>
<td>AGS Registration Desk</td>
</tr>
<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Breakfast Roundtable Discussions</td>
<td>Crown</td>
</tr>
<tr>
<td>8:00 AM – 11:00 AM</td>
<td>Conquering Coding and ICD-10, Avoiding PQRS, and VBM Penalties</td>
<td>Coronet</td>
</tr>
<tr>
<td>8:00 AM – 11:00 AM</td>
<td>Super Bowl of Glaucoma Grand Rounds</td>
<td>Tropics</td>
</tr>
</tbody>
</table>
The American Glaucoma Society was founded in 1985 with the stated purpose of maintaining and improving “the quality of patient care primarily through improvement, exchange and dissemination of information and scientific knowledge pertinent to glaucoma and related diseases.”

Although Drs. Douglas Anderson and Jonathan Herschler had organized the very successful Annual North American Glaucomatologists’ Learning Ensemble (ANGLE) in the 1970s to provide in-depth focus on glaucoma research topics of mutual interest, insightful members of the glaucoma community felt that an additional forum for both clinical and scientific interchange among glaucoma specialists was needed.

In May 1984, Drs. Max Forbes and Bruce Shields began to discuss the concept of an American glaucoma society. Drs. George Spaeth and Richard Simmons subsequently were persuaded to join in formalizing this concept and to help organize the AGS. Nine other leading members of the glaucoma community also were recruited to participate in this endeavor. An initial meeting of the group took place in Atlanta on November 11, 1984, at which everyone’s full agreement and cooperation was established.

Dr. Simmons prepared a Constitution and Bylaws for the AGS, which was incorporated in the Commonwealth of Massachusetts on August 30, 1985. The 13 founding members subsequently approved the Constitution and Bylaws in San Francisco, California, on September 29, 1985. The first elected officers included George L. Spaeth, President; Richard J. Simmons, Vice-President; Harry A. Quigley, Secretary; and John Hetherington Jr., Treasurer. The new executive committee met in the spring of 1986, at which time a list of invitations to 69 charter members was compiled. In 1986, 82 individuals became charter members of the newly formed Society.

In honor and memory of Dr. Charles D. Phelps, one of the founding members and former chair of the Department of Ophthalmology at the University of Iowa, who died in September 1985, the first meeting of the AGS was held in Iowa City, Iowa, in June 1987. Dr. M. Bruce Shields served as chair of the Program Committee for the Society’s inaugural meeting as well as the next four, and Dr. Stephen Drance delivered the first AGS Lecture. A Washington Hawthorne tree was planted in Dr. Phelps’ memory and still stands on the University of Iowa Medical Center campus, just outside of the office of the Chair of the Department of Ophthalmology and Visual Science.

In Iowa City, Dr. Spaeth quoted Sir Winston Churchill, stating, “We are at the beginning of the beginning.” Twenty-seven years and 25 meetings later, the AGS has grown to include over 1200 members and has become one of American ophthalmology’s premier and most influential subspecialty societies.
In Memoriam
David L. Epstein, MD
1944-2014
(3/4/14)

John Lynn, MD
1930-2014
(3/25/14)

Jonathan E. Pederson, MD
1947-2014
(6/27/14)

Thirteen Founding Members of
the American Glaucoma Society
George L. Spaeth, MD
Richard J. Simmons, MD
M. Bruce Shields, MD
Max Forbes, MD
Douglas R. Anderson, MD
David G. Campbell, MD
John Hetherington Jr., MD
H. Dunbar Hoskins Jr., MD
Allan E. Kolker, MD
William E. Layden, MD
Charles D. Phelps, MD*
Irvin P. Pollack, MD
Harry A. Quigley, MD

Additional 69 Charter Members
of the American Glaucoma Society
Robert C. Allen, MD*
Jorge A. Alvarado, MD
Mansour F. Armaly, MD*
Frank S. Ashburn Jr., MD
George S. Baerveldt, MD
Bernard Becker, MD*
Hugh Beckman, MD
C. Davis Belcher III, MD*
A. Robert Bellows, MD
Richard F. Brubaker, MD
Paul A. Chandler, MD*
John S. Cohen, MD
Marshall N. Cyrlik, MD
Gordon R. Douglas, MD, FRCSC
Stephen M. Drance, MD
David K. Duker, MD
David L. Epstein, MD*
Douglas E. Gaasterland, MD
Joseph S. Haas, MD

Thomas S. Harbin Jr., MD
Sohan S. Hayreh, MD, DSc
Jonathan Herschler, MD
Elizabeth A. Hodapp, MD
B. Thomas Hutchinson, MD
Murray A. Johnstone, MD
Frederick M. Kapetansky, MD
Michael A. Kass, MD
Paul L. Kaufman, MD
Edwin U. Keates, MD
Theodore Krupin, MD
Carl Kupfer, MD*
Raymond P. LeBlanc, MD
Pei-Fei Lee, MD*
Ralph Z. Levene, MD*
Paul R. Lichter, MD
Alan I. Mandell, MD*
Wayne F. March, MD*
A. Edward Maumenee, MD*
Samuel D. McPherson Jr., MD*
David W. Meltzer, MD, PhD
Donald S. Minckler, MD
Donald J. Morin, MD*
Robert A. Moses, MD*
Paul F. Palmberg, MD, PhD
Richard K. Parrish II, MD
Jonathan E. Pederson, MD*
Edward S. Perkins, MD
Steven M. Podos, MD*
Ronald L. Radius, MD
Kenneth T. Richardson Jr., MD
Thomas M. Richardson, MD
Robert Ritch, MD
Alan L. Robin, MD
Harold G. Scheie, MD*
Arthur L. Schwartz, MD
Bernard Schwartz, MD, PhD*
Marvin L. Sears, MD
Robert N. Shaffer, MD*
Jess A. Smith, MD*
Robert L. Stamper, MD
H. Saul Sugar, MD*
John V. Thomas, MD
E. Michael Van Buskirk, MD
Paul A. Weber, MD
Robert N. Weinreb, MD
Elliot B. Werner, MD
Jacob T. Wilensky, MD
Michael E. Yablonksi, MD, PhD*
Thom J. Zimmerman, MD, PhD*

*Deceased
## AGS Meetings

<table>
<thead>
<tr>
<th>Date and Location</th>
<th>Honoree</th>
<th>AGS Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 11-13, 1987, Iowa City, Iowa</td>
<td>Charles D. Phelps, MD</td>
<td>Stephen M. Drance, MD</td>
</tr>
<tr>
<td>December 2-4, 1988, Miami Lakes, Florida</td>
<td>Paul A. Chandler, MD</td>
<td>Richard J. Simmons, MD</td>
</tr>
<tr>
<td>July 6-7, 1990, Mackinac Island, Michigan</td>
<td>David Worthen, MD</td>
<td>Richard F. Brubaker, MD</td>
</tr>
<tr>
<td>December 12-14, 1991, Coronado, California</td>
<td>H. Saul Sugar, MD</td>
<td>David G. Campbell, MD</td>
</tr>
<tr>
<td>July 7-9, 1993, Reykjavik, Iceland</td>
<td>Hans Goldmann, MD</td>
<td>Franz Fankhauser, MD</td>
</tr>
<tr>
<td>(Joint meeting with the European Glaucoma Society)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>February 2-4, 1995, Key West, Florida</td>
<td>Bernard Becker, MD</td>
<td>Allan E. Kolker, MD</td>
</tr>
<tr>
<td>July 30 – August 2, 1996, Vancouver, British Columbia, Canada</td>
<td>Stephen M. Drance, MD</td>
<td>Gordon R. Douglas, MD</td>
</tr>
<tr>
<td>(Joint meeting with the Japanese Glaucoma Society)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>December 4-6, 1997, Scottsdale, Arizona</td>
<td>Robert N. Shaffer, MD</td>
<td>H. Dunbar Hoskins Jr., MD</td>
</tr>
<tr>
<td>February 18-20, 1999, Amelia Island, Florida</td>
<td>W. Morton Grant, MD</td>
<td>Douglas R. Anderson, MD</td>
</tr>
<tr>
<td>March 2-4, 2000, San Antonio, Texas</td>
<td>Marvin L. Sears, MD</td>
<td>M. Bruce Shields, MD</td>
</tr>
<tr>
<td>March 1-4, 2001, Newport Beach, California</td>
<td>George L. Spaeth, MD</td>
<td>Roger Hitchings, MD</td>
</tr>
<tr>
<td>February 28 – March 3, 2002, San Juan, Puerto Rico</td>
<td>Allan E. Kolker, MD</td>
<td>Theodore Krupin, MD</td>
</tr>
<tr>
<td>March 6-9, 2003, San Francisco, California</td>
<td>Richard J. Simmons, MD</td>
<td>E. Michael Van Buskirk, MD</td>
</tr>
<tr>
<td>March 4-7, 2004, Sarasota, Florida</td>
<td>Douglas R. Anderson, MD</td>
<td>Chris A. Johnson, PhD</td>
</tr>
<tr>
<td>March 3-6, 2005, Snowbird, Utah</td>
<td>Richard F. Brubaker, MD</td>
<td>David L. Epstein, MD</td>
</tr>
<tr>
<td>March 2-5, 2006, Charleston, South Carolina</td>
<td>E. Michael Van Buskirk, MD</td>
<td>Murray A. Johnstone, MD</td>
</tr>
<tr>
<td>March 1-4, 2007, San Francisco, California</td>
<td>Steven M. Podos, MD</td>
<td>Paul L. Kaufman, MD</td>
</tr>
<tr>
<td>March 6-9, 2008, Washington, District of Columbia</td>
<td>M. Bruce Shields, MD</td>
<td>Robert Ritch, MD</td>
</tr>
<tr>
<td>March 5-8, 2009, San Diego, California</td>
<td>Paul L. Kaufman, MD</td>
<td>Robert N. Weinreb, MD</td>
</tr>
<tr>
<td>March 4-7, 2010, Naples, Florida</td>
<td>Robert L. Stamper, MD</td>
<td>Michael A. Kass, MD</td>
</tr>
<tr>
<td>March 3-6, 2011, Dana Point, California</td>
<td>Richard P. Wilson, MD</td>
<td>Harry A. Quigley, MD</td>
</tr>
<tr>
<td>March 1-4, 2012, New York, New York</td>
<td>Theodore Krupin, MD</td>
<td>Alfred Sommer, MD, MHS</td>
</tr>
<tr>
<td>February 27 – March 2, 2014, Washington, District of Columbia</td>
<td>Donald S. Minckler, MD</td>
<td>George Baerveldt, MD</td>
</tr>
<tr>
<td>February 26 – March 1, 2015, Coronado, California</td>
<td>David L. Epstein, MD</td>
<td>Paul P. Lee, MD, JD</td>
</tr>
</tbody>
</table>
Clinician-Scientist Lecturers & President’s Award Recipients

AGS Clinician-Scientist Lecturers

The American Glaucoma Society Clinician-Scientist Lecture is given annually by an individual who exemplifies qualities of excellence in patient care and basic research. This individual is selected by a special committee of the AGS comprised of past, present, and future AGS Presidents and the AGS Program Chair. The AGS Clinician-Scientist Lecturer is invited to present a special scientific lecture at the AGS Annual Meeting.

<table>
<thead>
<tr>
<th>Year</th>
<th>Clinician-Scientist Lecturer</th>
<th>Lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Robert N. Weinreb, MD</td>
<td>The Other Outflow Pathway</td>
</tr>
<tr>
<td>2001</td>
<td>Paul L. Kaufman, MD</td>
<td>Gene Therapy for Glaucoma: Anterior and Posterior Segment Targets and Constraints</td>
</tr>
<tr>
<td>2002</td>
<td>Harry A. Quigley, MD</td>
<td>Do We Really Understand Angle-Closure Glaucoma?</td>
</tr>
<tr>
<td>2003</td>
<td>Martin B. Wax, MD</td>
<td>Roles of the Immune System in Glaucoma</td>
</tr>
<tr>
<td>2004</td>
<td>Wallace L. M. Alward, MD</td>
<td>Computer Geeks in the Genome: Bioinformatics</td>
</tr>
<tr>
<td>2005</td>
<td>Douglas H. Johnson, MD</td>
<td>Glaucoma: Clues from Ultrastructure, Lessons from Epidemiology</td>
</tr>
<tr>
<td>2006</td>
<td>George A. Cioffi, MD</td>
<td>Quotes, Questions &amp; Quandaries Regarding Optic Nerve Ischemia &amp; Glaucoma</td>
</tr>
<tr>
<td>2007</td>
<td>Carl B. Camras, MD</td>
<td>Serendipity versus Directed Hypothesis Driven Research in Medical Discovery</td>
</tr>
<tr>
<td>2008</td>
<td>Anne L. Coleman, MD, PhD</td>
<td>A Public Health Perspective on Glaucoma</td>
</tr>
<tr>
<td>2009</td>
<td>Joseph Caprioli, MD</td>
<td>The Importance of Rates in Glaucoma</td>
</tr>
<tr>
<td>2010</td>
<td>David S. Greenfield, MD</td>
<td>Unlocking Mysteries in Measurements of the Retinal Nerve Fiber Layer</td>
</tr>
<tr>
<td>2011</td>
<td>Joel S. Schuman, MD</td>
<td>Advances in Optical Coherence Tomography (OCT)</td>
</tr>
<tr>
<td>2012</td>
<td>James D. Brandt, MD</td>
<td>Is It Real or Is It Artifact? What the Cornea Can Tell Us About Glaucoma</td>
</tr>
<tr>
<td>2013</td>
<td>Jeffrey M. Liebmann, MD</td>
<td>The Central Ten Degrees</td>
</tr>
<tr>
<td>2014</td>
<td>Janey Wiggs, MD, PhD</td>
<td>Glaucoma Genetics: Families and NEIGHBORs</td>
</tr>
<tr>
<td>2015</td>
<td>Claude F. Burgoyne, MD</td>
<td>Predicting Optic Nerve Head Susceptibility to Glaucoma</td>
</tr>
</tbody>
</table>

AGS President’s Award

The recipient of the AGS President’s Award is chosen by the President and approved by a special committee of the AGS comprised of past, present, and future AGS Presidents and the AGS Program Chair for “significant contributions to the glaucoma community through his or her scientific achievements, service to the Society, and/or service to the profession as a whole.”

<table>
<thead>
<tr>
<th>Year</th>
<th>President’s Award Recipient</th>
<th>Year</th>
<th>President’s Award Recipient</th>
<th>Year</th>
<th>President’s Award Recipient</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Max Forbes, MD</td>
<td></td>
<td>AGS Founding Members: Douglas R. Anderson, MD, David G. Campbell, MD, Max Forbes, MD, John Hetherington Jr., MD, H. Dunbar Hoskins Jr., MD, Allan E. Kolker, MD, William E. Layden, MD, Charles D. Phelps, MD*, Irvin P. Pollack, MD, Harry A. Quigley, MD, M. Bruce Shields, MD, Richard J. Simmons, MD, George L. Spaeth, MD</td>
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<td>M. Roy Wilson, MD, MS</td>
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<tr>
<td>2007</td>
<td>Bernard Schwartz, MD, PhD*</td>
<td></td>
<td>AGS Founding Members: Douglas R. Anderson, MD, David G. Campbell, MD, Max Forbes, MD, John Hetherington Jr., MD, H. Dunbar Hoskins Jr., MD, Allan E. Kolker, MD, William E. Layden, MD, Charles D. Phelps, MD*, Irvin P. Pollack, MD, Harry A. Quigley, MD, M. Bruce Shields, MD, Richard J. Simmons, MD, George L. Spaeth, MD</td>
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<td>M. Roy Wilson, MD, MS</td>
</tr>
<tr>
<td>2008</td>
<td>Glaucoma Foundation</td>
<td></td>
<td>AGS Founding Members: Douglas R. Anderson, MD, David G. Campbell, MD, Max Forbes, MD, John Hetherington Jr., MD, H. Dunbar Hoskins Jr., MD, Allan E. Kolker, MD, William E. Layden, MD, Charles D. Phelps, MD*, Irvin P. Pollack, MD, Harry A. Quigley, MD, M. Bruce Shields, MD, Richard J. Simmons, MD, George L. Spaeth, MD</td>
<td></td>
<td>M. Roy Wilson, MD, MS</td>
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</table>

*Deceased
Research Fellowship Awards and Programs

The American Glaucoma Society Research Fellowship supports developing new investigators in the field of glaucoma research. The program is administered by the AGS Research Committee.

The 1997-2014 recipients are listed below. The recipients of the 2015 grants will be announced during the 2015 Annual Business Meeting.

Recipients will be selected each year, although applications for renewals will be considered. To be eligible, a candidate must have completed, within the past five years, at least one full year of fellowship training in glaucoma. He or she does not necessarily need to have a faculty appointment, but must be an active or provisional member of the American Glaucoma Society. For more information, interested individuals may contact the AGS Administrative Office in San Francisco or visit the AGS website, www.americanglaucomasociety.net.

The American Glaucoma Society congratulates the past recipients of the AGS Research Fellowships in Glaucoma.

Recipients of the AGS Young Physician Scientist Grants

1997 Deepak P. Edward, MD
1998 Young H. Kwon, MD, PhD
1999 Darrell WuDunn, MD, PhD
2000 Stuart J. McKinnon, MD, PhD
2001 Margaret P. Good, MD
2002 Edward M. Barnett, MD, PhD
2003 Steven L. Mansberger, MD, MPH
    Christopher A. Girkin, MD
    Pratap Challa, MD
2004 Christopher A. Girkin, MD
    Steven L. Mansberger, MD, MPH
    Douglas J. Rhee, MD
    Richard K. Lee, MD, PhD
    Shan C. Lin, MD
2005 Camille Hylton, MD
    Douglas J. Rhee, MD
    Shan C. Lin, MD
    Leslie S. Jones, MD
    Jeffrey A. Kammer, MD
2006 JoAnn A. Giaconi, MD
    Anjali M. Bhorade, MD, MPH
    Sameer Intiz Amad, MD
    Molly M. Walsh, MD, MPH
2007 Dana M. Blumberg, MD
    John H. Fingert, MD, PhD
    Malik Y. Kahook, MD
    Rachel W. Kuchey, MD, PhD
    Felipe A. Medeiros, MD, PhD
    Arthur J. Sit, MD
2008 Arthur J. Sit, MD
    John H. Fingert, MD
    Henry Tseng, MD, PhD
    Pradeep Y. Ramulu, MD, PhD
    Thasarat S. Vajaranant, MD
    Rachel W. Kuchey, MD, PhD
    Michael V. Boland, MD, PhD
    Joshua D. Stein, MD, MS
2009
2010 Brian Christopher Samuels, MD, PhD
    Vikas Gulati, MD
    Christopher C. Teng, MD
    Molly M. Walsh, MD, MPH
2011 Kathryn E. Bollinger, MD, PhD
    Nils A. Loewen, MD, PhD
    Kelly W. Muir, MD
    Kouros Nouri-Mahdavi, MD
    Yang Sun, MD, PhD
2012 Yvonne Ou, MD
    Lucy Q. Shen, MD
2013 Scott D. Lawrence, MD
    James C. H. Tan, MD, FRCOphth, PhD
    Benjamin J. Frankfort, MD, PhD
2014 Shandiz Tehrani, MD, PhD
    Derek S. Welsbie, MD
    Sung C. Park, MD
Mid-Career Physician-Scientist Awards

These awards are designed to provide an additional source of research funding for investigators between 5 and 20 years out of fellowship. These grants can be competitively renewed for a second year if substantial progress has been made during the first year. These grants are meant to allow mid-career investigators to conduct initial new research or continue ongoing research.

As with the AGS research fellowship, the winners of the 2015 Mid-Career Physician-Scientist Awards will be announced at the Business Meeting.

Recipients of the Mid-Career Physician-Scientist Award

<table>
<thead>
<tr>
<th>Year</th>
<th>Name 1</th>
<th>Name 2</th>
<th>Name 3</th>
<th>Name 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>Donald L. Budenz, MD, MPH</td>
<td>Douglas J. Rhee, MD</td>
<td>Sanjay G. Asrani, MD</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>Edward M. Barnett, MD, PhD</td>
<td>Cynthia L. Grosskreutz, MD, PhD</td>
<td>Darrell WuDunn, MD, PhD</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Claude F. Burgoyne, MD</td>
<td>Felipe A. Medeiros, MD, PhD</td>
<td>Anthony D. Realini, MD</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>Anjali Bhorade, MD</td>
<td>Richard K. Lee, MD, PhD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>John H. Fingert, MD</td>
<td></td>
<td>John Danias, MD, PhD</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Teresa C. Chen, MD</td>
<td>Thasarat S. Vajaranant, MD</td>
<td>Rachel W. Kuchtey, MD</td>
<td></td>
</tr>
</tbody>
</table>

Recipients of the Mid-Career Physician-Scientist Award

<table>
<thead>
<tr>
<th>Year</th>
<th>Name 1</th>
<th>Name 2</th>
<th>Name 3</th>
<th>Name 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>Pradeep Y. Ramulu, MD, PhD</td>
<td>Misha F. Syed, MD</td>
<td>Thasarat S. Vajaranant, MD</td>
<td>Husam Ansari, MD, PhD</td>
</tr>
<tr>
<td>2009</td>
<td>Cynthia L. Grosskreutz, MD, PhD</td>
<td>Vandana K. Badlani, MD</td>
<td>Annette L. Giangiacomo, MD, MD</td>
<td>Leysa M. Shuba, MD, PhD</td>
</tr>
<tr>
<td>2010</td>
<td>Misha F. Syed, MD</td>
<td>John H. Fingert, MD</td>
<td></td>
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</tr>
<tr>
<td>2011</td>
<td>Misha F. Syed, MD</td>
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<tr>
<td>2012</td>
<td>Arthur J. Sit, MS, MD</td>
<td></td>
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</tr>
<tr>
<td>2013</td>
<td>Derek S. Welsbie, MD</td>
<td>Ta C. Chang, MD</td>
<td></td>
<td></td>
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<tr>
<td>2014</td>
<td>Ta C. Chang, MD</td>
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</table>

Mentoring for Advancement of Physician-Scientists (MAPS) Program

The MAPS Program is a multi-faceted mentoring program of the AGS and predominant in fulfilling the mission of the organization by supporting glaucoma specialists and scientists to further their careers in science and research of glaucoma. The funding of this award provides AGS a vehicle to expand its reach to young physician-scientists and focus on providing tools and resources to further their careers as potential leaders in the specialty of glaucoma care.

Thank you, Allergan, for your continued support of the AGS MAPS Program.

MAPS Award Recipients

<table>
<thead>
<tr>
<th>Year</th>
<th>Name 1</th>
<th>Name 2</th>
<th>Name 3</th>
<th>Name 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>Constance O. Okeke MD, MSCE</td>
<td>Pradeep Y. Ramulu, MD, PhD</td>
<td>Zaher H. Sbeity, MD, FBO</td>
<td>Misha F. Syed, MD</td>
</tr>
<tr>
<td>2009</td>
<td>Kelly W. Muir, MD</td>
<td>Scott J. Fudemberg, MD</td>
<td>Nathan M. Radcliffe, MD</td>
<td>Lucy Q. Shen, MD</td>
</tr>
<tr>
<td>2010</td>
<td>Kathryn E. Bollinger, MD, PhD</td>
<td>Robert T. Chang, MD</td>
<td>JoAnn A. Giaconi, MD</td>
<td>Vikas Gulati, MD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pokros Nouri-Mahdavi, MD, MSc</td>
<td>Mina B. Pantcheva, MD</td>
<td>Yang Sun, MD, PhD</td>
</tr>
</tbody>
</table>

Thank you Alcon, Allergan, and Merck for support of the Research Fellowship Grants in one or both categories.
Recipients of the Bernard Schwartz, MD, Memorial Award

The Bernard Schwartz, MD, Memorial Award was established in 2009 by a generous donation from Dr. Ralph Levene and Elsevier Publications.

The award is given annually to the top scored paper or poster abstract being presented at the Annual Meeting by a resident.

2009   Christopher Rodarte, MD
2010   Denise S. Kim, MD
2011   Jennifer S. Huang, MD
2012   Jennifer Hu, MD
2013   Tracy M. Wright, MD
2014   Richard Kaplan, BA
2015   Mary Qiu, MD
LECTURERS AND HONOREES
Lecturers and Honorees

Honoree

David L. Epstein, MD, MMM, grew up in Chicago, Illinois, and attended Johns Hopkins University for both undergraduate and medical school, graduating in 1968. Following an internship at the University of Washington, Seattle, Washington, he was a pre-resident fellow in the Howe Laboratory of Ophthalmology, Massachusetts Eye & Ear Infirmary (MEEI), Harvard Medical School, from 1969 to 1970. He served as a flight surgeon at the USAF School of Aerospace Medicine in San Antonio, Texas, from 1970 to 1972. From 1973 to 1976, Dr. Epstein completed his residency and a clinical and research glaucoma fellowship at MEEI. In 1978, Dr. Epstein joined the faculty at MEEI and Harvard Medical School, and from 1982 to 1991, he served as the Director of the Glaucoma Consultation Service. After a year as Professor of Ophthalmology at the University of California at San Francisco, he became Professor and Chairman of the Department of Ophthalmology at the Duke University School of Medicine in 1992. In 1996, he was named Joseph A. C. Wadsworth Clinical Professor of Ophthalmology. He received his Masters of Medical Management degree in 2001 from Tulane University School of Public Health.

Dr. Epstein was a glaucoma clinician and scientist with both clinical and laboratory research interests. He was also a founder of a Duke “spinoff” glaucoma drug development company, Aerie Pharmaceuticals (2005). He has over 230 refereed scientific publications and has received numerous awards. He received the Alcon Research Institute Award in 1982 and most recently he received Duke University School of Medicine Medical Alumni Association’s Distinguished Faculty Award (2012) and the Association for Research in Vision and Ophthalmology (ARVO) Mildred Weisenfeld Award for Excellence in Ophthalmology (2013). He was President of the Association for Research in Vision and Ophthalmology (ARVO) from 1992 to 1993, President of the Chandler-Grant Glaucoma Society from 2004 to 2005, and he was President of the Association of University Professors of Ophthalmology (AUPO) in 2011.

Dr. Epstein gave many named lectures, some of which are the W. Morton Grant Lecture (1993), the Jules Stein Lecture (1995), the Robert N. Shaffer Glaucoma Lecture (1995), the Chandler-Grant Lecture (1997), the Saul Sugar Lecture (2000), the Irving Leopold Lecture (2002), the American Glaucoma Society Lecture (2005), the Mansour F. Armaly Lecture (2005), the Florence Teicher Lecture (2005), the F. Bruce Fralick Lecture (2006), the Hoover Lecture (2008), the John R. Lynn Lecture (2009), the Jose S. Pulido Endowed Lecture (2009), the Thorpe Lecture (2010), the Kerrison Lecture (2010), the Irvine Lecture (2011), the ARVO – Weisenfeld Award Lecture (2013), and the Bettman Lecture (2013). He served on many national Scientific Advisory Boards, often as Chairman. He had a special interest in fostering M.D. clinician scientists’ careers in ophthalmology and translating the best in science to the understanding and treatment of human ocular disease.
President’s Award

M. Roy Wilson, MD, MS, was unanimously elected President of Wayne State University by the Board of Governors on June 5, 2013. He assumed the presidency on August 1, 2013.

Prior to joining Wayne State, Dr. Wilson served as deputy director for strategic scientific planning and program coordination at the National Institute on Minority Health and Health Disparities (NIMHD) of the National Institutes of Health (NIH).

As deputy director, Dr. Wilson led the development and implementation of an integrated system for planning, coordinating, and evaluating the NIH health disparities research portfolio, in collaboration with the NIH institutes and centers. He also co-chaired the NIH Common Fund programs: the Building Infrastructure Leading to Diversity Initiative and the National Research Mentoring Network.

Previously, Dr. Wilson was dean of the School of Medicine and vice president for health sciences at Creighton University, president of the Texas Tech University Health Sciences Center, and, concurrently, chancellor of the University of Colorado Denver and chair of the Board of Directors of University of Colorado Hospital. Immediately prior to joining NIH, Dr. Wilson chaired the Board of Directors of Charles R. Drew University of Medicine and Science and was acting president during part of that time. Under Dr. Wilson’s leadership, the university regained full institutional accreditation and stabilized its finances.

Dr. Wilson’s research has focused on glaucoma and blindness in populations from the Caribbean to West Africa. He holds elected memberships in the Institute of Medicine of the National Academy of Sciences, the International Glaucoma Research Society, and the American Ophthalmological Society. He has served on the executive committee of the NIH-funded Ocular Hypertension Treatment Study and currently chairs the Data Monitoring and Oversight Committee of the NIH-funded Los Angeles Latino Eye Study. Dr. Wilson was a member of the advisory councils of both NIMHD and the former National Center for Research Resources, as well as the NIH Director’s Working Group on Diversity in the Biomedical Research Workforce.

Dr. Wilson received his undergraduate degree from Allegheny College, an M.S. in epidemiology from the University of California, Los Angeles, and an M.D. from Harvard Medical School. He was selected for the list of Best Doctors in America for a consecutive 14 years by Best Doctors, Inc. and was a finalist for the Los Angeles Business Journal’s Healthcare CEO of the Year in 2011. His additional honors include the American Academy of Ophthalmology’s Senior Achievement Award, the Distinguished Physician Award from the Minority Health Institute, the Herbert W. Nickens Award from the Association of American Medical Colleges, and the NIH Director’s Award.
Surgery Day Lecturer

Iqbal Ike K. Ahmed, MD, is a fellowship-trained glaucoma, cataract, and anterior segment surgeon with a practice focus on the surgical management of glaucoma, complex cataract and intraocular lens complications. He is board certified in ophthalmology in Canada and the USA, and is an active member of the Canadian Ophthalmological Society (COS), the American Academy of Ophthalmology (AAO), the American Society of Cataract and Refractive Surgery (ASCRS), the Association for Vision and Research in Ophthalmology (ARVO), the International Society of Glaucoma Surgery (ISGS), the Canadian Glaucoma Society (CGS), and the American Glaucoma Society (AGS).

Dr. Ahmed has become world renowned for his skills and groundbreaking work in the diagnosis and surgical treatment of highly complex eye diseases including glaucoma and surgical complications. He is recognized as being one of the most experienced complex eye surgeons in the world and has trained numerous surgeons in innovative surgical techniques. Furthermore, he has been at the leading edge of novel treatments for cataract surgery and the latest designs in intraocular lens implants. Patients are referred to him locally, nationally, and from around the world. In 2010, Dr. Ahmed was selected as one of Canada’s “Top 40 Under 40” – a prestigious national award recognizing significant achievements at a young age.

Dr. Ahmed has a keen interest in the development of advanced microsurgical techniques in glaucoma surgery and complicated cataract extraction, and he is actively involved in research and medical education at a national and international level. He has received research grants to study glaucoma medications, glaucoma laser and surgical devices/techniques, angle closure glaucoma, anterior segment and retinal/optic nerve imaging in glaucoma, cataract surgical techniques and devices, and intraocular lens designs. Dr. Ahmed has designed innovative glaucoma diamond scalpels for surgery, microsurgical instrumentation, and devices, implants, and techniques for the management of the dislocated cataract, iris reconstruction, and glaucoma implant devices. As a result of his innovative expertise, Dr. Ahmed has been asked to consult for a variety of companies and manufacturers, especially pertaining to the development of new devices and technologies.

Course directorships include the Toronto Cataract Course, COS Surgical Teaching Series, University of Toronto Resident Phaco Course, and AAO and ASCRS Non-Penetrating Glaucoma Surgery and Cataract/IOL Courses. He directed the third International Congress on Glaucoma Surgery in May 2006 in Toronto. He sits on the editorial boards of Ophthalmology (Associated Editor, Multimedia), Journal of Cataract and Refractive Surgery, Clinical and Surgical Ophthalmology, Ocular Surgery News, Cataract and Refractive Surgery Today, and Glaucoma Today, and he is a reviewer for numerous journals.

Dr. Ahmed has published numerous peer-reviewed articles and book chapters, and has won five film festival awards, three best papers of session, and a poster award at ASCRS, as well as an ESCRS first place video award and AAO “Best of Show” award. He has given over 550 scientific presentations thus far in his career, including 19 visiting professor’s lectures around the world.

He is currently an Assistant Professor at the University of Toronto and a Clinical Assistant Professor at the University of Utah. He is the Research Fellowship Director, Department of Ophthalmology, University of Toronto, and is the Director of the Glaucoma and Advanced Anterior Segment Surgery (GAASS) fellowship at the University of Toronto. He has trained glaucoma specialists who are now practicing in Canada and around the world, as well as residents and medical students. Dr. Ahmed has a large tertiary glaucoma/ cataract practice at Credit Valley EyeCare and Osler EyeCare in the Greater Toronto Area, and primarily performs surgery at the Credit Valley Hospital, Mississauga, Ontario, and the Kensington Eye Institute, University of Toronto, Toronto, Ontario.
Special Guest Lecturer

Dr. Christian Otto, MD, MMSc, is an emergency physician, and an operational space medicine researcher. He completed his undergraduate degree in exercise physiology and his medical degree at the University of Ottawa. He completed his residency in Family Medicine and Emergency Medicine at Queen’s University in Kingston, Ontario, and graduate studies in Medical Science (Remote Medicine) at UTMB, Galveston, TX. Dr. Otto is experienced in remote medicine, high altitude medicine, and polar medicine having worked in the Canadian High Arctic, and as a medical researcher on Mount Everest, Mount McKinley and Mount Logan. In addition, Dr. Otto completed two one-year tours with the United States Antarctic Program, most recently as the 2004–05 Amundsen-Scott South Pole Station Physician. Dr. Otto has spent two field seasons on Devon Island in 2007 and 2008 at the Mars Institute’s analogue research site conducting space medicine research.

Dr. Otto is also a member of the International Scientific Committee on Antarctic Research, Expert Group on Human Biology and Medicine, and an advisory board member of the National Center for Human Performance at the Texas Medical Center.

Dr. Otto is the recipient of the American Institute of Aeronautics and Astronautics Presidential Citation, and the U.S. Congressional Polar Medal. On May 23, 2008 Dr. Otto summited Mt. Everest, the world’s highest mountain, via the South Col route.
AGS Lecturer

Paul P. Lee, MD, JD, is the F. Bruce Fralick Professor and Chair of the Department of Ophthalmology and Visual Sciences at the University of Michigan; and Director of the W.K. Kellogg Eye Center. He has published over 200 papers on glaucoma and eye care delivery, particularly on understanding and improving eye care. His research interests include improving access to and the quality of health care, patient-centered care, and exploring the impact of health policy and financing on patients and populations. Dr. Lee also serves as consultant to the Centers for Disease Control and Prevention, on the Board of Directors of the American Board of Ophthalmology, on the Advisory Committee of the Hoskins Center for Patient Safety and Quality of the American Academy of Ophthalmology Foundation, and he is a member of the Board of Governors and Chair of the Foundation of the Association of Research in Vision and Ophthalmology.

Paul P. Lee, MD, JD
Clinician-Scientist Lecturer

Claude F. Burgoyne, MD, is a Glaucoma clinician and surgeon, Van Buskirk Chair for Ophthalmic Research, and Director of the Optic Nerve Head Research Laboratory at the Devers Eye Institute in Portland, Oregon. After an undergraduate Bachelor of Arts degree in Architecture and Medical School at the University of Minnesota, he pursued Ophthalmology residency training at the University of Pittsburgh and Glaucoma Fellowship training at the Wilmer Eye Institute at the Johns Hopkins Hospitals in Baltimore, MD. For twelve years he was Director of Glaucoma Services at the LSU Eye Center in New Orleans before moving with his collaborative research group to Devers in 2005. For the past 17 years his laboratory has been NIH funded to study the effects of aging and experimental glaucoma on the neural and connective tissues of the monkey optic nerve head within 3D histomorphometric reconstructions. This work now extends to studying the cell biology of connective tissue remodeling and axonal insult early in the disease. Building upon its 3D capabilities, his laboratory is also funded to use spectral domain optical coherence tomography (SD-OCT) to visualize and quantify the deep tissues of the monkey optic nerve head and peripapillary sclera. NIH-funded collaborations are allowing his laboratory and those of his collaborators to apply these techniques to human glaucoma patient eyes. The long-term goal of his work is to build both a clinical science to predict how an individual human optic nerve head will respond to a given level of intraocular pressure, and the clinical tools to detect and treat that response.
International Recognition Award

**Anders Heijl, MD, PhD,** is Professor and earlier Chairman at the Department of Ophthalmology, Malmö University Hospital, Lund University, Sweden.

Professor Heijl is a graduate of the Lund University Medical School, where he also completed his residency in ophthalmology. He received a PhD from the University of Lund in 1977 for his early work on computerized perimetry, and later completed a post-doctoral fellowship under the mentorship of Professor Stephen Drance at the University of British Columbia. Dr Heijl has served as Chairman at the Department of Ophthalmology, Malmö University Hospital, since 1990.

Professor Heijl and his research group have invented and developed the Statpac programs for the Humphrey perimeter, including the now widely used concepts of Probability Maps, Pattern Deviation, Change Probability Maps, and the Glaucoma Hemifield Test. The Swedish Interactive Thresholding Algorithm (SITA) was also developed by his research group, as were the Glaucoma Progression Analysis (GPA) programs and the VFI index.

Professor Heijl initiated and still serves as Study Director of the Early Manifest Glaucoma Trial.

Between 1980 and 1996 Anders Heijl served the International Perimetric Society, first as Scientific Secretary and later as President. Between 2003 and 2008 he served as President of the Glaucoma Research Society.

He was the chief ophthalmological advisor to the Swedish National Board of Health and Welfare for 9 years, headed the group of glaucoma experts producing a systematic literature review on the diagnosis and treatment of open-angle glaucoma for the Swedish Council on Technology Assessment in Health Care, and serves on the board of the European Glaucoma Society, now as Chairman of EGS National Glaucoma Society Liaison Committee.

Professor Heijl has published 200 scientific papers, chapters, and books. He has served as Editor-in-Chief of *Acta Ophthalmologica*, and on the editorial boards of several ophthalmic journals.

Dr. Heijl has received scientific awards or delivered invited named lectures in about twenty instances, and he is an honorary member of the Glaucoma Research Society, the Finnish Ophthalmological Society, and the South African Glaucoma Society.
Innovator Award

Anthony Molteno, FRANZCO, FRCS, MB, graduated in medicine from Cape Town University in 1962 and specialized in ophthalmology, receiving his Edinburgh Fellowship in 1968. He took up an ophthalmologist position at Baragwanath Hospital before moving on to Stellenbosch, where he became Acting Head of Department. In 1977 his family emigrated to Dunedin, New Zealand, where he was appointed Senior Lecturer in ophthalmology at the University of Otago. He became Professor in 2002 and Emeritus Professor in 2012; he retired from clinical and teaching work at the end of 2014 but continues his research.

Dr. Molteno has earned an international reputation for his research, most notably into the effects of the Molteno implant, which was the first successful glaucoma drainage device and remains the “gold standard.”

He established and directs the Otago Glaucoma Surgery Outcome Study, which is the world’s longest ongoing follow-up study into glaucoma surgery. Over 1040 cases with a Molteno implant and 1070 that had a trabeculectomy at Dunedin Hospital since 1977 are being followed to determine their long-term outcomes. In recent years research has particularly focused on the immunohistochemical and electron microscopic examination of Molteno implant and trabeculectomy blebs to investigate the relationship between the clinical behavior and the pathophysiology of the tissue response to draining aqueous around implants.

Dr. Molteno also developed the M-Sphere orbital implant used following enucleation, and a method of photoscreening for infants to detect early strabismus and anomalies in focusing.

He has wide ranging research interests which in recent years include the following:

- The clinical use and effect of Avastin
- Stereotactic radiotherapy in the treatment of uveal melanomas
- Ultraviolet photography of the living human cornea
- Star testing of intraocular lens optical quality
- Fourier analysis of digital retinal images in estimation of cataract severity
- The histology of the tuatara pineal complex

He has published over 95 articles and seven book chapters.

His work has been acknowledged by numerous international and national honors and awards including the following:

- the International Society of Glaucoma Surgery medal for outstanding achievement in 2014
- Emeritus Membership in the Glaucoma Research Society in 2011
- a Distinguished Service Award by the Royal Australian and New Zealand College of Ophthalmologists in 2009
- the Lion Clubs International Foundation’s Melvin Jones Fellow in 2008
- an Officer of the New Zealand Order of Merit in the New Years Honors 2006
- the Goldmann Medal by the International Glaucoma Association for his significant contribution to the understanding and treatment of glaucoma in 1998

Tony and his wife, Tess, have three children. Life around Tony is never dull—his registrars get to view the ice caps on Mars through a telescope on his lawn and his grandchildren do all sorts of exciting things with him, such as viewing amoeba from the sheep trough through a microscope and being taught how to safely shoot opossums.
Humanitarian Award

Donald L. Budenz, MD, MPH, graduated magna cum laude and Phi Beta Kappa from the University of Pennsylvania, and he received his medical degree from Harvard Medical School. He completed an ophthalmology residency at the University of Pennsylvania, Scheie Eye Institute. Dr. Budenz then completed a Heed Foundation Fellowship in glaucoma at the University of Miami, School of Medicine, where he subsequently was a faculty member for 17 years. In 2004, he received a Masters in Public Health from the Johns Hopkins Bloomberg School of Public Health. He is the Kittner Distinguished Professor and Chair of Ophthalmology at the University of North Carolina, Chapel Hill.

Dr. Budenz is an editorial reviewer for numerous medical journals, is on the Editorial Board of the Journal of Glaucoma, and is the Editor of the Glaucoma issue of Current Opinion in Ophthalmology. He has been the principal investigator in a number of clinical trials, including the Ocular Hypertension Treatment Study. Concurrent with his research, Dr. Budenz has been published widely in the field of glaucoma; he has authored a textbook, Atlas of Visual Fields, contributed chapters to several other books, and written or coauthored more than 175 peer-reviewed journal articles.

Dr. Budenz is the recipient of a Golden Apple Award for Best Resident Teacher (University of Pennsylvania, School of Medicine) and has received the teaching award for Best Course in the Department of Epidemiology and Public Health at the University of Miami. He has been a guest lecturer at numerous universities, hospitals, and medical societies worldwide.

Since 1995, Dr. Budenz has been providing eye care, teaching, research, administrative, and financial support to several eye clinics in Ghana through his affiliation with Christian Eye Ministry, which he took over in 2009.
# Program Schedule

## WEDNESDAY, FEBRUARY 25TH

<table>
<thead>
<tr>
<th>TIME</th>
<th>EVENT / TITLE</th>
<th>LOCATION / SPEAKER</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:00 PM – 8:00 PM</td>
<td>Registration &amp; Exhibitor Check-In</td>
<td>Crystal Continental Foyer</td>
</tr>
<tr>
<td>5:00 PM – 9:00 PM</td>
<td>Exhibitor Installation</td>
<td>Crown</td>
</tr>
</tbody>
</table>

## THURSDAY, FEBRUARY 26TH – AGS & NANOS JOINT SYMPOSIUM

<table>
<thead>
<tr>
<th>TIME</th>
<th>EVENT / TITLE</th>
<th>LOCATION / SPEAKER</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00 AM – 6:30 PM</td>
<td>Registration &amp; Exhibitor Check-In</td>
<td>AGS Registration Desk</td>
</tr>
<tr>
<td>6:00 AM – 7:00 AM</td>
<td>Poster Set-up (1-37)</td>
<td>Coronet</td>
</tr>
<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Breakfast – Exhibit Hall</td>
<td>Crown</td>
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<tr>
<td>7:00 AM – 3:50 PM</td>
<td>Exhibit Hall Viewing</td>
<td>Crown</td>
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<tr>
<td>7:00 AM – 5:00 PM</td>
<td>Poster Viewing (1-37)</td>
<td>Coronet</td>
</tr>
<tr>
<td>8:30 AM – 10:30 AM</td>
<td>Spouse/Guest Hospitality Room</td>
<td>Garden Room</td>
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<tr>
<td>9:30 AM – 10:15 AM</td>
<td>Concierge Visit to Hospitality Room</td>
<td>Garden Room</td>
</tr>
<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Poster Session with Authors: Optic Nerve (1-37)</td>
<td>Coronet</td>
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<tr>
<td></td>
<td>Moderators: Thasarat S. Vajaranant, MD; Luis E. Vazquez, MD; Helen L. Kornmann, MD, PhD; Sayoko E. Moroi, MD, PhD</td>
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<tr>
<td>8:00 AM – 8:02 AM</td>
<td>Announcements</td>
<td>Ballroom</td>
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<tr>
<td>8:02 AM – 8:04 AM</td>
<td>Welcome and Introduction</td>
<td>Ballroom</td>
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<td></td>
<td>AGS President – David S. Greenfield, MD</td>
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<td></td>
<td>Joint Symposium AGS &amp; NANOS</td>
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<tr>
<td>8:04 AM – 8:05 AM</td>
<td>Housekeeping</td>
<td>Ballroom</td>
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<tr>
<td></td>
<td>Program Chairs: Christopher A. Girkin, MD, MSPH; Steven J. Gedde, MD</td>
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<tr>
<td>8:05 AM – 9:42 AM</td>
<td>Section 1 – Glaucoma: The Other Optic Neuropathy</td>
<td>Ballroom</td>
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<tr>
<td></td>
<td>Helen V. Danesh-Meyer, MD, FRANZCO; Mark L. Moster, MD</td>
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<tr>
<td></td>
<td>IOP and Other Issues in Glaucoma</td>
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<tr>
<td>8:05 AM – 8:10 AM</td>
<td>Introduction – Moderators</td>
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<tr>
<td></td>
<td>Helen V. Danesh-Meyer, MD, FRANZCO</td>
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<td>Mark L. Moster, MD</td>
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<tr>
<td>8:10 AM – 8:17 AM</td>
<td>Case: Is It Glaucoma</td>
<td>Marlene R. Moster, MD</td>
</tr>
<tr>
<td>8:17 AM – 8:25 AM</td>
<td>What Is Glaucoma: Clinically, Functionally, Pathologically?</td>
<td>Paul L. Kaufman, MD</td>
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<tr>
<td>8:25 AM – 8:33 AM</td>
<td>The Role of IOP in Glaucoma</td>
<td>M. Roy Wilson, MD, MS</td>
</tr>
<tr>
<td>8:33 AM – 8:41 AM</td>
<td>Is Normal Tension Different than High Tension? Phenotypic Differences (VF/Discs)</td>
<td>Jonathan S. Myers, MD</td>
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<tr>
<td>8:41 AM – 8:49 AM</td>
<td>Vascular Autonomic Dysfunction</td>
<td>Louis R. Pasquale, MD</td>
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<tr>
<td>8:49 AM – 8:57 AM</td>
<td>Genetic/Epidemiologic Factors</td>
<td>Janey Wiggs, MD, PhD</td>
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<tr>
<td>8:57 AM – 9:05 AM</td>
<td>Role of Intracraniell Pressure in Glaucoma</td>
<td>Timothy J. McCulley, MD</td>
</tr>
<tr>
<td>9:05 AM – 9:13 AM</td>
<td>Miscellaneous (Autoimmune, Scleral Factors/Myopia, Sleep Apnea)</td>
<td>Martin B. Wax, MD</td>
</tr>
</tbody>
</table>

* CME credits for Thursday morning sessions 1 through 3 will be provided by NANOS.
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>9:13 AM – 9:42 AM</td>
<td>Debate: We Should Eliminate the Term “Normal-Tension Glaucoma”</td>
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<tr>
<td>9:13 AM – 9:20 AM</td>
<td>Pro: Robert N. Weinreb, MD</td>
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<tr>
<td>9:20 AM – 9:27 AM</td>
<td>Con: Robert Ritch, MD</td>
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<tr>
<td>9:27 AM – 9:42 AM</td>
<td>Discussion</td>
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<tr>
<td>9:42 AM – 10:12 AM</td>
<td>Morning Tea – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>10:12 AM – 11:17 AM</td>
<td>Section 2 – Clinical Differences Between Glaucoma and Other Optic Neuropathies</td>
<td>Ballroom</td>
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<tr>
<td>10:12 AM – 10:20 AM</td>
<td>The Morphological Difference Between Glaucoma and Other Optic Neuropathies</td>
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<tr>
<td>10:20 AM – 11:17 AM</td>
<td>Case Presentations and Panel Discussion</td>
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<tr>
<td>11:17 AM – 12:32 PM</td>
<td>Section 3 – The Neurology of Glaucoma</td>
<td>Ballroom</td>
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<tr>
<td>11:17 AM – 11:25 AM</td>
<td>Glaucoma as a Neurological Disease</td>
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<tr>
<td>11:25 AM – 11:33 AM</td>
<td>The Visual Brain in Glaucoma and Other Optic Neuropathies</td>
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<tr>
<td>11:33 AM – 11:41 AM</td>
<td>What are the Common Neurodegenerative Pathways Relevant to Glaucoma?</td>
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<tr>
<td>11:41 AM – 11:49 AM</td>
<td>Neuro-protection in Glaucoma: Where Are We Going?</td>
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<td>11:49 AM – 11:57 AM</td>
<td>Is Neuroregeneration a Viable Treatment for Glaucoma?</td>
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<tr>
<td>11:57 AM – 12:05 PM</td>
<td>Mitochondrial Disease and Glaucoma</td>
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<tr>
<td>12:05 PM – 12:18 PM</td>
<td>Pro: Harry A. Quigley, MD</td>
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<tr>
<td>12:18 PM – 12:31 PM</td>
<td>Con: Christopher A. Girkin, MD, MSPH</td>
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<tr>
<td>12:31 PM – 12:32 PM</td>
<td>Discussion</td>
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<tr>
<td>12:32 PM – 2:00 PM</td>
<td>Lunch – on your own</td>
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<tr>
<td>2:00 PM – 3:00 PM</td>
<td>Symposium 1 – The Pathogenesis of Optic Neuropathy: Glaucoma Versus the Rest</td>
<td>Ballroom</td>
</tr>
<tr>
<td>2:00 PM – 2:08 PM</td>
<td>Changes in the Lamina Cribosa: Glaucoma Versus Non-glaucomatous Optic Neuropathies</td>
<td>J. Crawford Downs, PhD</td>
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<tr>
<td>2:08 PM – 2:16 PM</td>
<td>What About Cupping? The Role of Glia in Glaucomatous and Non-glaucomatous Optic Neuropathies</td>
<td>John G. Flanagan, PhD</td>
</tr>
<tr>
<td>2:16 PM – 2:24 PM</td>
<td>Timing Matters: Rescuing Neurons in Acute Versus Chronic Optic Neuropathies</td>
<td>Kenneth S. Shindler, MD PhD</td>
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<tr>
<td>2:24 PM – 2:32 PM</td>
<td>Is Glaucoma Different in the CNS? Geniculate and Cortical Neuronal Loss</td>
<td>Yeni H. Yucel, MD, PhD</td>
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<tr>
<td>2:32 PM – 2:40 PM</td>
<td>Topographic Differences: Central Versus Peripheral</td>
<td>Randy H. Kardon, MD, PhD</td>
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</table>

* CME credits for Thursday morning sessions 1 through 3 will be provided by NANOS.
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tr>
<td>2:40 PM – 3:00 PM</td>
<td>Discussion</td>
<td>Crown</td>
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<tr>
<td>3:00 PM – 3:30 PM</td>
<td>Break – Exhibit Hall</td>
<td>Crown</td>
</tr>
<tr>
<td>3:30 PM – 4:30 PM</td>
<td>Paper Presentations 1-5</td>
<td>Ballroom</td>
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<tr>
<td>3:37 PM – 3:42 PM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>3:42 PM – 3:49 PM</td>
<td>Angiography of Peripapillary Retina in Glaucoma with 70 kHz Spectral OCT</td>
<td>David Huang, MD, PhD</td>
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<tr>
<td>3:49 PM – 3:54 PM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>3:54 PM – 4:01 PM</td>
<td>Lamina Cribrosa Position in the Monkey Optic Nerve Transection Model of a Non-glaucomatous Optic Neuropathy</td>
<td>Kevin Ivers, PhD</td>
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<tr>
<td>4:01 PM – 4:06 PM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>4:06 PM – 4:13 PM</td>
<td>The Prospective Observational Study of Ocular Health in International Space Station (ISS) Astronauts: The Visual Impairment Intracranial Pressure Risk</td>
<td>Christian Otto, MD, MMSc</td>
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<tr>
<td>4:13 PM – 4:18 PM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>4:25 PM – 4:30 PM</td>
<td>Discussion/Practical Applications</td>
<td></td>
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<tr>
<td>4:30 PM – 5:30 PM</td>
<td>Symposium 2 – Optic Nerve Imaging: New Parameters and Techniques</td>
<td>Ballroom</td>
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<tr>
<td>4:30 PM – 4:38 PM</td>
<td>Definition of the Disc Margin: Does It Matter?</td>
<td>Claude F. Burgoyne, MD</td>
</tr>
<tr>
<td>4:38 PM – 4:46 PM</td>
<td>Normal Databases for Imaging: Are They Ethnically Appropriate?</td>
<td>Balwantray C. Chauhan, PhD</td>
</tr>
<tr>
<td>4:46 PM – 4:54 PM</td>
<td>Macular Imaging for Glaucoma: Will It Replace the Nerve Head?</td>
<td>Kouros Nouri-Mahdavi, MD, MSc</td>
</tr>
<tr>
<td>4:54 PM – 5:02 PM</td>
<td>Structural Parameters to Measure Rates of Damage</td>
<td>Felipe A. Medeiros, MD, PhD</td>
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<tr>
<td>5:02 PM – 5:10 PM</td>
<td>Optic Disc Stereo Photographs: Do They Still Play a Role?</td>
<td>George L. Spaeth, MD</td>
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<tr>
<td>5:10 PM – 5:30 PM</td>
<td>Panel Discussion</td>
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<tr>
<td>5:00 PM – 5:45 PM</td>
<td>Poster Tear Down (1-37)</td>
<td>Coronet</td>
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<tr>
<td>5:45 PM – 6:30 PM</td>
<td>Poster Set-up (38-84)</td>
<td>Coronet</td>
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<tr>
<td>6:30 PM – 7:00 PM</td>
<td>Special Guest Speaker: Christian Otto, MD, MMSc</td>
<td>Ballroom</td>
</tr>
<tr>
<td>7:00 PM – 8:30 PM</td>
<td>Welcome Reception</td>
<td>Sundeck</td>
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**FRIDAY, FEBRUARY 27TH – SURGERY DAY**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tr>
<td>6:00 AM – 6:50 AM</td>
<td>Morning Yoga</td>
<td>Executive Room</td>
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<tr>
<td>6:30 AM – 8:00 AM</td>
<td>Continental Breakfast – Exhibit Hall</td>
<td>Crown</td>
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<tr>
<td>7:00 AM – 6:00 PM</td>
<td>Registration</td>
<td>AGS Registration Desk</td>
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<tr>
<td>7:00 AM – 4:30 PM</td>
<td>Exhibitor Viewing</td>
<td>Crown</td>
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<tr>
<td>Time</td>
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<tr>
<td>7:00 AM – 5:00 PM</td>
<td>Poster Viewing (38-84)</td>
<td>Coronet</td>
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<tr>
<td>8:30 AM – 10:30 AM</td>
<td>Spouse/Guest Hospitality Room</td>
<td>Garden Room</td>
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<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Poster Session with Authors: Surgery (38-84)</td>
<td>Crown</td>
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<tr>
<td></td>
<td>Moderators: Robert M. Feldman, MD; Kathryn E. Bollinger, MD, PhD;</td>
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<td></td>
<td>Lisa F. Gould, MD, FRCS; Matthew E. Emanuel, MD; Molly M. Walsh, MD</td>
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<tr>
<td>8:00 AM – 8:02 AM</td>
<td>Announcements and Housekeeping</td>
<td>Ballroom</td>
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<tr>
<td>8:02 AM – 8:35 AM</td>
<td>Glaucoma Surgery Day Lecturer – MIGS 2.0</td>
<td>Ballroom</td>
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<tr>
<td></td>
<td>Introduction of Glaucoma Surgery Day Lecture</td>
<td>Cynthia Mattox, MD</td>
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<tr>
<td>8:05 AM – 8:35 AM</td>
<td>Glaucoma Surgery Day Lecture</td>
<td>Iqbal I. Ahmed, MD</td>
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<tr>
<td>8:35 AM – 9:30 AM</td>
<td>Surgery Day Section 1 – MIGS</td>
<td>Ballroom</td>
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<tr>
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<td>Moderators: Ahmad Aref, MD; Richard A. Lewis, MD</td>
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<td>AGS Moderators: Ron Gross, MD; Kuldev Singh, MD, MPH</td>
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<tr>
<td>9:30 AM – 9:37 AM</td>
<td>Surgical Management of Pigmentary Glaucoma (Similarities to and Differences from POAG)</td>
<td>Reay H. Brown, MD</td>
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<tr>
<td>9:37 AM – 9:42 AM</td>
<td>iStent</td>
<td>Thomas W. Samuelson, MD</td>
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<tr>
<td>9:42 AM – 9:47 AM</td>
<td>Trabectome</td>
<td>Ronald Leigh Fellman, MD</td>
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<tr>
<td>9:47 AM – 9:54 AM</td>
<td>Lens-Related Pigment Dispersion Including Subluxed Cataract and Spherophakia</td>
<td>Paul Harasymowycz, MD, FRCSC</td>
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<tr>
<td>9:54 AM – 10:01 AM</td>
<td>UGH Syndrome</td>
<td>Douglas J. Rhee, MD</td>
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<tr>
<td>10:01 AM – 10:05 AM</td>
<td>Video Case Studies (1 of 3)</td>
<td>Garry P. Condon, MD</td>
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<tr>
<td>10:05 AM – 10:09 AM</td>
<td>Video Case Studies (2 of 3)</td>
<td>Brian A. Francis, MD</td>
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<tr>
<td>10:09 AM – 10:13 AM</td>
<td>Video Case Studies (3 of 3)</td>
<td>Marlene R. Moster, MD</td>
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<tr>
<td>10:13 AM – 10:27 AM</td>
<td>Panel Discussion</td>
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<tr>
<td>10:47 AM – 11:42 AM</td>
<td>Surgery Day Section 3 – Paper Presentations 6–10</td>
<td>Ballroom</td>
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<td>Moderators: Kelly W. Muir, MD; Janet B. Serle, MD</td>
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<tr>
<td>10:47 AM – 10:54 AM</td>
<td>24-Month Results from a Prospective, Randomized, Multicenter Study of a Schlemm’s Canal Microstent for IOP Reduction After Cataract Surgery in Open-Angle Glaucoma</td>
<td>Thomas W. Samuelson, MD</td>
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<tr>
<td>10:54 AM – 10:58 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>10:58 AM – 11:05 AM</td>
<td>Using a Flow Test to Predict Early Postoperative Hypertensive Phase Following Ahmed Valve Implantation</td>
<td>Edward Moss, MD, FRCSC</td>
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<tr>
<td>11:05 AM – 11:09 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>Time</td>
<td>Session</td>
<td>Speaker(s)</td>
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<tr>
<td>11:09 AM – 11:16 AM</td>
<td>Corneal Decompensation Following Glaucoma Drainage Device Implantation: An Experimental Model to Evaluate Nutritional Theory</td>
<td>Ramesh Ayyala, MD, FRCS, FRCOphth</td>
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<tr>
<td>11:16 AM – 11:20 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>11:20 AM – 11:27 AM</td>
<td>Two-Center Three-Year Follow-up of a Micro-Lumen Aqueous Humor Shunt</td>
<td>Paul F. Palmberg, MD, PhD</td>
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<tr>
<td>11:27 AM – 11:31 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>11:38 AM – 11:42 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>11:42 AM – 11:44 AM</td>
<td>Announcements – Transition to Business Meeting</td>
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<tr>
<td>11:44 AM – 12:04 PM</td>
<td>AGS Annual Business Meeting</td>
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<td>12:04 PM – 12:14 PM</td>
<td>Group Photo</td>
<td>TBD</td>
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<tr>
<td>12:14 PM – 1:35 PM</td>
<td>Lunch – on your own</td>
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<tr>
<td>1:35 PM – 2:35 PM</td>
<td>Surgery Day Section 4 – Glaucoma Training: At Home and Abroad</td>
<td>Ballroom</td>
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<tr>
<td>1:43 PM – 1:51 PM</td>
<td>Resident Glaucoma Surgery Training in an Organized Fashion</td>
<td>Steven J. Gedde, MD</td>
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<tr>
<td>1:51 PM – 1:59 PM</td>
<td>The Aravind Eye Hospital Training</td>
<td>Alan L. Robin, MD</td>
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<td>1:59 PM – 2:07 PM</td>
<td>Orbis: Training the Trainers Using Telemedicine</td>
<td>James D. Brandt, MD</td>
</tr>
<tr>
<td>2:07 PM – 2:15 PM</td>
<td>The Sandwich Fellowship: Training Specialists Abroad</td>
<td>Karim F. Damji, MD</td>
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<tr>
<td>2:15 PM – 2:23 PM</td>
<td>Incorporating New Surgeries into Your Practice</td>
<td>Darrell WuDunn, MD, PhD</td>
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<tr>
<td>2:23 PM – 2:35 PM</td>
<td>Panel Discussion</td>
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<tr>
<td>2:35 PM – 3:30 PM</td>
<td>Surgery Day Section 5 – Congenital and Secondary Glaucomas: The Science and the Surgeries</td>
<td>Ballroom</td>
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<tr>
<td>2:35 PM – 2:42 PM</td>
<td>Surgery for Primary Congenital Glaucoma</td>
<td>Allen Dale Beck, MD</td>
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<tr>
<td>2:42 PM – 2:49 PM</td>
<td>Glaucoma Surgery in the Nanophthalmic Eye</td>
<td>Paul F. Palmberg, MD, PhD</td>
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<tr>
<td>2:49 PM – 2:56 PM</td>
<td>Uveitis</td>
<td>Shan C. Lin, MD</td>
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<td>2:56 PM – 3:03 PM</td>
<td>Neovascular Glaucoma</td>
<td>Pratap Challa, MD</td>
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<td>3:03 PM – 3:10 PM</td>
<td>ICE Syndrome</td>
<td>Paul A. Sidoti, MD</td>
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<td>3:10 PM – 3:30 PM</td>
<td>Panel Discussion</td>
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<tr>
<td>3:30 PM – 3:50 PM</td>
<td>Break – Exhibit Hall</td>
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<tr>
<td>3:50 PM – 3:53 PM</td>
<td>Eye Care America Video Presentation</td>
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<tr>
<td>3:53 PM – 4:23 PM</td>
<td>AGS Lecturer – Paying it Forward: New Opportunities for Translational Research and Personalized Care</td>
<td>Ballroom</td>
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<tr>
<td>3:53 PM – 3:58 PM</td>
<td>Introduction</td>
<td>David S. Greenfield, MD</td>
</tr>
<tr>
<td>3:58 PM – 4:23 PM</td>
<td>AGS Lecture</td>
<td>Paul P. Lee, MD, JD</td>
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<tr>
<td>4:23 PM – 4:28 PM</td>
<td>Introduction of Innovator Award – Christopher A. Girkin, MD, MSPH</td>
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<td></td>
<td>Recipient: Anthony C. B. Molteno, FRANZCO, FRCS, MB</td>
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</tr>
<tr>
<td>Time</td>
<td>Session</td>
<td>Location</td>
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</table>
| 4:28 PM – 5:33 PM | Surgery Day Section 6 – Tweaks of the Trade: Trab and Tube  
Edward J. Rockwood, MD; Mark B. Sherwood, MD | Ballroom         |
| 4:28 PM – 4:35 PM | The Living Bleb: Clinical Applications of Cytokines and Bleb Survival | Jeffrey Freedman, MD, PhD |
| 4:35 PM – 4:42 PM | Role of Death Messengers in Bleb Function | Anthony C. B. Molteno, FRANZCO, FRCS, MB |
| 4:42 PM – 4:49 PM | Trabeculectomy in the Progressing Low Pressure Patient | Philip Chen, MD |
| 4:49 PM – 4:56 PM | Point-Counterpoint: Trabeculectomy With Ex-Press is the Better Technique | Leon W. Herndon Jr., MD |
| 4:56 PM – 5:03 PM | Point-Counterpoint: Trabeculectomy Without Ex-Press is the Better Technique | Mark B. Sherwood, MD |
| 5:03 PM – 5:10 PM | Has the ABC or the AVB Study Changed My Tube Preference? | JoAnn A. Giaconi, MD |
| 5:10 PM – 5:17 PM | Glaucoma Drainage Device: My Top 5 Complications | Herbert P. Fechter, MD, PE |
| 5:17 PM – 5:33 PM | Panel Discussion |                  |
| 5:33 PM – 6:05 PM | Surgery Day Section 7: Surgical Videos  
Nathan M. Radcliffe, MD; Teresa C. Chen, MD | Ballroom         |
| 5:30 PM – 6:00 PM | Poster Tear-Down (38-84) | Coronet          |
| 6:00 PM – 6:30 PM | Poster Set-up (85-124) | Coronet          |
| 7:00 PM – 8:00 PM | Gala Reception | Garden Patio     |
| 8:00 PM – 10:00 PM | Gala Banquet and Dinner | Ballroom         |
| 10:00PM – 11:00 PM | Music by the FlipSide and Dancing | Ballroom         |

**SATURDAY, FEBRUARY 28TH**

<table>
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<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
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<tbody>
<tr>
<td>6:00 AM – 6:50 AM</td>
<td>Fun Run/Walk</td>
<td>Beach</td>
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<tr>
<td>7:00 AM – 8:15 AM</td>
<td>Breakfast – Exhibit Hall</td>
<td>Crown</td>
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<tr>
<td>7:00 AM – 4:00 PM</td>
<td>Registration</td>
<td>AGS Registration Desk</td>
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<tr>
<td>7:00 AM – 11:00 AM</td>
<td>Exhibit Viewing</td>
<td>Crown</td>
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<tr>
<td>7:00 AM – 3:30 PM</td>
<td>Poster Viewing (85-124)</td>
<td>Coronet</td>
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<tr>
<td>8:30 AM – 10:30 AM</td>
<td>Spouse/Guest Hospitality Room</td>
<td>Garden Room</td>
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</tbody>
</table>
| 7:00 AM – 8:00 AM | Poster Session with Authors: Epidemiology and Clinical Studies (85-124)  
Moderators: Pratap Challa, MD; Prithvi S. Sankar, MD; Ruth D. Williams, MD; Alex A. Huang, MD, PhD | Coronet          |
| 8:00 AM – 8:05 AM | Announcements | Ballroom         |
| 8:05 AM – 9:05 AM | Paper Presentations 11-15  
Nathan M. Radcliffe, MD; Don Budenz, MD, MPH | Ballroom         |
<p>| 8:05 AM – 8:12 AM | New OCT System Shows Collector Channels Rapidly Open &amp; Close with Pressure Changes: A Factor in the Persistent Distal Resistance After MIGS? | Murray A. Johnstone, MD |
| 8:12 AM – 8:17 AM | Discussion/Practical Applications |                  |
| 8:17 AM – 8:24 AM | Aqueous Angiography: Real-Time Imaging of Physiologic Comprehensive Aqueous Humor Outflow | Alex A. Huang, MD, PhD |
| 8:24 AM – 8:29 AM | Discussion/Practical Applications |                  |</p>
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker(s)</th>
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<tbody>
<tr>
<td>8:29 AM – 8:36 AM</td>
<td>Association Between Progressive Retinal Nerve Fiber Layer Loss and Longitudinal Change in Quality of Life in Glaucoma</td>
<td>Carolina P. Gracitelli, MD</td>
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<tr>
<td>8:36 AM – 8:41 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>8:41 AM – 8:48 AM</td>
<td>The Proportion of Individual Eyes Demonstrating Spectral Domain Optical Coherence Tomography Change in Early Experimental Glaucoma and Its Eye-Specific Character</td>
<td>Hongli Yang, PhD</td>
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<tr>
<td>8:48 AM – 8:53 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>8:53 AM – 9:00 AM</td>
<td>Association Between Dark-to-Light Changes in Anterior Chamber Angle Width and Iris Configuration in Dark, Light, and Dark-to-Light Conditions</td>
<td>Shan C. Lin, MD</td>
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<tr>
<td>9:00 AM – 9:05 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>9:05 AM – 10:10 AM</td>
<td>Symposium 3 – Intraocular Pressure and Glaucoma: New Insights</td>
<td>Neeru Gupta, MD, PhD; Arthur J. Sit, SM, MD</td>
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<tr>
<td>9:05 AM – 9:13 AM</td>
<td>How Well Does IOP Relate to Glaucoma?</td>
<td>Jeffrey M. Liebmann, MD</td>
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<tr>
<td>9:13 AM – 9:21 AM</td>
<td>Tracking IOP – Mean, Peak, Fluctuation? What Matters Most</td>
<td>Anthony D. Realini, MD</td>
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<tr>
<td>9:21 AM – 9:29 AM</td>
<td>How Does Perfusion Pressure Relate to IOP and Glaucoma?</td>
<td>Alon Harris, PhD</td>
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<tr>
<td>9:29 AM – 9:37 AM</td>
<td>How Does Cerebrospinal Fluid Pressure Relate to IOP and Glaucoma?</td>
<td>R. Rand Allingham, MD</td>
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<tr>
<td>9:37 AM – 9:45 AM</td>
<td>Rethinking Aqueous Outflow Pathways</td>
<td>Paul L. Kaufman, MD</td>
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<td>9:45 AM – 9:53 AM</td>
<td>Do We Need a New Goldmann Equation?</td>
<td>Arthur J. Sit, SM, MD</td>
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<tr>
<td>9:53 AM – 10:10 AM</td>
<td>Panel Discussion</td>
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<tr>
<td>10:10 AM – 10:30 AM</td>
<td>Break – Exhibit Hall</td>
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<tr>
<td>10:30 AM – 11:30 AM</td>
<td>Paper Presentations 16-20</td>
<td>Steven L. Mansberger, MD; Mitra Sehi, PhD</td>
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<tr>
<td>10:30 AM – 10:37 AM</td>
<td>Disparities in Utilization of Glaucoma Testing Among Enrollees in Medicaid and Those with Commercial Health Insurance and How They Vary by Race</td>
<td>Angela Elam, MD</td>
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<tr>
<td>10:37 AM – 10:42 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>10:42 AM – 10:49 AM</td>
<td>The Impact of Educational Workshops on Individuals at Risk for Glaucoma in the Philadelphia Glaucoma Detection and Treatment Project</td>
<td>Michael Waisbourd, MD</td>
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<tr>
<td>10:49 AM – 10:54 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>10:54 AM – 11:01 AM</td>
<td>Results from the First Teleglaucoma Pilot Study in Addis Ababa, Ethiopia</td>
<td>Sourabh Arora, MD</td>
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<tr>
<td>11:01 AM – 11:06 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>11:06 AM – 11:13 AM</td>
<td>Association Between Hysterectomy &amp; Oophorectomy and Glaucoma Prevalence in the United States</td>
<td>Mary Qiu, MD</td>
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<tr>
<td>11:13 AM – 11:18 AM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>11:18 AM – 11:25 AM</td>
<td>Primary Cilia Signaling Mediates Intraocular Pressure Sensation</td>
<td>Yang Sun, MD, PhD</td>
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<tr>
<td>11:25 AM – 11:30 AM</td>
<td>Discussion/Practical Applications</td>
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<td>Time</td>
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<tr>
<td>11:30 AM – 12:00 PM</td>
<td>Clinician-Scientist Lecture – Predicting Optic Nerve Head Susceptibility to Glaucoma</td>
<td>Ballroom</td>
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<tr>
<td>11:30 AM – 12:00 PM</td>
<td>Introduction of Clinician-Scientist Lecture</td>
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<tr>
<td>11:35 AM – 12:00 PM</td>
<td>Clinician-Scientist Lecture</td>
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<tr>
<td>12:00 PM – 1:30 PM</td>
<td>Lunch – on your own</td>
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<tr>
<td>1:30 PM – 2:00 PM</td>
<td>Symposium 4 – Innovating the Glaucoma Practice of the Future</td>
<td>Ballroom</td>
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<tr>
<td>1:30 PM – 1:35 PM</td>
<td>Implications of the Elimination of the Surgical Global Period</td>
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<td>1:35 PM – 1:39 PM</td>
<td>IRIS Registry to Report and Improve Quality Care</td>
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<td>1:39 PM – 2:00 PM</td>
<td>Panel Discussion: Glaucoma Care Delivery: Now and in the Future</td>
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<tr>
<td>2:00 PM – 3:10 PM</td>
<td>Symposium 5 – Functional Impairment in Glaucoma</td>
<td>Ballroom</td>
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<tr>
<td>2:00 PM – 2:07 PM</td>
<td>Should My Patient Still Be Driving?</td>
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<td>2:07 PM – 2:14 PM</td>
<td>Are Standard Visual Fields and Acuity Enough to Measure Disability from Glaucoma?</td>
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<td>2:14 PM – 2:21 PM</td>
<td>When Does Glaucoma Start Affecting a Person’s Function?</td>
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<td>2:21 PM – 2:28 PM</td>
<td>Why Is My 20/20 Patient Complaining of Reading Difficulty?</td>
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<tr>
<td>2:28 PM – 2:35 PM</td>
<td>How Do We Incorporate Information About Function into Treatment</td>
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<td>2:35 PM – 2:42 PM</td>
<td>Improving the Lives of Our Patients Who Have Already Lost Vision: Can We Do More?</td>
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<td>2:42 PM – 2:49 PM</td>
<td>New Strategies for Assessment of Functional Impairment</td>
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<td>2:49 PM – 3:10 PM</td>
<td>Panel Discussion</td>
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<tr>
<td>3:10 PM – 4:10 PM</td>
<td>Paper Presentations 21 – 25</td>
<td>Ballroom</td>
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<tr>
<td>3:10 PM – 3:17 PM</td>
<td>Impact of the Introduction of Generic Latanoprost on Glaucoma Medication Adherence</td>
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<td>3:17 PM – 3:22 PM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>3:22 PM – 3:29 PM</td>
<td>Characteristics of Patients Who First Present with Severe Stage Glaucoma</td>
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<td>3:29 PM – 3:34 PM</td>
<td>Discussion/Practical Applications</td>
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<tr>
<td>3:34 PM – 3:41 PM</td>
<td>Longitudinal and Cross-Sectional Analyses of Age and Intraocular Pressure Effects on Retinal Nerve Fiber Layer and Ganglion Cell Complex Thickness</td>
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<td>3:41 PM – 3:46 PM</td>
<td>Discussion/Practical Applications</td>
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<td>3:46 PM – 3:53 PM</td>
<td>Are We Inadvertently Accelerating Glaucoma? Benzalkonium Chloride Penetration Studies and Its Effect on Outflow Facility and Trabecular Meshwork Cellularity</td>
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<td>3:53 PM – 3:58 PM</td>
<td>Discussion/Practical Applications</td>
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<td>Time</td>
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<td>3:58 PM – 4:05 PM</td>
<td>Intraretinal Changes Revealed by Two-Photon Microscopy in an Optineurin Normal Pressure Glaucoma Mouse Model</td>
<td>Garrick Chak, MD</td>
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<tr>
<td>4:05 PM – 4:10 PM</td>
<td>Discussion/Practical Applications</td>
<td>Crown</td>
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<td>1:30 PM – 4:30 PM</td>
<td>Exhibitor Tear-Down</td>
<td>Crown</td>
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<tr>
<td>3:30 PM – 4:15 PM</td>
<td>Poster Tear-Down (85-124)</td>
<td>Coronet</td>
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**SUNDAY, MARCH 1ST**

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<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker(s)</th>
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<tr>
<td>7:00 AM – 11:00 AM</td>
<td>Registration</td>
<td>AGS Registration Desk</td>
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<tr>
<td>7:00 AM – 8:00 AM</td>
<td>Breakfast Roundtable Discussions</td>
<td>Crown</td>
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<td>MIGS 1</td>
<td>Andrew C. S. Crichton, MD, FRCS</td>
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<td>Maximizing Use of an Electronic Health Record in a Glaucoma Practice</td>
<td>Michael V. Boland, MD, PhD</td>
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<td>MIGS 2</td>
<td>Hady Saheb, MD</td>
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<td>My Top Two Disasters</td>
<td>Anastasios P. Costarides, MD, PhD</td>
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<td>New Developments in OCT Imaging for Glaucoma: Update on the Macula</td>
<td>Robert T. Chang, MD, C. Gustavo V. De Moraes, MD</td>
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<td>Management of Tube Complications</td>
<td>Robert D. Fechtner, MD</td>
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<td>The Prevention of Complications from Trabeculectomy</td>
<td>Simon K. Law, MD</td>
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<td>Would My Patient Benefit From Genetic Testing?</td>
<td>John H. Fingert, MD, Janey Wiggs, MD</td>
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<tr>
<td>8:00 AM – 11:00 AM</td>
<td>Workshops</td>
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<td>Conquering Coding and ICD-10, Avoiding PQRS, and VBM Penalties</td>
<td>Coronet</td>
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<td>Sue Vicchrilli, COT, OCS; Ronald L. Fellman, MD; Cynthia Mattox, MD</td>
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<td>Super Bowl of Glaucoma Grand Rounds</td>
<td>Tropics</td>
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<td>Dale K. Heuer, MD; Eydie G. Miller-Ellis, MD; Jody R. Piltz-Seymour, MD</td>
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SYMPOSIA
Symposia

AGS & NANOS Joint Symposium

Thursday, February 26th

Co-chairs:

Christopher A. Girkin, MD, MSPH

Steven J. Gedde, MD

Symposium 1

The Pathogenesis of Optic Neuropathy: Glaucoma Versus the Rest

Moderator

Richard P. Mills, MD, MPH

Moderator

Leonard A. Levin, MD, PhD – (NANOS)

Summary

Glaucoma differs pathophysiologically from other optic neuropathies in several important ways, while retaining similarities based on a final common pathway of tissue damage. Our speakers will cover changes in the lamina cribrosa, the role of glia in cupping and optic atrophy, the different requirements for rescue in chronic versus acute neuropathies, the changes in the CNS downstream from the site of damage, and lessons we can learn from topographic differences in visual field damage.
Paper Presentations 1-5

Moderator
Richard P. Mills, MD, MPH

Moderator
Lawrence E. Kagemann, PhD

A Common Variant of the Gene SIX6 (rs33912345) Is Associated with Global and Regional Reduction in the Retinal Nerve Fiber Layer in a Non-glaucomatous Asian Population
R. Rand Allingham, MD

Angiography of Peripapillary Retina in Glaucoma with 70 kHz Spectral OCT
David Huang, MD, PhD

Lamina Cribrosa Position in the Monkey Optic Nerve Transection Model of a Non-glaucomatous Optic Neuropathy
Kevin Ivers, PhD

The Prospective Observational Study of Ocular Health in International Space Station (ISS) Astronauts: The Visual Impairment Intracranial Pressure Risk
Christian Otto, MD, MMSc

Assessing Optic Nerve Head Drusen Prevalence in Normal-Appearing Eyes Using Enhanced Depth Imaging Optical Coherence Tomography
Mark Ghassibi, BS

Symposium 2

Optic Nerve Imaging: New Parameters and Techniques

Moderator
Joseph A. Caprioli, MD

Moderator
Donald L. Budenz, MD, MPH

Summary
This symposium will review and compare the efficacies of contemporary and emerging imaging techniques used to make measurements of structural damage from glaucoma.

Definition of the Disc Margin: Does It Matter?
Claude F. Burgoyne, MD

Normal Databases for Imaging: Are They Ethnically Appropriate?
Balwantray C. Chauhan, PhD

Macular Imaging for Glaucoma: Will It Replace the Nerve Head?
Kourosh Nouri-Mahdavi, MD, MSc

Structural Parameters to Measure Rates of Damage
Felipe A. Medeiros, MD, PhD

Optic Disc Stereo Photographs: Do They Still Play a Role?
George L. Spaeth, MD
Glaucoma Surgery Day

Friday, February 27th

Co-chairs:
Michele. C. Lim, MD
Brian A. Francis, MD

Surgery Day Section 1 – MIGS

Moderator
Ahmad Aref, MD
Moderator
Richard A. Lewis, MD

Summary
Microinvasive glaucoma surgical procedures currently provide a pivotal option for the treatment of glaucomatous optic neuropathy. The field is rapidly evolving to incorporate innovative technologies, techniques, and devices. This session aims to discuss current indications, surgical techniques, and available outcome data of various MIGS procedures.

GATT
Davinder S. Grover, MD, MPH

Suprachoroidal Shunts
Steven D. Vold, MD

Trabectome
Sameh Mosaed, MD

Endoscopic Cyclophotocoagulation
Vikas Chopra, MD

TM Outflow Stents
Steven R. Sarkisian Jr., MD

Surgery Day Section 2 / Symposium 2

ASCRS/AGS: Spotlight on Pigment Dispersion Glaucoma

Moderator
Ron Gross, MD
Moderator
Kuldev Singh, MD, MPH

Summary
The surgical approach to pigment dispersion glaucoma requires individualized therapy based on the presence of active pigment release and the anatomical findings resulting in pigment dispersion. Current studies and literature are insufficient to guide decision making. The impact on the potential glaucoma damage progression must be taken into account.

Surgical Management of Pigmentary Glaucoma (Similarities to and Differences from POAG)
Reay H. Brown, MD

iStent
Thomas W. Samuelson, MD

Lens-Related Pigment Dispersion Including Subluxed Cataract and Spherophakia
Paul Harasymowycz, MD, FRCSC
Symposia

UGH Syndrome
Douglas J. Rhee, MD

Video Case Studies (1 of 3)
Garry P. Condon, MD

Video Case Studies (2 of 3)
Brian A. Francis, MD

Video Case Studies (3 of 3)
Marlene R. Moster, MD

Surgery Day Section 3 –
Paper Presentations 6-10

Moderator
Kelly W. Muir, MD

Moderator
Janet B. Serle, MD

24-Month Results from a Prospective, Randomized, Multicenter Study of a Schlemm's Canal Microstent for IOP Reduction After Cataract Surgery in Open-Angle Glaucoma
Thomas W. Samuelson, MD

Using a Flow Test to Predict Early Post-Operative Hypertensive Phase Following Ahmed Valve Implantation
Edward Moss, MD, FRCSC

Corneal Decompensation Following Glaucoma Drainage Device Implantation: An Experimental Model to Evaluate Nutritional Theory
Ramesh Ayyala, MD, FRCS, FRCOphth

Two-Center Three-Year Follow-up of a Micro-Lumen Aqueous Humor Shunt
Paul F. Palmberg, MD, PhD

Use of a 45-µm Ab Interno Subconjunctival Gel-stent with Adjunctive Mitomycin C for the Treatment of Uncontrolled Open-Angle Glaucoma
Iqbal Ike K. Ahmed, MD

Surgery Day Section 4 –
Glaucoma Training: At Home and Abroad

Moderator
Beth E. Edmunds, MD, PhD

Moderator
Robert L. Stamper, MD

Summary
This symposium is relevant to all glaucoma specialists whether involved in formal teaching training programs, overseas outreach settings, mentorship, or their own continued professional development. It starts with an overview of current glaucoma fellowship training in the United States, addresses how to structure a good resident experience, and ends with a highly relevant section on adopting new surgical techniques into established practices. We also gain insights into specialist training elsewhere in the world, such as the Aravind experience and the remit of organizations such as Orbis in the training of surgeons in developing countries.

Introduction: Resident and Fellow Glaucoma Surgeries – The Numbers and the Future?
Dale K. Heuer MD

Resident Glaucoma Surgery Training in an Organized Fashion
Steven J. Gedde, MD

The Aravind Eye Hospital Training
Alan L. Robin, MD
American Glaucoma Society 25th Annual Meeting

Symposia 65

**Orbis: Training the Trainers Using Telemedicine**
*James D. Brandt, MD*

**The Sandwich Fellowship: Training Specialists Abroad**
*Karim F. Damji, MD*

**Incorporating New Surgeries into Your Practice**
*Darrell WuDunn, MD, PhD*

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**Surgery Day Section 5 – Congenital and Secondary Glaucomas: The Science and the Surgeries**

**Moderator**
*Martta M. Wright, MD*

**Moderator**
*Jennifer Somers Weizer, MD*

**Summary**
Speakers will discuss the best surgical approach to uncommon, complex, or intractable glaucomas. Surgery for congenital glaucoma, inflammatory glaucoma, neovascular glaucoma, and ICE syndrome will be covered. Special considerations for glaucoma surgery in the nanophthalmic eye will be examined.

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**Surgery for Primary Congenital Glaucoma**
*Allen Dale Beck, MD*

**Glaucoma Surgery in the Nanophthalmic Eye**
*Paul F. Palmberg, MD, PhD*

**Uveitis**
*Shan C. Lin, MD*

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**Neovascular Glaucoma**
*Pratap Challa, MD*

**ICE Syndrome**
*Paul A. Sidoti, MD*

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**Surgery Day Section 6 – Tweaks of the Trade: Trab and Tube**

**Moderator**
*Edward J. Rockwood, MD*

**Moderator**
*Mark B. Sherwood, MD*

**Summary**
Successful outcomes from glaucoma filtering procedures rely on a combination of complex biological and technical factors involved in the procedure and subsequent wound healing following surgery. This session will address some of these issues. Factors related to filtering bleb development and survival will be explored. Different surgical techniques and patient selection for filtering procedures involving trabeculectomy and tube shunt devices will be debated and discussed.

**The Living Bleb: Clinical Applications of Cytokines and Bleb Survival**
*Jeffrey Freedman, MD, PhD*

**Role of Death Messengers in Bleb Function**
*Anthony C. B. Molteno, FRANZCO, FRCS, MB*

**Trabeculectomy in the Progressing Low Pressure Patient**
*Philip Chen, MD*
Trabeculectomy with Ex-Press Is the Better Technique
Leon W. Herndon Jr., MD

Trabeculectomy Without Ex-Press Is the Better Technique
Mark B. Sherwood, MD

Has the ABC or the AVB Study Changed My Tube Preference?
JoAnn A. Giaconi, MD

Glaucoma Drainage Device: My Top 5
Herbert P. Fechter, MD, PE

Saturday, February 28th

Paper Presentations 11-15

Moderator Nathan M. Radcliffe, MD

Moderator Don Budenz, MD, MPH

New OCT System Shows Collector Channels Rapidly Open & Close with Pressure Changes: A Factor in the Persistent Distal Resistance After MIGS?
Murray A. Johnstone, MD

Aqueous Angiography: Real-Time Imaging of Physiologic Comprehensive Aqueous Humor Outflow
Alex Huang, MD, PhD

Association Between Progressive Retinal Nerve Fiber Layer Loss and Longitudinal Change in Quality of Life in Glaucoma
Carolina P. Gracitelli, MD

The Proportion of Individual Eyes Demonstrating Spectral Domain Optical Coherence Tomography Change in Early Experimental Glaucoma and Its Eye-Specific Character
Hongli Yang, PhD

Association Between Dark-to-Light Changes in Anterior Chamber Angle Width and Iris Configuration in Dark, Light, and Dark-to-Light Conditions
Shan C. Lin, MD

Summary
Glaucoma surgical techniques are rapidly evolving. This forum will allow surgeons to share insight, tips, and tricks they use to enhance surgical outcomes.
Symposium 3

Intraocular Pressure and Glaucoma: New Insights

Moderator
Neeru Gupta, MD, PhD, MBA

Moderator
Arthur J. Sit, SM, MD

Summary
Cutting edge information will be presented on the relationship between IOP and glaucoma, and on parameters that influence the disease, including perfusion pressure and cerebrospinal fluid pressure. Current thinking about aqueous outflow and its measurement will be considered in the context of the recently discovered “uveolymphatic” outflow pathway.

How Well Does IOP Relate to Glaucoma?
Jeffrey M. Liebmann, MD

Tracking IOP – Mean, Peak, Fluctuation? What Matters Most
Anthony D. Realini, MD

How Does Perfusion Pressure Relate to IOP and Glaucoma?
Alon Harris, PhD

How Does Cerebrospinal Fluid Pressure Relate to IOP and Glaucoma?
R. Rand Allingham, MD

Do We Need a New Goldmann Equation?
Arthur J. Sit, SM, MD

Rethinking Aqueous Outflow Pathways
Paul L. Kaufman, MD

Paper Presentations 16-20

Moderator
Steven L. Mansberger, MD, MPH

Moderator
Mitra Sehi, PhD

Disparities in Utilization of Glaucoma Testing Among Enrollees in Medicaid and Those with Commercial Health Insurance and How They Vary by Race
Angela Elam, MD

The Impact of Educational Workshops on Individuals at Risk for Glaucoma in the Philadelphia Glaucoma Detection and Treatment Project
Michael Waisbourd, MD

Results from the First Teleglaucoma Pilot Study in Addis Ababa, Ethiopia
Sourabh Arora, MD

Association Between Hysterectomy & Oophorectomy and Glaucoma Prevalence in the United States
Mary Qiu, MD

Primary Cilia Signaling Mediates Intraocular Pressure Sensation
Yang Sun, MD, PhD
Symposium 4

Innovating the Glaucoma Practice of the Future

**Implications of the Elimination of the Surgical Global Period**
*Ronald L. Fellman, MD*

**Registry to Report and Improve Quality Care**
*Cynthia Mattox, MD*

**Panel Discussion: Glaucoma Care Delivery: Now and in the Future**

*Panelist*
*Ruth D. Williams, MD*

*Panelist*
*David G. Godfrey, MD*

*Panelist*
*Brian L. Lee, MD*

*Panelist*
*Michael V. Boland, MD, PhD*

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Symposium 5

Functional Impairment in Glaucoma

**Moderator**
*Felipe A. Medeiros, MD, PhD*

**Moderator**
*Pradeep Y. Ramulu, MD, PhD*

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**Summary**

Glaucoma is a leading cause of visual impairment and disability. Although a variety of functional and structural tests are available to diagnose and monitor the disease, there is little understanding of how the results of these tests are related to the ability of patients to perform everyday tasks such as driving or reading. This presentation will discuss currently available methods to assess functional impairment, their limitations, and also new work on this area.

**Should My Patient Still Be Driving?**
*Cynthia Owsley, MSPH, PhD*

**Are Standard Visual Fields and Acuity Enough to Measure Disability from Glaucoma?**
*Chris A. Johnson, PhD*

**When Does Glaucoma Start Affecting a Person’s Function?**
*Rohit Varma, MD, MPH*

**Why Is My 20/20 Patient Complaining of Reading Difficulty?**
*Bonnielin K. Swenor, MPH*

**How Do We Incorporate Information About Function into Treatment**
*Anjali Bhorade, MD*

**Improving the Lives of Our Patients Who Have Already Lost Vision: Can We Do More?**
*George L. Spaeth, MD*

**New Strategies for Assessment of Functional Impairment**
*Peter Rosen, MD*
Paper Presentations 21-25

Moderator
Rachel W. Kuchtey, MD, PhD

Moderator
George A. Cioffi, MD

Impact of the Introduction of Generic Latanoprost on Glaucoma Medication Adherence
Joshua D. Stein, MD

Characteristics of Patients Who First Present with Severe Stage Glaucoma
Victoria Addis, MD

Longitudinal and Cross-Sectional Analyses of Age and Intraocular Pressure Effects on Retinal Nerve Fiber Layer and Ganglion Cell Complex Thickness
Xinbo Zhang, PhD

Are We Inadvertently Accelerating Glaucoma? Benzalkonium Chloride Penetration Studies and Its Effect on Outflow Facility and Trabecular Meshwork Cellularity
Douglas J. Rhee, MD

Intraretinal Changes Revealed by Two-Photon Microscopy in an Optineurin Normal Pressure Glaucoma Mouse Model
Garrick Chak, MD
Breakfast Roundtables

**MIGS 1**

*Andrew C. S. Crichton, MD, FRCS*

*Alan S. Crandall, MD*

**Summary**

A review of which procedures are included in microinvasive glaucoma surgery.

Discussion will focus on integrating MIGS into clinical practice, with a focus on suitable patients, intraoperative considerations, and post-operative follow-up.

**MIGS 2**

*Hady Saheb, MD*

*Nils A. Loewen, MD, PhD*

**Summary**

This roundtable will allow clarification of the expanding indications for MIGS, and discussion on how to integrate MIGS into the ophthalmologist’s armamentarium. Surgical pearls and challenges will be discussed. Participants will better understand which categories of MIGS are available to patients in the United States, and which are investigational.

**Maximizing Use of an Electronic Health Record in a Glaucoma Practice**

*Michael V. Boland, MD, PhD*

*James D. Brandt, MD*

**Summary**

This session will provide practical examples of how electronic health records can be used to care for glaucoma patients. Discussion will focus on the management of longitudinal data and on the management of structural and functional information regarding the optic nerve. Participants will also be allowed to discuss issues specific to their own practices.

**My Top Two Disasters**

*Anastasios P. Costarides, MD, PhD*

*Paul F. Palmberg, MD, PhD*

**Summary**

Cases of complications of glaucoma surgery will be presented. Intraoperative complications such as suprachoroidal hemorrhage will be presented, with discussion of management options. Cases of late postoperative problems such as chronic hypotony and tube shunt exposure-related endophthalmitis will be presented. Management options for the effective reversal of hypotony and the reduction of tube exposure risk will be discussed.
New Developments in OCT Imaging for Glaucoma: Update on the Macula

Robert T. Chang, MD

C. Gustavo Y. De Moraes, MD

Summary
This presentation on spectral domain OCT for glaucoma will cover an update on macular imaging, practical tips for using OCT to make diagnostic decisions, how to avoid pitfalls when interpreting the images, and serial OCT imaging for assessing glaucoma progression.

Management of Tube Complications

Robert D. Fechtner, MD

Herbert P. Fechter, MD, PE

Summary
Tube surgery is an essential tool for the glaucoma surgeon but, as with other glaucoma procedures, can have early or late complications. This roundtable will discuss common and not-so-common complications of tube surgery and explore multiple options for management of these complications.

Prevention of Complications from Trabeculectomy

Simon K. Law, MD

James C. Tsai, MD

Summary
Trabeculectomy is believed by some to be not as safe, predictable, or efficacious as other glaucoma surgeries (tubes, shunts, and MIGS), with a steep learning curve. In this roundtable discussion, we would like to introduce ways to reduce complications, discuss techniques to improve predictability, and explore the role of trabeculectomy in the midst of different glaucoma surgeries.

Would My Patient Benefit from Genetic Testing?

John H. Fingert, MD, PhD

Janey Wiggs, MD, PhD

Summary
Genetic tests are increasingly available and may provide physicians and their patients with powerful information. However, it is important to differentiate between cases where testing has clinical utility for individual patients and cases where testing has research utility as part of population-based studies. Specific cases where genetic testing might be most useful in a glaucoma practice will be discussed.
Workshops

**Conquering Coding and ICD-10, Avoiding PQRS, and VBM Penalties**

**Summary**
Customized for glaucoma specialists, this intensive three-hour course will address CPT and Category III changes, PQRS, VBM, and ICD-10-CM knowledge and implementation.

**Moderators:**
- Sue Vicchirili, COT, OCS
- Cynthia Mattox, MD
- Ronald L. Fellman, MD

**Superbowl of Glaucoma Grand Rounds**

**Summary**
The Super Bowl of Glaucoma Grand Rounds at the AGS Annual Meeting is an inclusive, interactive session during which attendees present and discuss challenging glaucoma cases. Over the course of the morning, we cover a remarkable amount of content, learning from each other as we discuss the cases, the pertinent literature, and our clinical experiences. Five to eight cases are typically presented, and all attendees, including provisional members, are encouraged to submit a case for possible inclusion in the grand rounds. All are invited to attend and participate in the lively discussion.

**Moderators:**
- Dale K. Heuer, MD
- Eydie G. Miller-Ellis, MD
- Jody R. Piltz-Seymour, MD
A Common Variant of the Gene SIX6 (rs33912345) Is Associated with Global and Regional Reduction in the Retinal Nerve Fiber Layer in a Non-glaucomatous Asian Population

R RAND ALLINGHAM1, Tin Aung2, Eranga Vithana2, Michael Hauser1, Tien Yin Wong3, Ching-Yu Cheng2
1 Duke University 2 Singapore Eye Research Institute 3 National University of Singapore

Purpose/Relevance
POAG is a complex inherited trait. Recently, a common genetic variant of the gene SIX6, rs33912345 (Asn141His), has been identified that is highly associated with POAG-risk. This variant affects ocular development in the zebrafish model and is associated with reduced retinal nerve fiber layer (RNFL) thickness in POAG cases. We have examined the effect of this variant on RNFL thickness in a non-glaucomatous Singapore Chinese population.

Methods
Study subjects were enrolled within the Singapore Chinese Eye Study (SCES), a population-based survey of Singaporean Chinese aged 40 years or older. Subjects underwent a comprehensive ocular examination according to a standardized protocol. SD-OCT was used to measure RNFL thicknesses. Genotyping of SIX6 rs33912345 was performed using Illumina exome array (HumanExome BeadChip v1.0).

Results
A total of 2,096 eyes from 1,222 SCES subjects (mean age: 55.0±7.4 years) with rs33912345 genotype data and SD-OCT images were included for the analysis after glaucoma cases (21) were excluded. The allele frequency of rs33912345 risk variant C (His141) was 80%. Each rs33912345 risk allele was associated with a 1.39 um decrease in mean RNFL thickness, after adjusting for age, gender, genetic principal components, and axial length ($P = 0.001$). The strongest association was observed in the superior RNFL sector (a decrease of 2.76 µm in RNFL per risk allele, $P < 0.001$) followed by the inferior RNFL sector (a decrease of 2.16 µm per risk allele, $P = 0.004$). There was no significant difference in RNFL related to genotype in the nasal and temporal sectors.

Discussion
The common SIX6 POAG-risk variant, rs33912345, is associated with global reduction in the mean RNFL thickness in the Singaporean Chinese population without glaucoma. RNFL changes were confined to the superior and inferior sectors, which are classically affected in glaucomatous optic neuropathy. This suggests that this genetic variant in addition to increasing POAG also reduces RNFL in a large number of the population at large, including persons that will never be diagnosed with glaucoma in their lifetimes. Further studies are needed to determine how this variant, as well as other SIX6 variants, induce changes in RNFL and how SIX6 variants affect those not known to have glaucoma.

Conclusion
The common variant of SIX6 that is present in 80% of Asians and a large percent of all other populations not only increases risk of POAG but also affects the eyes of those who will never be diagnosed with glaucoma. This is likely the first variant to be discovered that will alter the manner in which we calculate POAG risk as well as refine the way we assess ocular health in years to come.

Reference
2 Angiography of Peripapillary Retina in Glaucoma with 70-kHz Spectral OCT

DAVID HUANG1, Yali Jia1, Liang Liu1, Beth Edmunds1, Lorinna Lombardi1, Rebecca Armour1, Ellen Davis1, John Morrison1
1 Casey Eye Institute-OHSU

Purpose/Relevance
To detect peripapillary perfusion defect in glaucoma using optical coherence tomography (OCT) angiography.

Methods
One eye of each study participant was imaged using a high-speed (70 kHz) 840 nm wavelength spectral OCT system (RTVue-XR, Optovue, Inc). The optic disc region was scanned twice using a 3x3 mm volumetric angiography scan. The split-spectrum amplitude decorrelation angiography (SSADA) algorithm was used.1 The peripapillary region was defined as a 700µm wide elliptical annulus outside the disc. En face angiogram of the retinal circulation was obtained by maximum flow (decorrelation value) projection. The peripapillary flow index was defined as the average decorrelation value on the en face retinal angiogram.2,3 The vessel density was defined as the percentage area occupied by vessels.

Results
The study included 28 normal and 12 glaucoma participants. In the normal eye, a dense microvascular network around disc was visible on OCT angiography (Fig. 1B). This network was visibly attenuated globally and focally in glaucomatous eyes (Fig. 1F). In normal participants, the between-visit reproducibility and population variability of peripapillary retina flow index/vessel density were 4.3%/2.7% and 9.9%/3.8% coefficient of variation, respectively. The flow index in the glaucoma group was 0.066 ± 0.012 (mean ± SD), lower (P<0.001 Wilcoxon rank-sum test) than the normal group (0.082 ± 0.008). The vessel density in the glaucoma group (80.6% ±11.1%) was lower (P<0.001) than the normal group (92.9% ± 3.1%). Both flow index (Pearson’s R = -0.808) and vessel density (R= -0.835) were highly and significantly (p=0.001) correlated with visual field pattern standard deviation in the glaucoma group. The area under the receiver operating curve for differentiating normal and glaucoma eyes was 0.869 and 0.917 for flow index and vessel density, respectively.

Discussion
Using OCT angiography implemented on a commercial system, glaucomatous reduction in peripapillary retinal perfusion could be visualized as focal defects and quantified as flow index and vessel density with high reproducibility and diagnostic accuracy.

Conclusion
OCT angiography could be useful in the clinical evaluation of glaucoma and glaucoma progression.
References


3 Lamina Cribrosa Position in the Monkey Optic Nerve Transection Model of a Non-glaucomatous Optic Neuropathy

KEVIN IVERS1, Eliesa Ing1, Hongli Yang1, Stuart Gardiner1, Juan Reynaud1, Grant Cull1, Lin Wang1, Claude Burgoyne1

1 Devers Eye Institute

Purpose/Relevance
To test the hypothesis that longitudinally detected, Spectral Domain Optical Coherence Tomography (SDOCT) posterior lamina cribrosa deformation will not occur in monkey optic nerve transection (ONT).

Methods
Both eyes of 5 adult monkeys underwent SDOCT imaging 3-5 times at baseline, then biweekly following unilateral ONT surgery for 1.5 to 2 months, when animals were sacrificed as per their primary study. The internal limiting membrane and Bruch’s Membrane Opening (BMO) were delineated in 48 ONH B-scans from each pre and post-ONT imaging session. Global ONH minimum rim width (MRW) and RNFL thickness (RNFLT - 12° circular scans) were calculated and compared to their baseline 95% Confidence (95% CI) to determine change. The anterior laminar cribrosa surface (ALCS) was delineated within the baseline and pre-sacrifice SDOCT data sets. Pre-sacrifice ALCS depth relative to a BMO reference plane (ALCSD) was then compared to its baseline 95% CI to determine ALCSD change.

Results
SDOCT data for 2 ONT animals (M1 and M2) have been analyzed. Pre and post-ONT global MRW, RNFLT and ALCSD data (pre-sacrifice only) for both eyes of each animal are shown in Figure 1. Representative ONT eye baseline and pre-sacrifice SDOCT B-scans from each animal are shown in Figure 2. Pre-sacrifice percent change in MRW and RNFLT was -31.3% and -45.0% for M1 and -25.2% and -41.4% for M2, respectively. Pre-sacrifice ALCSD was unchanged from baseline in both the ONT and Control eyes of both animals.

Discussion
In 2 recent monkey studies, SDOCT detected posterior lamina cribrosa deformation prior to RNFLT change following chronic experimental IOP elevation but failed to demonstrate lamina cribrosa deformation 2 years following chronic experimental cerebrospinal fluid (CSF) pressure lowering. Assuming our findings are confirmed in all 5 ONT animals, we propose that posterior lamina deformation should be included in the definition of a glaucomatous vs. non-glaucomatous optic neuropathy in the monkey eye.

Figure 1. Global retinal nerve fiber layer thickness (RNFLT), minimum rim width (MRW), and anterior lamina cribrosa surface depth (ALCSD) data for M1 and M2. The vertical dashed black line represents the data of optic nerve transection. Horizontal dashed blue lines represent the 95% confidence interval for the control eye. Horizontal dashed red lines represent the 95% confidence interval for the ONT eye. The percent change (calculated from the mean of the baseline time-points) for RNFLT and MRW are listed in parenthesis for M1 and M2 at their pre-sacrifice time-points. By convention, negative values for RNFLT and MRW indicate thinning and for ALCSD indicate posterior deformation from baseline. Positive values for RNFLT and MRW indicate thickening and for ALCSD indicate anterior deformation from baseline.
Conclusion

In a preliminary analysis of 2 ONT animals, while SDOCT MRW and RNFLT demonstrated profound change within the ONT eyes, ALCSD was unchanged from baseline at 51 (M1) and 49 (M2) days post transection. Data for all 5 animals will be presented at the meeting.

References

The Prospective Observational Study of Ocular Health in International Space Station (ISS) Astronauts: The Visual Impairment Intracranial Pressure Risk

CHRISTIAN OTTO¹, Yael Barr², Robert Ploutz-Snyder¹, Rachel Brady³, Charles Gibson⁴, David Alexander⁵, Ashot Sargsyan⁶, Nimesh Patel⁶, Kathleen Garcia⁷, Brian Samuels⁷

¹ Universities Space Research Association
² The University of Texas Medical Branch
³ Wyle Science, Technology & Engineering
⁴ Coastal Eye Associates
⁵ NASA Johnson Space Center
⁶ The University of Houston
⁷ University of Alabama at Birmingham

Purpose/Relevance
Following space flight, 70% of tested ISS astronauts have manifested signs of altered eye structure and function; 32% with disc edema. Similar to glaucoma, the leading hypothesis involves an elevated translaminar pressure gradient (TLPG); but unique to space flight, this is believed to be precipitated by increased intracranial pressure (ICP). This study prospectively characterized the changes in astronaut eye structure and function across the three phases of an ISS space flight.

Methods
Five astronauts were recruited. Ocular coherence tomography, ocular ultrasound, vision testing, funduscopy, and intraocular pressure (IOP) were collected pre-, post- and inflight monthly over each six-month mission. Cycloplegic refraction and axial biometry were collected pre- and postflight.

Results
One astronaut developed disc edema. On average, the 5 subjects’ ONS diameter increased inflight (6.28±0.32mm, p<0.0001), compared to preflight (5.89±3.24mm), and returned towards preflight levels postflight (6.01± 0.32mm, p=0.28). Retinal artery peak systolic velocity was elevated inflight (15.92±1.64cm/s, p<0.0001) and postflight (13.27±1.72cm/s, p<0.011) compared to preflight (10.66±1.78cm/s). Mean IOP was unchanged inflight (13.95±0.55mmHg, p=0.19) from preflight (14.44±0.63mmHg), but was lower postflight (12.78±0.58mmHg, p<0.0001).

Average circumpannial retinal nerve fiber layer (RNFL) increased inflight (104.66±2.71µm, p<0.0001) from preflight (101.42± 2.75µm), and remained higher postflight (105.78± 2.73µm, p<0.0001). Circumpapillary choroidal thickness also increased inflight (228.44± 21.67µm, p<0.0001) and was higher postflight (203.10±21.77µm, p=0.094) compared to preflight (193.90±21.88µm). Axial length remained unchanged; however uncocorreted distance vision improved inflight compared to preflight, and remained improved postflight. Cycloplegic refraction preflight (-1.50± 0.55D) to postflight (-1.22± 0.56D) revealed a 0.27 Diopter shift (p<0.003).

Discussion
Elevated inflight ONS diameter and increased retinal artery velocity reflect an elevated pressure within the ONS and likely contributes to the altered TLPG causing RNFL thickening. Choroidal thickness increased inflight, and trended toward persisting postflight, contributing to a hyperopic shift and an improvement in visual acuity in the four myopes.

Conclusion
Significant alterations to astronaut eye structure and function occur with exposure to microgravity and are believed to be the result of chronically elevated ICP and changes in the TLPG.

Reference
Assessing Optic Nerve Head Drusen Prevalence in Normal-Appearing Eyes Using Enhanced Depth Imaging Optical Coherence Tomography

MARK GHASSIBI1,2, Jason Chien1,2, Ramiz Abumasmah1, Jeffrey Liebmann3,4, Robert Ritch1, Sung Chul Park1,6
1 Moise and Chella Safra Advanced Ocular Imaging Laboratory, Einhorn Clinical Research Center, New York Eye and Ear Infirmary
2 George Washington University School of Medicine and Health Sciences
3 Columbia University College of Physicians and Surgeons
4 Harkness Eye Institute, Columbia University Medical Center
5 Einhorn Clinical Research Center, New York Eye and Ear Infirmary
6 Icahn School of Medicine at Mount Sinai

Purpose/Relevance
To investigate the prevalence of optic nerve head drusen (ONHD) in normal-appearing eyes using enhanced depth imaging (EDI) optical coherence tomography (OCT) and to associate the presence of ONHD with axial length, age, and gender.

Methods
Serial horizontal and vertical EDI OCT scans (interval between scans, ~30 µm) of the optic nerve head were obtained on both eyes of normal subjects. EDI OCT scans were assessed for ONHD by an experienced observer. Signs of ONHD were defined as hyper-reflective bands perpendicular to the OCT beam with or without a signal-poor core, as previously reported.1 Isolated very short hyper-reflective bands were categorized as suspected ONHD. Associations of ONHD with axial length, age, and gender were assessed.

Results
Among 130 normal subjects with both eyes scanned, ONHD were detected in at least one eye in 18 subjects (13.8%). Of these 18 subjects, 15 (11.5%) showed short horizontal hyper-reflective bands with no signal-poor core, and 3 (2.3%) showed a signal-poor core surrounded by hyper-reflective bands. Four (3.1%) of 130 subjects showed very short hyper-reflective bands only (ONHD suspects). There were no significant differences in age (44 vs 39 years, p=0.22) or gender proportion (56% vs 51% female; p=0.72) between ONHD and non-ONHD subjects.

Axial length was measured in both eyes of 70 out of 130 subjects. Of these 140 eyes, the mean axial length of eyes with ONHD (12 eyes; 23.5±0.8 mm) was significantly shorter than that of eyes without ONHD (128 eyes; 24.7±1.5 mm) (p=0.007). A decrease in axial length by 1 mm increased the odds of ONHD two-fold (OR=2.00 [CI, 1.15-3.49]; p=0.015).

Discussion
Using EDI OCT, results yielded a higher ONHD prevalence (13.8%) than previously reported (0.3-3.7%).2,3 A significant association between ONHD and shorter axial length is consistent with the hypothesis that ONHD occurs more often in small, crowded optic nerve heads.

Figure 1

A. Isolated hyper-reflective band perpendicular to the OCT beam
B. Isolated hyper-reflective bands perpendicular to the OCT beam
C. A signal-poor core surrounded by hyper-reflective bands
D. Isolated very short hyper-reflective band (ONHD suspect)
Conclusion
Subclinical ONHD may be more prevalent than previously
believed, especially in eyes with shorter axial length.

References
   optical coherence tomography of optic nerve head drusen.
3. Davis PL, Jay WM. Optic nerve head drusen. *Semin Ophthalmol*
   2003;18:222-42.
Paper Presentations 6-10: Surgery

6 24-Month Results from a Prospective, Randomized, Multicenter Study of a Schlemm’s Canal Microstent for IOP Reduction After Cataract Surgery in Open-Angle Glaucoma

THOMAS W. SAMUELSON
Minnesota Eye Consultants, P.A., Minnetonka, MN, United States

Purpose/Relevance
To evaluate the long-term ability of a novel implantable device to lower IOP in patients with open angle glaucoma (OAG) undergoing concurrent cataract surgery.

Methods
This is a prospective, randomized, controlled, multicenter clinical evaluation comparing phacoemulsification and intracanalicular scaffold (Hydrus™ Microstent, Irvine, CA) to phacoemulsification alone in patients with OAG and concurrent cataract with intraocular pressure (IOP) ≤24 mm Hg on ≤4 hypotensive medications, washed out diurnal IOP of 21-36 mm Hg, and BCVA of ≥20/40. In the Device group the microstent was placed into Schlemm’s canal via an ab interno approach under gonioscopic guidance following phacoemulsification and intraocular lens placement. Control group subjects received phacoemulsification only. Follow-up was conducted at 1 day, 7 days, and 1, 3, 6, 12, 18 and 24 months postoperatively. Study eyes were evaluated at each follow-up visit for IOP using Goldmann tonometry, medication use, visual acuity and ocular health. Medication washout was conducted at baseline, 12, and 24 months and a diurnal IOP was measured in order to assess IOP without the influence of topical hypotensive medications.

Results
100 eyes from 100 patients were recruited into the study. Prior to washout, IOP was 18.9±3.3 mm Hg in the Device group and 18.6±3.8 mm Hg in the Control group; subjects from both groups were on an average of 2.0±1.0 medications. Baseline washout diurnal IOP was 26.3±4.4 and 26.6±4.2 in the Device and Control groups. At 24 months, the proportion of patients with a 20% reduction in washed out diurnal IOP was significantly higher in the Device group compared to the Control group (80 vs. 46%, P=0.0008). Washed out mean diurnal IOP in the Device group was significantly lower compared to Control (16.9±3.3 vs. 19.2 ± 4.7 mm Hg, P = 0.0093). The proportion of patients using no hypotensive medications was higher at 24 months in the Device group (73% vs. 38%, P=0.0008). There were no differences in follow-up visual acuity between groups.

Discussion
The drop in IOP and medication use between baseline and follow-up show that the Schlemm’s canal microstent lowers IOP and medication use when used as an adjunct to cataract surgery. While the cataract surgery alone conferred an IOP and medication use reduction, the magnitude diminished in the second year of follow-up, while the device group was stable. Surgical complications were minor and transitory, and visual acuity was comparable in both groups over the 2 year follow-up period.

Conclusion
This study shows that a Schlemm’s canal microstent implanted in patients undergoing cataract surgery provided a significant reduction in IOP and medication use compared to cataract surgery alone after two years.

Reference
7 Using a Flow Test to Predict Early Post-operative Hypertensive Phase Following Ahmed Valve Implantation

EDWARD MOSS1,4, Jason Cheng2, Laura Beltran-Agullo3, Yvonne Buys4, Johanna Gonzalez-Rodriguez4, Graham Trope4

1 University of Toronto
2 Khoo Tech Puat Hospital, Singapore
3 Institut Catala de la Retina, Barcelona
4 Toronto Western Hospital

Purpose/Relevance
A flow test measures certain parameters before implantation of an Ahmed glaucoma valve (AGV).1,2 Our purpose was to validate the use of such pre-implantation testing to predict early post-operative intraocular pressure outcomes.

Methods
Patients were enrolled prospectively before AGV (model FP7) surgery. A simple pre-implantation flow test using readily-available materials was conducted prior to each operation. Opening pressure (OP) and closing pressure (CP) were defined as manometer-measured levels at which BSS began or stopped flowing through the device, respectively. The early hypertensive phase was defined as IOP >21mmHg within first 2 weeks postoperatively. Patients were followed for 12 weeks.

Results
20 eyes from 19 patients were enrolled. At 12 weeks, mean IOP decreased from 29.2±9.1 to 16.8±5.2 mmHg (p<0.01). The mean AGV OP was 17.5±5.4 mmHg; CP was 6.7±2.3 mmHg. EHP was detected in 5 of 7 (71%) eyes receiving valves with OP≥18 mmHg and in 2 of 12 (17%) eyes receiving valves with OP<18 mmHg. Using this 18mmHg OP cut-off yielded a sensitivity of 0.71 and specificity of 0.83 for predicting EHP.

Discussion
Our results suggest a link between the variability of pre-implantation AGV functional characteristics and the likelihood of EHP. EHP was more likely to occur in AGVs with an OP>18mmHg. This may be due to excess valve resistance causing elevated IOP.

Conclusion
Preoperative OP may predict early hypertensive phase. This measurement could guide quality control prior to surgical implantation.

References
8 Corneal Decompensation Following Glaucoma Drainage Device Implantation: An Experimental Model to Evaluate Nutritional Theory

RAMESH AYYALA1, Blake Williamson1
1 Tulane University Health Sciences Center

Purpose/Relevance
Corneal endothelial dysfunction is known to occur in eyes with glaucoma drainage device implantation (GDD), the etiology of which remains unknown. Nutritional deficiency has been proposed as a possible cause. The goal of this study was to investigate the aqueous humor changes following GDD implantation in a rabbit model.

Methods
Animals: 8 New Zealand white rabbits were used. Surgery: An Ahmed glaucoma valve was implanted into the left eye of all rabbits while the un-operated right eye served as control. pO2 measurement: Oxygen tension was measured at each of these time points using the OxyLite™ oxygen monitoring system with oxygen/temperature bare-fibre sensor manufactured by Oxford Optronix immediately before surgery and at 1 month and 2 months post-op. The probe obtained measurements every 5 seconds and was held in the anterior chamber for 2 minutes. 0.05cc of aqueous was collected from the experimental and control eye at each time point for metabolite analysis and stored at -70C. Glucose and Lactate Analyses: Glucose and lactate were analysed using respective assay kits (Glucose Assay Kit [ab65333, Abcam] & Lactate Assay Kit [MAK064 Sigma]).

Results
Oxygen: Oxygen tension was found to be lower in the eye with the GDD compared to the control eye, and this was statistically significant at 2 months post op (p=0.0014), Table 1. L1, 2, and 3 represent time points post op day 0, month 1 and month 2 respectively. Regression analysis demonstrated oxygen tension steadily decreased over time in the surgical eye, and was found to be an average of 9.1 mmHg lower in the eye with the GDD at 2 months post op (L3). Metabolites: There were no statistically significant differences in the concentrations of glucose or lactate.

Discussion
Hypoxia seen in the surgical eye may be secondary to increased aqueous humor turnover/alteration in the aqueous flow pattern via the GDD (video demonstration). Increased drainage of the oxygen rich anterior chamber aqueous humor by the GDD allows the oxygen depleted posterior chamber aqueous humor to have a greater effect of lowering the overall oxygen content in the AC. We posulate that this relative paucity of oxygen in the eye can contribute to corneal endothelial dysfunction.

Conclusion
Oxygen concentration in the anterior chamber aqueous humor was significantly lower in the surgical eye compared to the control eye after 2 months of follow up. Hypoxia coupled with the altered aqueous flow patterns established by the GDD may contribute to corneal endothelial dysfunction.

Reference

<table>
<thead>
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<td>2.8631</td>
<td>-14.7546</td>
<td>-3.5415</td>
<td>10.22</td>
</tr>
</tbody>
</table>

Table 1
9 Two-Center Three-Year Follow-up of a Micro-Lumen Aqueous Humor Shunt

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Purpose/Relevance
To assess the safety and efficacy of a trans-scleral micro-lumen aqueous drainage device (InnFocus MircoShunt\(^ TM\)) made of poly(styrene-block-isobutylene-block-styrene), used with adjunctive Mitomycin C.

Methods
Prospective 2-center study of primary surgery of 50 eyes in 50 patients who failed maximum tolerated medication. Subjects received a Microshunt alone (N=32) or in combination with cataract surgery (N=18), all with 0.4 mg/mL Mitomycin C, implanted ab externo through a 3 mm needle tract in the sclera. Main outcome measures include success rate (IOP \(\leq 21 \text{ mmHg}\) and \(\geq 20\%\) reduction in IOP from baseline), IOP, medication use and adverse events with three years follow-up.

Results
At 3 years (n=22), the qualified success rate (with or without glaucoma medication) was 95%; the complete success rate (with glaucoma medication) was 73%; the mean IOP was reduced from 23.5 ± 5.4 to 10.7 ± 3.5 mmHg (54%) and glaucoma medications were reduced from 2.7 ± 1.2 to 0.5 ± 0.9 (81%). All cases of postoperative transient hypotony (12%, 6/50) and transient choroidal effusion (6%, 3/50) resolved spontaneously. There were no sight-threatening long-term adverse events.

Discussion
The rationale for substituting the microshunt for the scleral flap in glaucoma filtering surgery is that at normal aqueous flow the dimensions of the tube and hydrophobic effects set the trans-scleral pressure gradient at about 6 mm Hg, a level expected to reduce the risk of shallow or flat anterior chambers, hypotony maculopathy and choroidal detachments, as was the case. The material used, SIBS, previously was shown in rabbits to incite only a 20u acellular capsule versus a 200u cellular capsule with silicone, and sheathing of the tube post-operatively was thus avoided.

Conclusion
The MicroShunt\(^ TM\) yielded a reduction in intraocular pressure and reduction in supplemental medication at least comparable to trabeculectomy\(^1\) or combined surgery\(^2\) with Mitomycin C in a similar racial distribution of patients and by substituting a small diameter tube for a scleral flap avoided hypotony-related complications.

References
Use of a 45-µm Ab Interno Subconjunctival Gel-Stent with Adjunctive Mitomycin C for the Treatment of Uncontrolled Open-Angle Glaucoma

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Purpose/Relevance
To study the intraocular pressure (IOP) lowering effect and complications of an ab-interno gelatin stent with adjunctive mitomycin C (MMC) in patients with uncontrolled open-angle glaucoma (OAG).

Methods
This was a prospective, non-randomized, single-center trial in patients with OAG whose IOP’s were uncontrolled by medications. A 45-µm x 6mm gel-stent (XEN45, Aquesys Inc., Aliso Veijo, CA) was implanted via a preloaded injector using an ab interno approach through a clear corneal incision and through the anterior chamber angle into the subconjunctival space to create an ab interno bleb. Adjunctive MMC was used in all cases and delivered via subconjunctival injection preoperatively. No adjunctive procedures were permitted in this study. Needling was permitted postoperatively if necessary. Main outcome measure was IOP reduction postoperatively. Additional outcome measures included postoperative glaucoma medication reduction, and postoperative complications.

Results
A total of 57 eyes of 57 patients were included in this study, with a mean age of 55.6 (range 18 to 86) years old. Seven eyes had previous glaucoma bleb surgery. All eyes had successful implantation of the gel-stent. The mean follow-up at the time of this report was 12.5 ± 5.8 months. The mean preoperative IOP was 26.7 (SD ± 5.1). The mean postoperative IOP was 14.3 ± 4.7 mmHg at 3 months (n=57), 13.8 ± 4.1 at 6 months (n=56), 12.0 ± 2.9 mmHg at 12 months (n=55), 12.5 ± 3.5 mmHg at 18 months (n=46), and 13.1 ± 3.7 mmHg at 24 months (n=33). At all time points postoperatively, the postoperative IOP was lower than preoperatively (p<0.0001). Mean postoperative glaucoma medications were reduced from a mean of 3.5 ± 1.5 preoperative to 0.5 ± 0.4 at 12 months and 0.8 ± 0.5 at 24 months (p<0.001). Six eyes (11%) required postoperative needling. Three eyes (5%) required re-operation for additional glaucoma surgery. No eyes lost 2 or more lines of visual acuity postoperatively. There were no cases of persistent hypotony.

Discussion
The XEN45 implant is a 45-µm gelatin stent designed to create an ab-interno bleb without the need to make conjunctival incisions or scleral flaps. With the use of MMC, the results of this study show significant IOP-lowering ability of this device approaching that of a MMC trabeculectomy. Bleb needling was needed in a subset of eyes. Although the numbers in this study were limited, no patients lost 2 or more lines of vision and the procedure was well tolerated with minimal serious complications.

Conclusion
The 45-µm ab interno subconjunctival gel-stent with adjunctive MMC provided significant IOP-lowering in medium-term follow-up with minimal serious complications.

Reference
**Paper Presentations 11-15: Imaging**

**11 New OCT System Shows Collector Channels Rapidly Open & Close with Pressure Changes: A Factor in the Persistent Distal Resistance After MIGS?**

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**Purpose/Relevance**
To describe rapid pressure-dependent opening and closing of collector channels using a new OCT platform.

**Methods**
Radial limbal segments of *ex vivo* non-human primate (NHP) nemestrina (2) and human (4) eyes are imaged by SD-OCT from the surface of the TM. Segments are mounted in a Petri dish under BSS. An optical microscope and micromanipulator permit cannula insertion and retention in Schlemm’s canal (SC). Paired reservoirs provide controlled pressures Δs (5,10,20,30 mm Hg) and a perfusion pump provides pulse transients. Assembly into 3D volumes uses a Matlab algorithm to binarize 2D images using a set threshold. Quantification of SC height and area uses manual delineation followed by segmentation with FIJI (ImageJ software). Anatomic appearance by SEM under comparable conditions (SC dilation by using viscoelastic) is assessed in radial sections cut to a thickness of ~100 µm from each quadrant of the limbus of 19 NHPs and 8 humans (6,739 total SEM images).

**Results**
Dilation of SC with BSS for OCT or with viscoelastic for SEM reveals SC relationships (Fig. 1). Collagen septa at collector channel ostia (CCO) generally attach at only one end resulting in a flap-like arrangement that permits mobility. After perpendicular scleral entry, the lumen of CCO abruptly turn circumferentially forming intrascleral collector channels (CC) parallel to SC; thin collagen septum between the SC and CC lumens result. Cylindrical attachment structures (CAS) arise from the TM then course across SC where they attach to flaps at CCO entrances and to thin CC septa. In each of 10 CCO, SC pressure Δs induced large SC, CCO and CC lumen dimension Δs in msec (Fig. 2) with visible lumen opening and closing in response to as little as 5 mm ΔP.

**Discussion**
SC dilation before SEM and OCT permits appreciation and correlation of complex 3D relationships of SC structural elements. The new OCT platform permits high resolution imaging of the lumen of SC, CCO and CC permitting quantification of pulse-dependent Δs in lumen dimensions. MIGS usually only achieve IOPs in the mid teens suggesting the presence of an unidentified distal resistance; pressure-responsive CCO & CC may explain that distal resistance.
Conclusion
This newly developed OCT platform permits identifying rapid pressure-dependent opening and closing of the lumen of CCO and CC; changing lumen dimensions can determine distal outflow system resistance suggesting the region can also play a role in the glaucoma process. MIGS development and placement may benefit from awareness of this CCO & CC behaviour.

References
12 Aqueous Angiography: Real-Time Imaging of Physiologic Comprehensive Aqueous Humor Outflow

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2 Doheny Eye Institute
3 UCLA and Doheny Eye Institute
4 University of California, San Diego

Purpose/Relevance
Minimally invasive glaucoma surgeries (MIGS) attempt to enhance native aqueous humor outflow (AHO) in the eye to lower intraocular pressure (IOP). While results of trabecular meshwork (TM) bypass are promising, inconsistent success is seen. One hypothesis for this variability rests upon segmental (non-360 degrees uniform) AHO past the trabecular meshwork. We propose aqueous angiography, a real-time, physiologic, and comprehensive AHO imaging technique.

Methods
Bovine, pig (Fig. 1), and human (Fig. 2) enucleated eyes were obtained (within 6, 30, and 48 hours of death respectively from abattoirs or San Diego Eye Bank) and orientated based upon their inferior oblique insertions. Eyes were pre-perfused at 30 mm Hg with BSS. Fluorescein (2.5% in BSS), as per AAO guidelines for capsular stain, was introduced intracamerally. With an angiographer, infrared and fluorescent (488 nm; aqueous angiography) images were acquired. Concurrent OCT was performed and fixable fluorescent dextrans were also introduced into the eye for histological analysis of angiographically positive areas.

Results
Aqueous angiography yielded high quality images given excitation with a 488 nm laser. Segmental patterns were observed (p<.0001; Kruskal-Wallis test). In angiographically positive but not negative areas, OCT demonstrated intrascleral lumens with observable dextrans trapped in the outflow pathways. High IOP (70 mm Hg) did not lead to blockage of AHO. Quantitative analyses showed that there was no difference in outflow among the four quadrants of the eye by looking for overall differences in signal intensity among the four quadrants (p = 0.39; Kruskal-Wallis test).

Discussion
Aqueous angiography provides a comprehensive view of AHO. It provides 360 degrees of simultaneous outflow information and incorporates contributions from both the TM (proximal) and post-TM (distal) outflow pathways. It is also physiologic as the images are obtained at normal IOP without irrigation-related high IOP or fluctuations. We propose aqueous angiography for human intra-operative use to individualize and guide MIGS toward angiographically functional areas for improved surgical results.

Conclusion
Aqueous angiography is a real-time, physiologic, and comprehensive AHO imaging technique.

Reference
13 Association between Progressive Retinal Nerve Fiber Layer Loss and Longitudinal Change in Quality of Life in Glaucoma

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Purpose/Relevance
Evaluation of structural optic nerve damage is a fundamental part of diagnosis and management of glaucoma. However, the relationship between structural measurements and disability associated with the disease is not well characterized. Quantification of this relationship may help validate structural measurements as markers directly relevant to quality of life. The purpose of this study was to evaluate the relationship between rates of retinal nerve fiber layer (RNFL) loss and longitudinal changes in quality of life in glaucoma.

Methods
Observational cohort study including 260 eyes of 130 glaucoma patients enrolled in the Diagnostic Innovations in Glaucoma Study (DIGS). Patients were followed for an average of 3.5 ± 0.7 years. All patients had repeatable visual field defects on standard automated perimetry (SAP) at baseline. NEI VFQ-25 questionnaires were performed annually, and spectral domain optical coherence tomography (SDOCT) and SAP were performed at 6-month intervals. A joint model was used to investigate the association between change in NEI VFQ-25 Rasch-calibrated scores and change in RNFL thickness, adjusting for confounding socio-economic and clinical variables.

Results
Progressive binocular RNFL thickness loss was associated with worsening of NEI VFQ-25 scores over time. In a multivariable model adjusting for baseline disease severity and rate of change in binocular SAP sensitivity, each 1 µm/year loss of RNFL thickness was associated with a decrease of 1.3 units (95% CI 1.02 to 1.56) per year in NEI VFQ-25 scores (P < 0.001). After adjusting for the contribution from SAP, 26% (95% CI: 12%–39%) of the variability of change in NEI VFQ-25 scores was associated uniquely with change in binocular RNFL thickness. The association remained significant (P<0.001) after adjusting for potential confounding factors.

Discussion
Progressive binocular RNFL thickness loss was associated with longitudinal loss in quality of life, even after adjustment for progressive visual field loss.

Conclusion
These findings suggest that rates of binocular RNFL change are valid markers for the degree of neural loss in glaucoma with significant relationship to glaucoma-associated disability.

References
The Proportion of Individual Eyes Demonstrating Spectral Domain Optical Coherence Tomography Change in Early Experimental Glaucoma and Its Eye-Specific Character

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2 Alcon Laboratories, Inc.

Purpose/Relevance
To characterize eye-specific, Spectral Domain Optical Coherence Tomography (SDOCT) optic nerve head (ONH) minimum rim width (MRW) and retinal nerve fiber layer (RNFL) change in early experimental glaucoma (EG).

Methods
Both eyes of 8 monkeys (1.4-21.9 yrs) underwent SDOCT ONH/RNFL imaging 3-5 times at baseline, then biweekly following laser-induced, unilateral IOP elevation until the onset of Confocal Scanning Laser Tomographic (CSLT) surface change in the EG eye. For each imaging session, ONH/RNFL landmarks were delineated in 40 SDOCT B-scans and ONH MRW and RNFL thickness 1500 microns from Bruch’s Membrane Opening (BMO) centroid (RNFLT1500) were calculated for twelve 30º sectors oriented relative to the Foveal-BMO (FoBMO) axis. Eye-specific event and trend-based change onset was then evaluated for MRW and RNFLT1500 within each 30º sector of each control and EG eye.

Results
EG eye IOP and axon loss (0-30%) have been previously reported. For the 8 EG eyes considered together (Figure 1), at CSLT-detected early EG onset, the pattern of SDOCT MRW and RNFLT1500 onset by event and trend-based analyses overlap. However, MRW change is more frequent and extensive than detected RNFL change and its pattern is not confined to the superior and inferior temporal quadrants. Eye-specific MRW change (Figure 2) occurred in a larger proportion of EG eyes, was greater in sectoral extent, and preceded RNFLT1500 change where it occurred. Control eye change in two adjacent 30º degree sectors occurred for RNFLT1500 only and in only 1 eye (C-M3). The eye-specific pattern (i.e sectoral extent) of event and trend-based MRW onset was qualitatively similar and not confined to the superior and inferior temporal sectors for most EG eyes.

Discussion
Eye-specific, SDOCT 30º sectoral ONH MRW change is detected earlier and more extensively than SDOCT RNFLT change at the onset of monkey EG. Neither MRW nor RNFL change are confined to or consistently earliest within the superior and inferior temporal sectors.

Conclusion
ONH MRW sectoral change is SDOCT-detected earlier than RNFLT change in most monkey EG eyes. This finding supports the ONH as a target for early glaucoma detection. The lack of preferential superior and inferior temporal involvement is noteworthy, warranting further study.
Figure 2. Eye-specific Time to Event (upper) and Time to Trend-based (lower) Onset for MRW and RNFLT1500 within the 8 early EG and Control Eyes by Fo8MO 30° sector. All data are plotted in right eye orientation (legends to the right). Animals are ordered M1-M8 based on the magnitude of EG eye MRW % change from baseline within the pre-sacrifice SD-OCT data sets (M1 (-3.1%) to M8 (-33.6%) - data not shown). Time to onset is plotted in post-laser days as yellow (no onset), darkest purple (earliest onset) and white (latest onset) (scale to the right). These data suggest that eye-specific SD-OCT detected MRW change is more frequent, greater in sectoral extent and earlier than RNFLT1500 in most EG eyes. Control eye change in two adjacent 30° degree sectors occurred for RNFLT1500 only and in only 1 eye (C-M3). The eye-specific pattern (i.e. sectoral extent) of event and trend-based MRW onset was qualitatively similar and not confined to the superior and inferior temporal sectors for most EG eyes. However, the sectoral location and timing of earliest onset were commonly different using event vs trend-based criteria for a given eye.

References
Association Between Dark-to-Light Changes in Anterior Chamber Angle Width and Iris Configuration in Dark, Light, and Dark-to-Light Conditions

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Purpose/Relevance
To evaluate the association between dark-to-light changes in anterior chamber angle width and iris configuration in dark, light, and dark-to-light conditions.

Methods
In this prospective study, anterior segment optical coherence tomography images, obtained under both light and dark conditions, were analyzed to determine angle opening distance measured at 500 µm from the scleral spur (AOD500), iris thickness measured at 750 µm from the scleral spur (IT750), iris thickness measured at 2000 µm from the scleral spur (IT2000), iris area, and pupil diameter. Comparisons of AOD500, IT750, IT2000, iris area, and pupil diameter were made between dark and light conditions. Linear regression models were used to evaluate the association between dark-to-light changes in anterior chamber angle width and iris configuration in dark, light, and dark-to-light conditions.

Results
Three hundred and thirteen eyes from 176 nonglaucomatous patients were analyzed. AOD500, IT750, IT2000, iris area, and pupil diameter showed significant dark-to-light changes. IT750, iris area, and pupil diameter in light conditions were significantly associated with dark-to-light changes in AOD500 (all P<0.05). IT2000 in light conditions was borderline significantly associated with dark-to-light changes in AOD500 (P=0.07). IT750, IT2000, iris area, and pupil diameter in dark conditions were not significantly associated with dark-to-light changes in AOD500 (all P>0.05). IT750, IT2000, iris area, and pupil diameter in dark-to-light conditions were not significantly associated with dark-to-light changes in AOD500 (all P>0.05).

Discussion
Evaluation of four iris parameters in dark, light, and dark-to-light conditions demonstrated that IT750, IT2000, iris area, and pupil diameter in light condition are significant predictors of dark-to-light changes in anterior chamber angle width.

Conclusion
In our previous study, we demonstrated that iris thickness may play a role in determining the anterior chamber angle width because the iris periphery forms one of the boundaries of the anterior chamber angle and a thicker peripheral iris may directly contribute to more angle crowding. In the current study, we showed that assessment of iris parameters under light conditions can provide insight into the dynamics of dark-light changes in anterior chamber angle width.

Reference
16 Disparities in Utilization of Glaucoma Testing Among Enrollees in Medicaid and Those with Commercial Health Insurance and How They Vary by Race

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Purpose/Relevance
Utilization patterns of glaucoma testing have been studied for Medicare beneficiaries, but little is known about utilization of glaucoma testing for those in Medicaid or those with commercial health insurance and how rates of testing vary by plan type and race.

Methods
We identified persons age ≥ 40 years enrolled in Medicaid or a large managed care network continuously for ≥ 3 years, newly-diagnosed with OAG between 2007-2009, and ≥ 1 confirmatory OAG diagnosis. We determined the proportion who underwent visual field (VF) testing, fundus photography (FP), other ocular imaging (OOI), and any or none of these tests within 15 months after initial OAG diagnosis. Logistic regression modelling was used to assess the impact of insurance type and race on the odds of undergoing each test.

Results
9444 persons with commercial insurance and 2123 Medicaid recipients met the inclusion criteria. The proportion of commercially-insured patients with newly-diagnosed OAG undergoing VF, FP, and OOI were 63%, 21%, and 53%, respectively, while the proportions were 35%, 19% and 30% for Medicaid recipients. Compared to those with commercial insurance, Medicaid recipients were almost 2.5 times more likely to not receive glaucoma testing in the first 15 months following initial diagnosis (OR=3.44,CI 3.12-3.79). After adjustment for confounders, a 60 y.o. white male with OAG enrolled in Medicaid had a 225% higher odds of receiving no glaucoma testing compared with a 60 y.o. white male with commercial insurance (OR=3.25,CI 2.59-4.08); a 60 y.o. black male with OAG enrolled in Medicaid had a 334% higher odds (OR=4.34,CI 3.36-5.60) of receiving no testing and a 60 y.o. Latino male with OAG in Medicaid had a 154% higher odds of no testing (OR=2.54,CI 2.54-3.66) than their counterparts possessing commercial insurance.

Discussion
Regardless of race/ethnicity, Medicaid recipients are receiving substantially less follow-up testing for OAG compared to others with commercial insurance. More work is needed to understand reasons for these disparities, their impact on outcomes, and ways to overcome them.

Conclusion
Patients with newly-diagnosed OAG enrolled in Medicaid are receiving considerably less glaucoma diagnostic testing compared to others with commercial insurance. Disparities are observed across all races but are most dramatic among blacks.

Reference
The Impact of Educational Workshops on Individuals at Risk for Glaucoma in the Philadelphia Glaucoma Detection and Treatment Project

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Purpose/Relevance
The Philadelphia Glaucoma Detection and Treatment Project is a community-based project that aims to improve detection, management, treatment, and follow-up eye care of individuals at high risk for glaucoma in community-based settings in Philadelphia. The purpose of this study was to investigate the impact of educational workshops on the level of knowledge, perceived risk of glaucoma, and rate of attendance in a subsequent glaucoma detection exam.

Methods
Participants completed an 8-question pre-test to assess knowledge about glaucoma, attended an educational workshop, and completed a post-test. A paired samples t-test was used to assess mean differences in composite pre- and post-test scores, correct responses, and perceived risk of glaucoma after the workshop. The rate of attendance of the eye exam following the educational workshops was assessed.

Results
Seven hundred and seven pre- and post-test surveys were completed. For all 8 questions, there was a significant increase in the level of knowledge about glaucoma (P<0.001). The composite scores increased from M=3.86 (SD=1.95) to M=4.97 (SD=1.82), P<0.001. There was a 30% increase in participants’ perceived risk of glaucoma (from 30% to 39%, P<0.001). In the 5 largest community sites, 44% (n=221/480) of the participants who attended an educational workshop scheduled a glaucoma exam appointment and 33% (n=160/480) completed their glaucoma detection exam.

Discussion
Our study is in agreement with others,¹,² showing an increase in individuals’ knowledge of glaucoma following an educational intervention. To the best of our knowledge, this is the first study to investigate the impact of educational workshops on recruitment of patients for a glaucoma detection exam in community-based settings.

Conclusion
Educational workshops increased knowledge and awareness about glaucoma and were helpful in recruiting patients for community-based glaucoma detection exams. We recommend including these workshops when conducting outreach programs.

References
18 Results from the First Teleglaucoma Pilot Study in Addis Ababa, Ethiopia

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Purpose/Relevance
To review diagnostic outcomes and clinical referral pathways of high risk patients assessed through an innovative community-based teleglaucoma (TG) program.

Methods
Prospective cohort study. Patients over age 40 were referred to the TG program from outpatient diabetic & hypertensive clinics at Ras Desta Hospital as well as via community awareness programs. Assessment consisted of a structured clinical history, VA, IOP with tonopen, CCT, and dilated anterior segment as well as stereo fundus photographs (disc & disc/macula). Information was uploaded via the Secure Diagnostic Imaging (SDI) website, and reviewed by a glaucoma specialist (AG, AM, GG), who provided remote diagnosis & management recommendations. Clinical referral pathways were noted. Part way through the program front line staff were empowered to refer patients the same day based on criteria for obvious and serious eye pathology.

Results
There were 1002 patients (53% female) assessed with a mean age of 51.0±11.7 years. The prevalence of glaucoma and glaucoma suspects were 7.9% (79 cases) and 13.8% (138 cases) respectively. Retinopathy was found in 9.1%, with hypertensive retinopathy 2.7% & diabetic retinopathy 2.5% of all cases. AMD was present in 1.5% and cataract in 16% of all cases. Hyperopia and myopia were present in 31.6% and 13.4%, respectively. 31% of cases were normal. Disposition: 26.7% of patients were referred to a general ophthalmologist, 0.7% to a glaucoma specialist (for surgery), 1.5% to a retina specialist and 19.3% to an optometrist.

Discussion
There is a high prevalence of glaucoma in patients with high risk characteristics assessed through this TG program. The majority of patients had ocular pathology that could be managed by local comprehensive ophthalmologists. Downstream effects of increasing referrals to care providers need to be further explored.

Conclusion
This model of healthcare delivery can improve access to glaucoma care for community members at high risk for glaucoma.

References
19 Association Between Hysterectomy & Oophorectomy and Glaucoma Prevalence in the United States

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Purpose/Relevance
It has been hypothesized that female sex hormones may be protective of the optic nerve, and that early loss of estrogen may lead to premature aging and increased susceptibility of the optic nerve to glaucomatous damage. Clinical studies of post-menopausal women suggest that hormone replacement therapy may be associated with lower intraocular pressure, protection against retinal nerve fiber layer defects, and overall reduction in the risk of glaucoma. A recent clinical study reported that bilateral oophorectomy before age 43 was associated with a 60% increased risk of glaucoma. The purpose of this study is to investigate the relationship between hysterectomy / oophorectomy and glaucoma prevalence in a United States population.

Methods
This cross-sectional study included 2067 women from the 2005-2008 National Health and Nutrition Examination Survey (NHANES) who were 40 years or older and answered the survey questions about history of glaucoma, hysterectomy, and oophorectomy. Multivariate logistic regression models were created to identify independent predictors for self-reported glaucoma, adjusting for demographics, female reproductive variables, and other medical and ophthalmic conditions.

Results
After adjustment for demographics, medical conditions, and reproductive variables, hysterectomy and/or bilateral oophorectomy was associated with increased prevalence of glaucoma (OR: 2.21, p=0.02). Subjects with both hysterectomy and bilateral oophorectomy had a higher prevalence of glaucoma compared to those without both hysterectomy and bilateral oophorectomy (OR: 1.62, p=0.07), though this was not statistically significant. When hysterectomy and bilateral oophorectomy were analyzed independently from each other, the odds ratio for hysterectomy was 2.12 (p=0.09) and the odds ratio for bilateral oophorectomy was 1.07 (p=0.9).

Discussion
In women aged 40 years or older in the United States, hysterectomy and/or oophorectomy is independently associated with a 2-fold higher prevalence of glaucoma, after adjusting for other reproductive factors. This finding supports the hypothesis that early loss of estrogen may be a risk factor for glaucoma. When hysterectomy and oophorectomy were examined as independent variables, hysterectomy was more strongly associated with increased glaucoma than oophorectomy, although neither was statistically significant.

Conclusion
It is possible that the association between hysterectomy/oophorectomy and glaucoma is not mediated through estrogen.

References
20 Primary Cilia Signaling Mediates Intraocular Pressure Sensation

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Purpose/Relevance

Primary cilia are sensory organelles on the surface of eukaryotic cells that mediate mechanotransduction in the kidney, brain, and bone. However, their potential role in the trabecular meshwork (TM) is unknown. We propose that primary cilia also mediate pressure mechanotransduction in TM cells.

Methods

Using human TM cells isolated from patients, we performed immunofluorescence, electron microscopy, and immunohistochemistry experiments to examine the TM. We examined subcellular distribution of OCRL, an inositol phosphatase, and TRPV4, an mechanosensory channel, in cilia function. Using murine models, we examined the role of cilia in IOP regulation.

Results

We show that TM cells, which are defective in glaucoma, have primary cilia that are critical for response to pressure changes. Primary cilia in TM cells shorten in response to fluid flow and elevated hydrostatic pressure, and promote increased transcription of TNF-α, TGF-β, and GLI1 genes. Furthermore, OCRL is found to be required for primary cilia to respond to pressure stimulation. The interaction of OCRL with transient receptor potential vanilloid 4 (TRPV4), a ciliary mechanosensory channel, suggests that OCRL may act through regulation of this channel. A novel disease-causing OCRL allele prevents TRPV4-mediated calcium signaling. In addition, TRPV4 agonist treatment reduced intraocular pressure in mice; TRPV4 knockout animals exhibited elevated intraocular pressure.

Discussion

Once thought as a vestigial organelle, the primary cilium has increasingly become recognized as a critical regulator of mechanotransduction. Our study shows that cilia in the TM cells of the eye are similarly required for the regulation of pressure, which when dysregulated is strongly implicated in the pathogenesis of glaucoma.

Conclusion

Mechanotransduction by primary cilia in TM cells is implicated in how the eye senses pressure changes and highlights OCRL and TRPV4 as attractive therapeutic targets for the treatment of glaucoma.

References


Paper Presentations 21-25: Hot Topics

21 Impact of the Introduction of Generic Latanoprost on Glaucoma Medication Adherence

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Purpose/Relevance
To determine whether enrollees with open-angle glaucoma who switched from brand name to generic prostaglandin analogues (PGAs) exhibited a change in medication adherence compared to those who remained on brand name products when generics became available.

Methods
All beneficiaries age >40 years with open-angle glaucoma continuously enrolled in a nationwide managed-care network from 2009-2012 who were taking PGAs prior to generic latanoprost availability were identified. We calculated the mean adherence rates for topical PGAs during the 18 months prior to generic latanoprost availability (September 2009-February 2011). We then determined the mean adherence rates during the subsequent 18 months after generic latanoprost first became available (July 2011-December 2012) for those enrollees who were exclusively maintained on brand name PGAs and compared these adherence rates to those who switched exclusively to generic latanoprost. Multivariable logistic regression identified factors associated with an improvement or worsening of adherence rates of ≥25%.

Results
8,427 enrollees met the study eligibility criteria. Compared to enrollees who switched to generic latanoprost once it became available, enrollees remaining on brand name PGAs were 28% less likely to experience an improvement of adherence (odds ratio (OR)=0.72, 95% CI 0.55-0.94) and 39% more likely to experience worsening of adherence (OR=1.39, 95% CI 1.04-1.86). Other factors associated with improved adherence during the post-generic period included lower monthly medication copay during the post-generic entry period (p<0.0001) and black race (OR=1.25, 95% CI 1.04-1.50). A total of 612 patients (7.3%) completely discontinued all interventions for glaucoma at the time generic latanoprost became available.

Discussion
With cost often being a significant barrier to adherence, switching patients to generic medications may help improve adherence. The ophthalmological community should be aware of the large number of patients who completely discontinued glaucoma medication use altogether during the transition period when generic latanoprost became available and work with insurers and pharmacists to prevent this from happening when other PGAs become available as generics.

Conclusion
This study highlights the impact of medication cost and access to generic PGAs on medication adherence. We identified a subset of patients who clearly exhibited an improvement in adherence when they were switched from a brand name PGA to generic latanoprost. When clinicians know or suspect that a patient is struggling with adherence, attempts should be made, whenever feasible, to switch such patients to generic glaucoma medications. This can be particularly helpful for patients with high copays and racial minorities.

Reference
22 Characteristics of Patients Who First Present with Severe Stage Glaucoma

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² New England Eye Center
³ Glaucoma Associates of Texas

Purpose/Relevance
It is challenging to care for patients presenting with severe stage glaucoma as they have extensive visual field loss upon initial presentation and are at high risk of blindness. The purpose of this study is to assess the sociodemographic and other characteristics of patients presenting with severe stage glaucoma and compare them with others who present with less severe disease.

Methods
Enrollees aged ≥40 years in a large US managed care network that were newly diagnosed with glaucoma and received an ICD-9-CM glaucoma severity staging code (mild, moderate, or severe) on the date of first glaucoma diagnosis were identified. Logistic regression modeling was used to identify factors associated with an initial presentation of severe stage glaucoma as compared to mild or moderate stage disease.

Results
There were 2535 patients with newly-diagnosed glaucoma who met the inclusion criteria. The proportion with mild, moderate, and severe stage disease was 55.0%, 31.7%, and 13.3%, respectively. Females had a 35% reduced odds of presenting with severe stage disease (odds ratio [OR], 0.65; CI, 0.50-0.84; P=0.001). Compared with non-Hispanic whites, Asian Americans had a 108% increased odds of presenting with severe stage glaucoma (OR, 2.08; CI, 1.13-3.82; P=0.02). There was no significant difference in the odds of presenting with severe stage glaucoma for Blacks or Latinos relative to whites. The higher one’s level of income, the lower the odds of presenting with severe stage glaucoma. Persons with incomes of ≥$125,000 per year had a 69% reduced odds of presenting with severe stage glaucoma compared to those earning <$30,000/yr. (OR, 0.31; CI, 0.17-0.56; P<0.0001). There was no significant association between education level, geographic region of residence, urban/rural residence, or comorbid diabetes and the risk of presenting with severe stage glaucoma.

Discussion
Patients benefiting most from glaucoma screening programs are those at greatest risk for going blind. This study identifies characteristics of persons who present with severe stage disease in at least one eye and who may benefit from glaucoma screenings.

Conclusion
Among this group of patients with health insurance, characteristics of persons who first present with severe stage glaucoma in at least 1 eye include males, Asian Americans, and persons of lower income.

Reference
23 Longitudinal and Cross-Sectional Analyses of Age and Intraocular Pressure Effects on Retinal Nerve Fiber Layer and Ganglion Cell Complex Thickness

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1 Oregon Health & Science University
2 Doheny Eye Institute
3 University of Southern California
4 University of Miami
5 University of Pittsburgh

Purpose/Relevance
To study the effect of age and intraocular pressure (IOP) on retinal nerve fiber layer (NFL) and ganglion cell complex (GCC) thickness in normal eyes.

Methods
We analyzed the data from subjects enrolled in the multi-center longitudinal Advanced Imaging for Glaucoma (AIG) Study (www.AIGStudy.net). The data included yearly visits from the normal subjects group in the AIGS study. Fourier-domain optical coherence tomography (OCT) was used to map the thickness of NFL and GCC three times on each visit. To adjust for the repeated measurements for the same subjects, mixed effect models were used to evaluate the longitudinal effect of age and IOP on the NFL and GCC thickness. The measurements at baseline were used to examine the cross-sectional effects among individual subjects.

Results
The analysis included 192 eyes of 92 normal participants with follow-up visits between 2009 and 2013. The longitudinal analyses showed the overall GCC thickness on average decreased 0.25 µm per year (p < 0.001, standard error = 0.049), while the overall NFL thickness decreased 0.10 µm per year (p = 0.18, standard error = 0.077). The cross-sectional analyses showed the GCC thickness was 0.17 µm thinner for each year older (p < 0.001, standard error = 0.050), while the RNFL was 0.21 µm thinner for each year older (p < 0.001, standard error = 0.065). We did not find significant IOP effect on either GCC or RNFL from either longitudinal or cross-sectional analysis.

Discussion
These results on normal age-related thinning of NFL and GCC can be used to establish criteria to detect abnormally rapid thinning that might indicate glaucomatous progression.

Conclusion
NFL and GCC thin with age; they do not seem to be affected by IOP.

References
24 Are We Inadvertently Accelerating Glaucoma? Benzalkonium Chloride Penetration Studies and Its Effect on Outflow Facility and Trabecular Meshwork Cellularity

DOUGLAS J. RHEE¹, Dong Jin Oh¹, Min Kang¹, Xu He¹, Marc Toeteberg-Harms²
¹ Case Western Reserve University
² University Hospital Zurich

Purpose/Relevance

Introduction: Cadaveric studies have long implicated accelerated trabecular meshwork endothelial (TM) cell loss in glaucoma pathogenesis. It was unknown if the TM cell loss was a primary mechanism or secondary to chronic therapy. The preservative benzalkonium chloride (BAC) is toxic to TM cells in vitro, but BAC has yet to be recovered from aqueous humor. We hypothesized that topical BAC reaches TM tissue in vivo and that chronic BAC exposure would lead to alterations of outflow facility and TM cell loss ex vivo.

Methods

Topical BAC (0.2%), or fluorescently labeled BAC (for penetration studies), and preservative free artificial tears (control) were applied to rabbits. Rabbits were sacrificed at 5, 15, 30, 45, 60 minutes. MALDI-TOF mass spectrometry determined the peak and trough tissue/aqueous concentrations of BAC. Immunohistochemistry was used for ocular penetration studies. Perfused cadaveric human anterior chambers determined the effect of peak and trough concentrations of BAC on outflow facility and TM cellularity.

Results

BAC was found in TM, ciliary body, lens, iris, and corneal endothelium, but not aqueous. Peak and trough concentrations were 6.96 µL and 1.02 µL/30 mL at 30 minutes and 5 minutes, respectively, in TM tissue. At 12 minutes, labeled BAC showed the highest fluorescent intensity areas between TM and sclera (49,554). At 20 minutes, the collector channels had the higher fluorescent intensity (43,216). IOP in BAC perfused anterior segments, 1.02 mL/30 mL (n=3), trended higher and was statistically significant (p<0.05) at three time points (fig 1). TM cellularity experiments are on-going, but preliminary evidence (n=2) demonstrates decreased cellularity in BAC anterior segments (p=0.41).

Discussion

BAC reaches rabbit TM at pharmacologic doses. Chronic exposure of trough levels of BAC had a small impact on IOP. Preliminary data indicate a decrease in TM cellularity.

Conclusion

These data indicate that BAC may contribute to long-term TM dysfunction.

References


Figure 1. The average of 3 Human ex vivo anterior chamber perfusion systems perfused with BAK of 1.02 µL of ex vivo media of 30 mL. There were statistically significant at 81, 83, and 84 hrs.
25 Intraretinal Changes Revealed by Two-Photon Microscopy in an Optineurin Normal Pressure Glaucoma Mouse Model

GARRICK CHAK1, P.J. Nicholls1, Marc Caron1, Henry Tseng1
1 Duke University

Purpose/Relevance
Because the eye is grossly normal in primary open angle glaucoma (POAG), the mechanism of how retinal ganglion cells (RGC) degenerate in POAG remains elusive. We recently generated and characterized a novel mouse model expressing the E50K optineurin mutation (BAC-hOPTNE50K mouse) found in patients with familial normal-pressure POAG. We hypothesized that E50K optineurin may induce retinal changes associated with RGC loss. Using two-photon microscopy, we found novel intraretinal structural changes from aged BAC-hOPTNE50K mice that may yield fresh insight into POAG pathophysiology.

Methods
The BAC-hOPTNE50K mouse model has been previously reported by our laboratory. Two-photon microscopy was used to image flat mount retinas from young (2 months old) and aged (18 months old) wildtype and BAC-hOPTNE50K mice (n=5 animals per age group and genotype). Images were acquired using a Zeiss LSM 510 microscope with a motorized stage, assembled into a mosaic with at least 120 z-stack optical sections, and analyzed with ImageJ software.

Results
In aged BAC-hOPTNE50K retinas, we discovered an intricate network of reticular intraretinal structures that appear to be cellular processes localized to the outer plexiform layer (OPL). These structures were restricted to the OPL and not observed in other retinal layers. Additionally, they are associated with small, round deposits within capillaries penetrating into the OPL from the inner surface of the retina. These reticular structures and intravascular deposits were minimally observed in retinas from age-matched wildtype mice, and not observed in both young BAC-hOPTNE50K and wildtype mice.

Discussion
Because age-related RGC degeneration occurs despite normal intraocular pressure in our mouse model, this data suggest that intrinsic retinal changes may influence RGC function and survival in POAG. Our discovery also raises the possibility that subclinical intraretinal changes might be found in POAG patients for use as novel diagnostic biomarkers or therapeutic targets in early POAG.

Conclusion
To our knowledge, this is the first report to describe novel intraretinal changes and intravascular deposits in retinas from an aged, genetic POAG animal model. Further studies may elucidate the role of these intraretinal structures in RGC degeneration for POAG.

Reference
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**FRIDAY, FEBRUARY 27**
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**Optic Nerve**

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# SATURDAY, FEBRUARY 28

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Optic Nerve

Protection Against Retinal Ganglion Cell Death by Sigma Receptor Ligand (+)-Pentazocine

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Purpose/Relevance
Sigma Receptor 1 (σR1) is a member of a family of endoplasmic reticulum-associated proteins that are expressed throughout the mammalian nervous system and visceral organs. The endogenous function of σR1 is not known. However, ligands for this receptor have shown robust neuroprotective effects in brain and retina. The goal of this work is to determine whether the sigma receptor ligand, (+)-Pentazocine (PTZ), can alter survival of retinal ganglion cells (RGCs) exposed to the inflammatory stimulus, TNF-α, or to the excitotoxic stimulus, NMDA (N-Methyl-D-Aspartate).

Methods
Purified primary cultures of RGCs derived from mice were subjected to TNF-α (10ng/ml) in the presence/absence of (+)-PTZ (3µM) for 48 hours. TUNEL analysis was performed. Western blots were also performed to detect MAPK and caspase-3 expression. In addition, neurotoxicity was induced by intravitreal injection of NMDA into wild-type and (+)-PTZ-treated mice. RGC survival was assayed by measuring Brn3a immunoreactivity in flat-mounted retinas.

Results
Our data showed that TNF-α induced apoptosis of cultured RGCs. The σR1 ligand, (+)-PTZ, significantly decreased apoptotic cell death. Western blot analyses showed that cleaved caspase-3 was increased in RGCs treated with TNF-α, and pre-treatment with (+)-PTZ inhibited the cleaved caspase-3 increase. In addition, TNF-α activated p-38, and (+)-PTZ pre-treatment inhibited p-38 activation within primary RGC cultures. NMDA intravitreal injection induced 40% loss of RGCs from within the ganglion cell layer (GCL) of mouse retinas. Pre-treatment of animals with (+)-PTZ prior to NMDA treatment resulted in a statistically significant increase in RGC survival.

Discussion
In vitro activation of sigma receptor 1 with (+)-PTZ protects RGCs from TNF-α-induced cell death, and decreases p38 MAPK activation. In vivo (+)-PTZ treatment protects RGCs from NMDA-induced excitotoxicity.

Conclusion
Sigma receptor 1 activation is a therapeutic target for retinal neurodegenerative diseases including glaucoma.

References
2 Frequency Doubling Technology Perimetry and Changes in Quality of Life of Glaucoma Patients: A Longitudinal Study

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Purpose/Relevance
To evaluate the relationship between rates of change on frequency doubling technology (FDT) perimetry and longitudinal changes in quality of life (QoL) of glaucoma patients.

Methods
Prospective observational cohort study with one hundred fifty-two subjects (127 glaucoma and 25 healthy) followed for an average of 3.2 ± 1.1 years. All subjects were evaluated with National Eye Institute Visual Function Questionnaire (NEI VFQ-25), FDT and standard automated perimetry (SAP). Subjects had a median of 3 NEI VFQ-25, 8 FDT and 8 SAP tests during follow up. Mean sensitivities (MS) of the integrated binocular visual fields were estimated for FDT and SAP and used to calculate rates of change. A joint longitudinal multivariable mixed model was used to investigate the association between change in binocular MS and change in NEI VFQ-25 Rasch-calibrated scores. Potentially confounding socio-economic and clinical variables were also analyzed.

Results
There was a statistically significant correlation between change in binocular MS for FDT and change in NEI VFQ-25 scores during follow-up in the glaucoma group. In multivariable analysis, each 1dB/year change in binocular FDT MS corresponded to a change of 0.8 units per year in the NEI VFQ-25 scores (P = 0.001). For binocular SAP MS, each 1 dB/year change was associated with 2.2 units per year change in NEI VFQ-25 scores (P <0.001). The multivariable model containing baseline and rate of change information from SAP had stronger ability to predict change in NEI VFQ-25 scores compared to the equivalent model for FDT (R² of 50% and 30%, respectively). There were no significant associations between changes in FDT and SAP and changes in NEI VFQ-25 scores for the healthy group.

Discussion
Rates of progressive visual field loss on FDT perimetry were significantly associated with decline in patient-reported QoL in glaucoma. However, SAP performed significantly better than FDT in predicting NEI VFQ-25 scores in our population.

Conclusion
SAP may still be the preferable perimetric technique for predicting risk of disability from the disease.

Reference
3 Dynamic Changes of the Anterior Chamber Angle Following Intravitreal Injection

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2 Duke University Eye Center

Purpose/Relevance
A post-hoc analysis of the MARINA and ANCHOR trials reported four cases of eyes receiving laser peripheral iridotomies during the course of anti-VEGF treatment presumably for the development of angle-closure.1 We hypothesize that the sudden increase of vitreous volume produced by intravitreal injections may affect anterior segment anatomy and increase risk of acute angle closure. In this study, we use AS-OCT to evaluate the dynamic changes of the anterior chamber angle following routine intravitreal injections to evaluate changes in the iris-lens configuration induced by intravitreal injections.

Methods
Patients receiving intravitreal anti-VEGF injections for the treatment of NVAMD were recruited after informed consent. Pre- and immediate post-injection IOP and AS-OCT images were acquired. Measurements of the anterior segment including angle opening distance (AOD) and trabeculo-iris space area (TISA) at 500 µl and 750 µl from the scleral spur (AOD500, AOD 750, TISA-500 and TISA750, respectively) and scleral spur angle were compared.

Results
Twenty-one eyes from 21 patients were studied. The mean increase in IOP following injection was 23.4±11.4 mmHg. The mean (±SD) differences between pre- and post-injection images of the temporal angle were: 0.05±0.11 mm (AOD500) (p=0.04), 0.07±0.13 mm (AOD750) (p=0.01), 0±0.04 mm² (TISA500) (p=0.7), 0.02±0.07 mm² (TISA750) (p=0.17) and 2.55±4.5 degrees (p=0.02). There was no significant difference between pre- and post-injection image measurements of the nasal angle. However, there was significant narrowing of the nasal AOD and TISA in phakic vs pseudophakic eyes (nasal AOD500, TISA 500 and TISA750 measurements; p=0.05, 0.03 and 0.02, respectively).

Discussion
While all eyes demonstrated significant narrowing of the temporal AOD and angle measurements, the nasal angle in phakic eyes demonstrated significantly greater narrowing following intravitreal injections compared to pseudophakic eyes. Further studies are needed to determine whether these changes may lead to clinically relevant angle closure, especially in phakic eyes.

Conclusion
Physicians performing intravitreal injections should be aware of these dynamic anterior segment changes following intravitreal injections and the possibility that there may be increased risk of angle closure with prolonged elevation of IOP in predisposed eyes.

Reference
Clinical Significance of Computationally Derived Visual Field Defect Archetypes in Patients with Glaucoma

SOPHIE CAI1, Tobias Elze2, Peter Bex3, Louis Pasquale4, Lucy Shen4
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2 Schepens Eye Research Institute
3 Northeastern University
4 Massachusetts Eye and Ear Infirmary

Purpose/Relevance
Glaucoma monitoring would benefit from a clinically-validated quantitative classification system for visual field (VF) defects. Recently, Elze et al. applied the unsupervised statistical learning method of archetypal analysis to a large VF database from a tertiary glaucoma practice, deriving 17 VF archetype (AT) patterns into which any VF can be decomposed (Figure). VF archetypal analysis may aid clinicians in reproducibly describing VFs, tracking VF changes over time, and separating complex VF defects into different etiologies. Here, we evaluated clinical correlates of ATs.

Methods
From 30,995 reliable Humphrey 24-2 VFs, we used Elze et al.’s algorithm to select VFs most representative (coefficient>0.7) of each AT. Medical records of corresponding patients were reviewed; systemic and ocular characteristics were compared between each AT and all others combined using the chi-square or two-tailed t-test.

Results
243 patients were included. AT1 (no focal defect) (P<0.001), AT2 (superior defect) (P=0.043), AT4 (temporal wedge defect) (P<0.001), and AT11 (peripheral rim defect) (P=0.002) were associated with cup-to-disc ratio (CDR)≤0.5. AT6 (central island) (P=0.018), AT10 (inferonasal defect) (P=0.046), AT14 (superior paracentral defect) (P=0.048), and AT16 (inferior paracentral defect) (P=0.028) were associated with CDR>0.5. Other significant associations included AT2 (superior defect): ptosis (P<0.001); AT4 (temporal wedge defect): systemic hypertension (P=0.024); AT11 (peripheral rim defect): trial lens hyperopia>6D (P=0.028); AT6 (central island): age 40-50 years (P<0.001), African ancestry (P<0.001), current smoking (P<0.001), and higher intraocular pressure (P<0.001); AT10 (inferonasal defect): diabetes mellitus (P=0.008); AT12 (temporal hemianopia): stroke (P=0.002) and diabetes mellitus (P=0.025); AT13 (diffuse inferior defect): African ancestry (P=0.002) and chronic angle closure glaucoma (P<0.001); and AT16 (inferior paracentral defect): female sex (P=0.015).

Discussion
Associations with systemic and ocular characteristics were identified across ATs. Several associations are consistent with previous literature, supporting VF ATs’ clinical validity. We also found features of debilitating glaucomatous VF loss (AT6 and AT13) that may help identify at-risk populations for targeted screening.

Conclusion
Computationally derived VF ATs may reflect underlying differences in patient clinical characteristics, with implications for glaucoma diagnosis and monitoring.

Reference
1. Elze T et al. 2013 IOVS; 54 ARVO E-Abstract 3962.
5 Patient Characteristics Associated with Artifacts in Spectral Domain Optical Coherence Tomography Imaging of the Retinal Nerve Fiber Layer in Glaucoma

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² Harvard Medical School

Purpose/Relevance
To determine patient factors and eye conditions associated with artifacts in spectral domain optical coherence tomography (SD-OCT) retinal nerve fiber layer (RNFL) scans.

Methods
A retrospective review was performed of patients who underwent a complete eye exam (by TCC) with SD-OCT RNFL scanning during the period of September 2009 to July 2013 at an academic institution. The latest SD-OCT scan was used for the study if a patient had multiple eye scans. The frequencies of twelve artifact types were described in this retrospective review of 2313 eye scans from 1188 patients. Generalized estimating equations model was utilized to analyze associations between increased artifact incidence and 10 patient characteristics, which included age, sex, race, visual acuity, refractive error, astigmatism, cataract status, glaucoma staging, visual field reliability, and glaucoma diagnosis.

Results
The study population primarily consisted of normal and glaucoma suspect eyes as well as eyes with open angle glaucoma, ocular hypertension, and pediatric glaucoma. A total of 1070 or 46.3% of the 2313 eye scans had at least one artifact. De-centration error was the most common artifact (27.8%), followed by posterior vitreous detachment artifacts (14.4%). Visual acuity of less than 20/40 (p<0.0001), presence of moderate to severe cataracts (p<0.0001), advanced stage of glaucoma (p<0.0001), and a diagnosis of open angle glaucoma (p=0.0003) were associated with increased incidence of artifacts.

Discussion
The most common reasons for SD-OCT RNFL measurement artifacts were de-centration, posterior vitreous detachments, poor central vision, moderate to severe cataracts, and advanced glaucoma.

Conclusion
To the best of our knowledge, this is the largest and most comprehensive study on artifacts in spectral domain OCT imaging for glaucoma. Clinicians should first assess scans for artifacts before making therapeutic decisions based on RNFL thickness measurements. Future technology improvements should focus on eliminating artifacts from de-centration and posterior vitreous detachments.

References
6 Actin-Rich Astrocytic Extensions Re-orient Prior to Axonal Injury Within the Optic Nerve Head in a Rat Model of Glaucoma

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Purpose/Relevance
Optic nerve head (ONH) astrocytes react to tissue stress in the setting of elevated intraocular pressure (IOP).\(^1\) ONH astrocytic reactivity may be the link between elevated IOP and axonal degeneration. The purpose of this study is to identify and quantify morphologic changes in the orientation of ONH astrocytic extensions in a rat model of glaucoma using the filamentous actin marker, phalloidin.

Methods
Episcleral hypertonic saline injection was used to produce chronic IOP elevation in rats and tissues were collected after 5 weeks. Fellow eyes served as controls. For comparison, eyes with optic nerve transection were also collected at 2 weeks. Axonal degeneration in retrobulbar optic nerves was graded on a scale of 1-5. ONH sections (n ≥ 4 eyes per group) were co-labeled with phalloidin and antibodies to astrocytic glial fibrillary acidic protein (GFAP) and aquaporin 4 (Aqp4), or axonal tubulin βIII. Confocal microscopy and FIJI image analysis software were used to quantify the orientation of actin bundles.

Results
Control ONHs showed stereotypically arranged actin bundles within astrocyte extensions (Fig. 1A, B), in contrast to myelinated optic nerve (Fig. 1C). Actin-rich astrocytic extensions co-labeled with GFAP and Aqp4; however, actin labeling defined more astrocytic extensions than either GFAP or Aqp4 (Fig. 1D, E). ONH actin bundle orientation was nearly perpendicular to axons (82.9° ± 6.3° relative to axonal axis), unlike the retrobulbar optic nerve (45.4° ± 28.7°, p<0.05). With IOP elevation, ONH actin bundle orientation became disorganized, even in eyes with no perceivable axonal injury (i.e. 38.8° ± 15.1° in grade 1, p<0.05 in comparison to control ONHs; Fig. 2A, B). With severe injury, ONH actin bundle orientation became more parallel to the axonal axis (24.1° ± 28.4°, p<0.05 in comparison to control ONHs; Fig. 2C, D). ONH actin bundle orientation in transected optic nerves was unchanged (Fig. 2A-C).

Discussion
Actin filament labeling with phalloidin delineated fine astrocytic extensions not reflected by either GFAP or Aqp4. Actin-rich astrocytic extensions in the ONH are uniquely ordered in contrast to the remainder of the optic nerve.

Conclusion
Re-orientation of ONH astrocyte extensions occurs early in response to elevated IOP, is unique to the ONH, and specific for IOP elevation.
Reference

Association Between Intraocular Pressure Changes and Structural Changes in Schlemm’s Canal, Choroid, and Iridocorneal Angles During the Water Drinking Test in Normal Subjects

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4 Harkness Eye Institute, Columbia University Medical Center
5 Icahn School of Medicine at Mount Sinai

Purpose/Relevance
To investigate the structural changes in Schlemm’s canal (SC), choroid, and iridocorneal angles in conjunction with intraocular pressure (IOP) changes during the water drinking test (WDT).

Methods
Normal subjects were instructed to drink 1 liter of water within 5 minutes. 41 serial horizontal anterior segment enhanced depth imaging (EDI) optical coherence tomography (OCT) scans (interval between scans, ~70 µm) of the temporal corneoscleral limbus, a horizontal macular EDI OCT scan at the foveal center, and horizontal and vertical swept-source OCT scans of the anterior segment were obtained on one eye of each participant 5 times: before, and at 15 minutes, 1, 3, and 24 hours after water drinking. SC cross-sectional area (CSA) was measured after manual SC delineation in anterior segment EDI OCT scans in the overlapping area among the 5 sets of serial scans. Subfoveal choroidal thickness was measured in each macular EDI OCT scan. Trabecular iris angle (TIA500) was measured in horizontal and vertical swept-source OCT scans.

Results
We included 12 eyes of 12 normal subjects (mean age = 37±15 years). Mean IOP increased significantly from baseline (14.9±1.6 mmHg) at 15 minutes after water drinking (18.2±2.2 mmHg; p<0.001) and subsequently decreased at 1 (15.9±2.2 mmHg), 3 (14.3±1.9 mmHg), and 24 hours (14.4±1.9 mmHg) (p=0.19, 0.18, and 0.37, respectively). Mean SC CSA decreased significantly from baseline (4998±725 µm²) at 15 minutes (4566±679 µm²; p<0.001) and subsequently increased at 1 (4784±538 µm²) and 3 (4784±538 µm²) and 24 hours (4821±604 µm²) (p=0.14, 0.19, and 0.14, respectively). Mean subfoveal choroidal thickness increased significantly from baseline (296±104 µm) at 15 minutes (310±108 µm; p<0.001) and 1 hour (304±105 µm; p=0.004) and subsequently decreased at 3 (300±108 µm) and 24 hours (296±101 µm) (p=0.10 and 0.74, respectively). Mean TIA500 decreased significantly from
baseline (44.1±13.3°) at 15 minutes (41.0±13.5°; p=0.006) and 1 hour (42.2±12.5°; p=0.037) and subsequently increased at 3 (44.4±12.7°) and 24 hours (45.1±13.6°) (p=0.76 and 0.32, respectively). In all parameters studied, peak changes from baseline occurred at 15 minutes after water drinking.

Discussion
SC compression in acute IOP elevation is consistent with a previous report. Our results further demonstrated that SC returns to baseline size as IOP decreases to its baseline level. Transient choroidal expansion and iridocorneal angle narrowing at the time of IOP elevation suggest a pathophysiologic mechanism for SC compression.

Conclusion
Dynamic changes occur in posterior (choroid) and anterior (SC and iridocorneal angles) segments during WDT provocation. Transient SC compression in acute IOP elevation during the WDT may be attributed to choroidal expansion and subsequent forward movement of the iris-lens diaphragm. Studies on these dynamic changes may be useful to elucidate the pathophysiology of IOP elevation in various conditions.

References
Kalman Filter User-Friendly Decision Support Tool for Visualizing and Monitoring Open-Angle Glaucoma Progression

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2 Indiana University

Purpose/Relevance
To create a user friendly interface and decision support tool that can visualize tonometric and perimetric measurements of patients with open angle glaucoma (OAG), including intraocular pressure (IOP), mean deviation (MD), and pattern standard deviation (PSD) values, and to display dynamically-adjusted, personalized forecasts of these indicators and optimized recommendations for when the patient should be tested next.

Methods
The tool was developed in Excel 2013 using Visual Basic for Applications (VBA) and MATLAB Compiler Runtime. The tool displays data from past visits and changes in key ophthalmic test results to support clinical decision making. It runs Kalman filtering algorithms1 to model the IOP, MD, and PSD dynamics of patients with OAG. Knowledge about those dynamics is updated as additional readings from the patient are obtained.

Results
A sample screenshot from the tool is presented in Figure 1. This tool calculates adjusted predictions and personalized testing frequencies in real-time, providing clinicians with valuable insight to enable personalized glaucoma management.

Discussion
This software generates real-time personalized predictions of the status of each patient’s OAG and when future testing should be performed so as to identify progression in a timely manner.

Conclusion
It is possible to integrate a Kalman Filter approach into a software tool that can run on personal computers to improve visualization of tonometric and perimetric measurements and how they change over time. Such information can enhance patient care.

Reference

Figure 1. Sample tool output. Visual field plots (left) and prior, current, and forecasted test results (right).
Purpose/Relevance

Although drivers with glaucoma are at increased risk of motor vehicle collisions (MVCs), the association with conventional tests of visual function is weak. Better methods to assess MVC risk are needed. The aim of this study was to examine the possible role of two tests of divided attention – Useful Field of View (UFOV) and divided attention during simulated driving.1

Methods

A cross-sectional study of 153 drivers with glaucoma or suspect glaucoma from the Diagnostic Innovations in Glaucoma Study (DIGS) at Hamilton Glaucoma Center, University of California, San Diego. All subjects had visual acuity, contrast sensitivity, SAP, UFOV, driving simulation, and cognitive assessment. The driving simulator evaluated reaction times to peripheral stimuli presented at 3 contrasts during a driving task. Three-year history of MVCs and average mileage per week were recorded.

Results

18 of 153 subjects (11.8%) reported a MVC. The MVC group was older, had worse binocular SAP sensitivity, worse contrast sensitivity, worse ability to divide attention (UFOV and driving simulation) and drove fewer miles. Low contrast driving simulation was the best discriminator of MVC (AUC 0.80 versus 0.69 for binocular SAP and 0.59 for UFOV). In multivariate models, longer reaction times to driving simulator tasks provided additional value compared to SAP and UFOV, with a 1 standard deviation increase in reaction time (approximately 0.75s) associated with 2-fold increased odds of MVC.

Discussion

Measures of ability to divide attention during simulated driving were more strongly associated with MVC than conventional functional measures or UFOV.

Conclusion

Given the significance of MVCs, the present study underscores the need to develop better methods of risk assessment in drivers with glaucoma, and provides evidence that predictive models that account for the ability to divided attention may provide a means to improve estimates of risk.

Reference

10 Agreement Between Gonioscopic Examination and Swept Source Spectral Domain Anterior Segment Optical Coherence Tomography (ASOCT) Imaging

MOHAMMED RIGI1, Alice Chuang2, Laura Baker1, Lauren Blieden1,2, Hector Bello Lopez-Portillo1,2, David Lee1,2, Vandana Minnal1,2, Robert Feldman1,2
1 Robert Cizik Eye Clinic
2 The University of Texas Medical School

Purpose/Relevance
To evaluate agreement between gonioscopy and spectral domain (CASIA SS-1000, Tomey, Nagoya, Japan) ASOCT, as well as the interobserver and intervisit agreement in narrow and open angle eyes.

Methods
One eye of 86 participants was enrolled in the study. The study eye was examined by gonioscopy using the Spaeth grading system in the dark by 2 glaucoma specialists on the same day and imaged by the CASIA SS-1000 in the dark using 2D mode. A second set of measurements was taken within 6 months of the first. The images were exported, and superior angles were evaluated by 2 readers and described using Spaeth terms. The Spaeth grades from both instruments were converted to angle status “Closed” if the grade was A or B and “Open” if the grade was C, D, or E. Both the gonioscopy and ASOCT examiners were masked to the readings performed by their counterparts. Kappa statistics were used to calculate inter-instrument agreement as well as the interobserver and intervisit agreement for each instrument. The agreement criteria were <0.4 poor; 0.4 – 0.75 fair to good; and > 0.75 excellent.1

Results
Of 86 participants, the mean age was 50.9 ± 18.4 years with 69% female and 40% White, 23% Hispanic, and 22% Black. Forty-seven percent were normal eyes, 23% open angle glaucoma eyes (or suspects), and 30% narrow angle glaucoma eyes (or suspects). Seventeen percent of participants did not return for the second visit. Please see Tables 1 and 2 for additional results. ASOCT “over-called” closed angles compared to gonioscopy in 13-33% of eyes.

Discussion
Both gonioscopy examiners and ASOCT readers had good to excellent agreement when classifying angle status as open or closed. The agreement between gonioscopy and ASOCT was poor to fair on visit 1 and fair to good for visit 2, which may be due to the indentation of the cornea during gonioscopy.

Conclusion
ASOCT and gonioscopy have good to excellent interobserver and intervisit agreement. ASOCT may result in more angles being classified as closed.

Reference

Table 1. Gonioscopy and ASOCT Agreement (Kappa [SE])

<table>
<thead>
<tr>
<th>Angle Status (Open vs Closed)</th>
<th>Visit 1</th>
<th>Visit 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examiner 1 vs Reader 1</td>
<td>0.47 (0.10)</td>
<td>0.61 (0.10)</td>
</tr>
<tr>
<td>Examiner 1 vs Reader 2</td>
<td>0.44 (0.09)</td>
<td>0.66 (0.09)</td>
</tr>
<tr>
<td>Examiner 2 vs Reader 1</td>
<td>0.30 (0.11)</td>
<td>0.50 (0.11)</td>
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<tr>
<td>Examiner 2 vs Reader 2</td>
<td>0.34 (0.10)</td>
<td>0.54 (0.10)</td>
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</table>

Table 2. Interobserver and Intervisit Agreement (Kappa [SE])

<table>
<thead>
<tr>
<th>Visit</th>
<th>Gonioscopy</th>
<th>ASOCT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visit 1</td>
<td></td>
</tr>
<tr>
<td>Intervisit</td>
<td>0.74 (0.09)</td>
<td>0.82 (0.07)</td>
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<tr>
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<td>0.64 (0.08)</td>
<td>0.51 (0.10)</td>
</tr>
<tr>
<td>Intervisit</td>
<td>0.71 (0.09)</td>
<td>0.52 (0.10)</td>
</tr>
<tr>
<td>Intervisit</td>
<td>0.75 (0.10)</td>
<td>0.59 (0.08)</td>
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<tr>
<td>Intervisit</td>
<td>0.73 (0.10)</td>
<td>0.58 (0.08)</td>
</tr>
</tbody>
</table>
11 Shorter Scleral Spur in Eyes with Primary Open-Angle Glaucoma

HAIYAN GONG1, David Swain1, Joseph Ho2, Julia Lai1
1 Boston University
2 Tufts-New England Eye Center

Purpose/Relevance
To determine whether the scleral spur is shorter in primary open-angle glaucoma (POAG) eyes compared to age-matched normal eyes and whether the collapse of Schlemm’s canal (SC) is more prevalent in eyes with a shorter scleral spur.

Methods
The anterior segments of normal (n = 21) and POAG eyes (n = 21) were fixed and processed for light microscopy. The scleral spur length, ratio of posterior trabecular meshwork (TM) insertion into the scleral spur to the posterior TM height, and the percentage of SC collapse were measured. Analysis using an existing mathematical model was conducted to estimate the distances that the scleral spur would theoretically move in vivo and to determine if these distances would be sufficient to keep SC open in POAG compared to normal eyes.

Results
The mean scleral spur length was significantly shorter in POAG eyes compared to normal eyes (p < 0.0001). A higher percentage of SC collapse was found in POAG than in normal eyes (p < 0.0001). Estimated posterior movement of scleral spur in POAG eyes was less than sufficient to prevent the collapse of SC. A significant negative correlation was found between the posterior scleral spur movement and percent collapse of SC (p < 0.0001).

Discussion
A shorter scleral spur found in POAG eyes is associated with an insufficient posterior scleral spur movement and a high incidence of SC collapse, which we believe is due to insufficient support of SC and TM by the short scleral spur. If these values could be measured in-vivo, they could provide additional means for management of POAG.

Conclusion
A shorter scleral spur found in POAG eyes was associated with a higher percent of SC collapse. Our data suggest that a shorter scleral spur may be a risk factor in the development of POAG by being insufficient to hold SC open.

References
12 Retinal Glutamate Uptake in Stressed Müller Cells

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1 University of Copenhagen
2 New York Eye and Ear Infirmary of Mount Sinai and Icahn School of Medicine at Mount Sinai

Purpose/Relevance
The viability of retinal ganglion cells is essential to maintain the neuronal function of the retina. Müller cells (MC) are assumed to be vital in neuroprotection of the retinal ganglion cells (RGC). In this study we evaluate the ability of MC, stressed by energy restriction, mitochondrial inhibition or low-grade inflammation, to remove glutamate from the extracellular space and to protect RGC.

Methods
The human Müller glial cell line, MIO-M1 (Limb et al.) and primary mouse Müller cells, were used in combination with primary mouse RGC. Changes in glutamate (glu) uptake and release were evaluated in stressed MC. The viability and mitochondrial function were evaluated, and the expression of glutamate receptors as well as apoptotic and inflammatory genes were evaluated. By means of western blot analysis and immunohistochemistry gene regulations were confirmed at the protein level. Finally, MC ability to protect RGC was evaluated in a co-culture model in which MC were exposed to the different stress factors.

Results
The glutamate transporters EAAT1-3 were identified in MIO-M1 cells. Levels of EAAT1 protein were identified in MIO-M1 cells and was shown to be up-regulated in energy restricted MC. Energy restriction caused a graduate loss of glycogen stores but did not cause MC death. Glu uptake was increased in energy restricted MC whereas glu uptake decreased in MC exposed to endothelin-1 or H2O2. Inhibition of mitochondrial activity did not affect viability or glu uptake in MC with sufficient energy availability, whereas inhibition of mitochondrial activity in energy compromised MC reduced MC viability, and reduced their ability to remove glu from the extracellular space. The presence of MC in inserts over RGC increased RGC viability. When MC were stressed their ability to protect RGC decreased.

Discussion
In a model system the presence of MC increase RGC survival. The MC homeostasis and the regulation of glu-transporters and low-grade inflammatory molecules are affected in MC when stressed by either energy restriction or exposure to oxidative stress/low-grade inflammation. When MC are exposed to either restricted energy availability or low-grade inflammation, their homeostasis change and their ability to protect RGC is affected.

Conclusion
Overall, the present study reveals an important role of MC in RGC survival.

Reference
13 Pilocarpine Expands Schlemm’s Canal in Open-Angle Glaucoma Patients

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¹ New York Eye and Ear of Mount Sinai
² Harkness Eye Institute, Columbia University
³ Manhattan Eye and Ear Infirmary

Purpose/Relevance
Pilocarpine, a non-selective muscarinic receptor agonist, increases trabecular outflow and has been used in the treatment of glaucoma for over 140 years.¹ An improved understanding of its effect on the structure of Schlemm’s canal (SC) in vivo in glaucoma patients may help better explain its mechanism of action.

Methods
Open-angle glaucoma patients with no other ocular or systemic diseases known to affect iridocorneal angle or trabecular aqueous outflow structures were prospectively recruited. Eighty-one serial horizontal enhanced depth imaging (EDI) optical coherence tomography (OCT) B-scans (interval between B-scans, ~35 µm) of the nasal corneoscleral limbal area were obtained before and 40 minutes after topical administration of pilocarpine 2% in one eye of each patient. All patients developed miosis after pilocarpine administration. The EDI OCT B-scans in the overlapping area between the two sets of serial scans (before and after pilocarpine administration) were selected for analysis using conjunctival vessels and iris anatomy as landmarks. The SC cross-sectional area was measured in each selected EDI OCT B-scan. After three-dimensional reconstruction, SC volume was determined.

Results
Ten eyes (10 subjects; mean age, 69±12 years) were included. Mean intraocular pressure was 18.6±6.5 mmHg before pilocarpine administration and 17.7±6.5 mmHg after (p<0.01). SC could be imaged successfully before and after pilocarpine administration and was continuous in the scanned area in all eyes. Following pilocarpine administration, mean SC cross-sectional area increased by 40%, from 2107±313 µm² to 2938±904 µm² (p<0.001). Mean SC volume increased from 7294201 ±1076359 µm³ to 10139750 ±3124602 µm³ (p=0.01).

Discussion
We demonstrated significant increase in SC cross-sectional area and volume after pilocarpine administration. Whether this results from a direct effect on SC or is secondary to an effect on the ciliary musculature and/or trabecular meshwork remains to be determined.

Conclusion
Pilocarpine expands SC in open-angle glaucoma patients. EDI OCT of SC may prove useful in the evaluation the mechanisms of action of pharmacologic agents for glaucoma.

Reference
14 Differences in Iris Parameters Among Caucasians, Chinese, and Japanese

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1 UCSF School of Medicine
2 UCSF
3 UCLA
4 Juntendo University School of Medicine

Purpose/Relevance
To assess the differences in iris structural measurements among American Caucasians, Chinese, and Japanese aged 40 years and over, in order to determine associated factors of increased risk for angle closure in Chinese and Japanese patients.

Methods
Prospective multi-center cross-sectional study with three gender- and age-matched cohorts: American Caucasians, Chinese, and Japanese. Anterior segment optical coherence tomography (ASOCT) was used to image the anterior segment. Customized software was then used to calculate the related parameters from ASOCT images.

Results
The main outcome measures of this study were iris thickness at 750μm from the scleral spur (IT750), iris curvature (ICurv), iris area (IArea), and pupil diameter (PD). Data from 121 Caucasian, 124 Chinese, and 62 Japanese subjects were eligible for analysis after exclusions. ANOVA, ANCOVA, and multiple linear regression analysis showed that both Chinese and Japanese had thicker irises (P = 0.023, P = 0.040, respectively) and larger iris areas (P=0.002, P<0.001, respectively) than Caucasians. In addition, Japanese patients had more concave irises and larger pupil diameters compared to Caucasians (P<0.001 for ICurv and PD) and Chinese (P<0.001 for ICurv, P=0.005 for PD).

Discussion
After controlling for potential confounding variables using ANCOVA, we found that there are indeed significant differences in IT750, ICurv, IArea, and pupil diameter between the three ethnicities. Multiple linear regression showed that both Chinese and Japanese had thicker irises and larger iris areas than their Caucasian counterparts. These data corroborate previous studies implicating these factors as causing “crowding” at the angle, impeding the outflow of aqueous fluid to create relatively high angle closure rates in Asian populations.

Conclusion
In dark conditions, Japanese patients are similar to Chinese in that they have thicker irises and larger iris areas compared to age- and gender-matched Caucasians. In addition, Japanese patients have more anteriorly bowed irises and larger pupil diameters compared to both Chinese and Caucasians.

References
15 Effect of Latanoprostene Bunod Compared with Timolol Maleate on Ocular Perfusion Pressure in Subjects with Open-Angle Glaucoma or Ocular Hypertension (CONSTELLATION)

JOHN LIU1, Jason Vittitow2, Baldo Sforzolini2, Robert Weinreb1
1 University of California, San Diego
2 Bausch+Lomb

Purpose/Relevance
Latanoprostene bunod (LBN) is an NO-donating prostaglandin F2α receptor agonist under development for the reduction of elevated intraocular pressure (IOP) in patients with open angle glaucoma (OAG) or ocular hypertension (OHT). The CONSTELLATION study previously showed that LBN ophthalmic solution 0.024% administered QD reduced IOP in patients with OAG or OHT over a 24 hour period whereas timolol maleate ophthalmic solution 0.5%, administered BID, reduced daytime IOP only. Here we explore ocular perfusion pressure (OPP), the relationship between systemic blood pressure and IOP, in that study.

Methods
This was a randomized, single-center, open-label, active-comparator, crossover study. Subjects instilled either 1 drop of LBN QD (8 PM) or 1 drop of timolol BID (8 PM, 8 AM) for 4 weeks and were crossed over to the alternate treatment for another 4 weeks. IOP and arterial blood pressure (BP) were measured every 2 hours for 24 hours at the baseline, week 4 and week 8 study visits. Sitting OPP was defined as 95/140 x mean blood pressure - IOP, while supine OPP was defined as 115/130 x mean blood pressure - IOP.

Results
LBN 0.024% demonstrated consistent, higher than baseline, OPP for the entire 24-hour period (n=21). The mean (±SE) change from baseline (CFB) diurnal sitting, diurnal supine and nocturnal supine OPP (mmHg) was 3.8 (±1.0), 4.0 (±0.9), and 2.2 (±1.2), respectively, during LBN treatment (P<0.01 for diurnal sitting and supine) and 2.0 (±1.0), 2.2 (±0.9), and -1.3 (±1.2), respectively, during timolol treatment. The difference between treatments in the CFB was significant for diurnal sitting and nocturnal supine OPP (P≤0.02).

Discussion
Low OPP has been implicated as a risk factor in the progression of OAG. In our study, LBN lowered IOP without any negative effects on MAP leading to a greater OPP compared to baseline during the day and compared to timolol during the night.

Conclusion
The ability of LBN to improve OPP together with sustained IOP lowering over a 24 h period may be of benefit in the management of patients with OHT and OAG and warrants further study.

Reference
Differences in SENSIMED Triggerfish® Parameters Between Treated Glaucomatous Eyes Experiencing Previous Fast and Slow Rates of Visual Field Progression

C. GUSTAVO DE MORAES1, Sonja Simon-Zoula2, Jessica Jasien3, Robert Ritch4, Jeffrey Liebmann1
1 Columbia University Medical Center
2 Sensimed AG
3 New York Eye and Ear Infirmary of Mount Sinai

Purpose/Relevance
SENSIMED Triggerfish® (TF) is a device based on a contact-lens sensor that measures ocular dimensional changes in corneoscleral biomechanics that occur in part due to changes in intraocular pressure (IOP). We tested the hypothesis that TF parameters differ between treated glaucoma eyes experiencing previous fast and slow visual field (VF) progression.

Methods
In this prospective interventional study, primary open-angle glaucoma (POAG) patients with at least 8 reliable 24-2 SITA-Standard VF tests were included. Eyes were classified as having fast progression if (i) pointwise progression (defined as two or more adjacent VF test locations in the same hemifield) revealed a threshold sensitivity rate of change more negative than -1.0 dB/year with p<0.01 or (ii) a global rate of VF change based on mean deviation score (MD) more negative than -1.0 dB/year. Slowly or minimally progressing eyes were those with a VF MD rate of change more positive than -0.5 dB/year with no significant pointwise progression. 40 eyes (40 patients) were enrolled although 9 eyes were excluded due to poor or insufficient TF signals. 24-hour TF parameters were compared between the two groups.

Results
15 fast and 16 slow progressors safely underwent 24-hour TF session and provided satisfactory outputs. Paradoxically, eyes with previous slow progression revealed TF parameters consistent with higher peaks and fluctuation at night, despite similar profiles during the day (Figure). However, fast progressors had lower Goldman IOP at the time of TF placement, were on a greater number of anti-glaucoma medications (particularly prostaglandins), and had greater number of laser trabeculoplasty procedures (overall P<0.05). Logistic modeling of the relationship between TF parameters and disease progression rate yielded a model with 94.1% specificity and 41.2% sensitivity, with TF variability from mean during the sleep period as the only significant variable. Linear regression identified 24-hour median peak ratio, TF variability from mean during sleep period and 24-hour mean trough ratio as significant variables.

Discussion
Patients with previous fast progression were treated more aggressively, which resulted in the decrease of nocturnal peaks and variability, despite similar daytime profiles. TF parameters are useful to depict the effects of glaucoma treatment on 24-hour volumetric changes of eyes experiencing previous fast or slow progression.

Conclusion
TF parameters may be useful to define treatment efficacy of IOP-lowering interventions.

Reference
Optic Nerve Morphology as a Marker for Disease Severity in Cerebral Palsy of Perinatal Origin

DEEPTA GHATE1,2, Sachin Kedar1,2, Abdulbaset Kamour3
1 University of Nebraska Medical Center
2 Truhlsen Eye Institute
3 University of Kentucky College of Public Health

Purpose/Relevance
To correlate optic nerve head (ONH) pallor and cupping to period of gestation (POG) at birth and severity of neurological damage in children with perinatal onset static encephalopathy (POSE).

Methods
54 consecutive patients with POSE were enrolled. Exclusion criteria included genetic, metabolic or congenital structural brain abnormalities not related to perinatal complications; intraocular disease (ROP/glaucoma/cataract) and hydrocephalus. ONH morphology (pallor and cup to disc ratio-CDR) was assessed independently by 2 fellowship-trained ophthalmologists by dilated examination using direct and indirect ophthalmoscopy. ONH were labeled as pale or large cup (cup/disc ratio \( \geq 0.5 \)) only if the 2 ophthalmologists agreed. Inter-rater reliability was >0.8 for all parameters. A pediatric neurologist determined eligibility, age of onset of POSE, neurological deficit and reviewed available neuroimaging.

Results
Mean age was 11.88±6.53 years; period of gestation at birth: 33.26±4.78 weeks. 33/54 (61%) showed ONH pallor or cupping. Of the patients with ONH pallor (n=17), 88% were quadriplegic and 82% non-ambulatory. Mean cup/disc ratio was 0.45±0.22; 50% patients had large cup. Multivariate logistic regression models showed that disc pallor was significantly associated with non-ambulatory status (OR: 12.5; \( p=0.03 \)) and quadriplegia (OR: 21.7; \( p=0.0025 \)) and large cup was associated with age at examination (OR 1.15; \( p=0.025 \)). Cup/disc ratio and age showed positive correlation (\( r=0.42; p=0.002 \)). ONH parameters were not statistically associated with POG at birth.

Discussion
It has been previously hypothesized that a large cup in premature children is associated with period of gestation (POG) > 28 weeks.1 It is difficult to prognosticate the eventual neurologic outcome and ambulatory status from POSE till age 2-5 years. Earlier referral for rehabilitation can result in improved functional outcomes in children with POSE. Recognition of the association of POSE and large cups will prevent unnecessary examinations under anesthesia for glaucoma.

Conclusion
ONH changes are common in POSE and are not associated with POG. Optic disc pallor, a bedside clinical finding is a prognostic indicator for severe neurological insult in high-risk children with perinatal complications that should prompt early referral for rehabilitation. Optic disc cupping is correlated with the age at examination which may indicate that the cupping worsens with age.

Reference
18 A Randomized Trial of Fixed-Dose Combination Brinzolamide 1% / Brimonidine 0.2% as Adjunctive Therapy to Prostaglandin Analogs

ROBERT FECHTNER1, Donald Budenz2, Harvey Dubiner3, Albert Khouri1, Douglas Hubatsch4, Jonathan Myers5

1 Institute of Ophthalmology and Visual Science, New Jersey Medical School, Rutgers, Newark, NJ
2 University of North Carolina School of Medicine, Chapel Hill, NC
3 Clayton Eye Center, Morrow, GA
4 Alcon Laboratories, Inc., Fort Worth, TX
5 Wills Eye Hospital, Philadelphia, PA

Purpose/Relevance
Brinzolamide 1%/brimonidine 0.2% fixed combination (BBFC) is an effective IOP-lowering therapy that produces IOP reductions of 5.4 to 8.8 mmHg from untreated baseline levels.1 The purpose of this study was to evaluate the safety and efficacy of adding BBFC to patients with open-angle glaucoma or ocular hypertension who were inadequately controlled with prostaglandin analog (PGA) monotherapy.

Methods
This was a multicenter, randomized, double-masked, parallel-group study conducted at 30 sites in the United States from October 2013 to May 2014 (NCT01937312). Patients washed out prior glaucoma medications and received once-daily latanoprost 0.005%, bimatoprost 0.01%, or travoprost 0.004% open-label for 30 days. Eligible patients were randomized to receive BBFC or vehicle 3 times daily plus their once-daily PGA for the 6-week study phase. The primary efficacy endpoint was the between-group difference in mean diurnal IOP (8 am, 10 am, 3 pm, and 5 pm average) at week 6; mean and percent between-group difference in diurnal IOP change from baseline at week 6 were secondary endpoints. Adverse events (AEs) were monitored throughout the study.

Results
188 patients were randomized and received study medication; the intent-to-treat population comprised 182 (BBFC+PGA, n=88; vehicle+PGA, n=94). Mean ± SD age was 65.1±9.5 years, and most patients were female (63.7%), white (63.7%), and diagnosed with open-angle glaucoma (78.6%). Mean diurnal IOP at baseline was similar between groups (BBFC+PGA, 22.7±2.1 mmHg; vehicle+PGA, 22.4±2.8 mmHg). Least squares (LS) mean ± SE diurnal IOP at week 6 was 17.1±0.4 mmHg with BBFC+PGA and 20.5±0.4 mmHg with vehicle+PGA. The between-group difference was −3.4±0.5 mmHg (P<0.0001). Mean diurnal IOP reduction from baseline was −5.7±0.30 with BBFC+PGA mmHg vs −1.9±0.3 mmHg with vehicle+PGA (difference, −3.7±0.4 mmHg; P<0.0001); this translated to −24.7±1.3% vs −8.2±1.2% (difference, −16.5±1.8%; P<0.0001). The most common treatment-related AE was blurred vision (BBFC+PGA, 9.7%; vehicle+PGA, 6.3%). AE-related discontinuations were reported for 10.8% and 1.1% of patients, receiving BBFC+PGA or vehicle+PGA, respectively.

Discussion
BBFC+PGA produced significantly lower IOP and significantly greater IOP reductions from baseline at week 6 compared with vehicle+PGA, demonstrating an additive effect. AEs were consistent with the known safety profile of BBFC and PGAs.2,3

Conclusion
The IOP-lowering efficacy of BBFC adjunctive to PGA therapy was superior to PGA monotherapy and was not associated with new safety concerns. BBFC+PGA offers an effective treatment option for patients inadequately controlled with PGA monotherapy.

References
19 Relationship Between 24-hour Systemic Blood Pressure and SENSIMED Triggerfish Recording in Glaucoma Patients

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1 Columbia University
2 New York Eye and Ear Infirmary
3 Sensimed

Purpose/Relevance
SENSIMED Triggerfish® (TF) is a device based on contact-lens sensor that measures dimensional changes in corneoscleral biomechanics that occur in part due to changes in intraocular pressure (IOP), allowing real-time, semi-continuous 24-hour monitoring. We investigated the relationship between TF IOP-related parameters and systemic blood pressure (BP) variations in treated glaucoma patients with previous fast vs. slow rates of visual field (VF) progression.

Methods
Patients were classified as either fast or slow progressors based on VF testing prior to TF placement. Eyes were classified as having fast progression if (i) pointwise progression (defined as two or more adjacent VF test locations in the same hemifield) revealed a threshold sensitivity rate of change more negative than -1.0 dB/year with p<0.01 or (ii) a global rate of VF change based on mean deviation score (MD) more negative than -1.0 dB/year. Slowly or minimally progressing eyes were those with a VF MD rate of change more positive than -0.5 dB/year with no significant pointwise progression. 40 eyes (40 patients) were enrolled although 9 eyes were excluded due to poor or insufficient TF signals. We tested the association between BP parameters and the following TF IOP-related parameters: 24-hour median:peak ratio; 24-hour minimum:peak ratio; 24-hour variability from mean; sleep variability from mean; 24-hour mean:trough ratio; 24-hour wake to sleep slope; 24-hour number of peaks; sleep number of peaks.

Results
15 fast and 16 slow progression eyes were studied. Table A summarizes the main findings. Overall, fast progressors had significantly lower systolic BP at all periods compared to slow progressors, whereas mean arterial BP and diastolic BP reached borderline significance in the period patients were awake. There was no significant correlation between BP parameters and any of the TF IOP-related parameters.

<table>
<thead>
<tr>
<th>Parameter/ Period/ Progression group</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
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<th>Max</th>
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<td>Diastolic Blood Pressure (mmHg)</td>
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<td>24-hour</td>
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<td>83.0</td>
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TABLE A
Discussion
Our findings support recent studies suggesting an association between systemic BP and glaucomatous VF progression. However, there appears to be no significant relationship between these hemodynamic changes and TF IOP-related parameters. TF parameters may not be affected by circadian hemodynamic variations in treated glaucoma patients.

Conclusion
In conclusion, parameters as measured by the SENSIMED Triggerfish did not appear to have a significant relationship to systemic blood pressure. Additional research is warranted to more fully explicate these findings.

References
Characterization of Ocular Phenotypes of Microfibril Deficient Mice

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1 Vanderbilt Eye Institute, Vanderbilt University

Purpose/Relevance
To characterize ocular phenotypes of mice with defective microfibrils.

Methods
Two independent lines of mice with microfibril deficiencies due to mutations in the fibrillin-1 gene were investigated and compared to normal controls. Measurements were made at 3, 6 and 9 months of age. Central cornea thickness (CCT), anterior chamber depth (ACD) and axial length (AL) were measured by spectral domain optical coherence tomography (SD-OCT) using the Bioptigen Envisu imaging system for mice. Retinal nerve fiber layer thickness (RNFL) was determined by analysis of retinal SD-OCT images using Diver 2.0 and MatLab software.

Results
Similar results were found for both lines of microfibril deficient mice. CCT of microfibril deficient mice was approximately 17% thinner than CCT of controls (P<10^-9). Microfibril mice had 3% greater ACD as compared to controls (p<0.05). For both microfibril deficient and wild type mice, AL of females was approximately 1.3% shorter as compared to males. From 3 to 6 months of age, AL increased approximately 3.6%. Axial length was not different between microfibril deficient and wild type controls. Thinning of the RNFL was observed in the superior quadrants of microfibril deficient mice at 3 and 6 months. Thinning of the RNFL progressed to include the inferior quadrants at 9 months.

Discussion
Microfibril deficient mice have thinner CCT and deeper ACD but normal AL, as compared to controls. Similar findings in both lines of microfibril deficient mice suggest that these ocular phenotypes are caused by microfibril deficiency. Progressive thinning of the RNFL found in microfibril deficient mice is consistent with a glaucoma phenotype caused by microfibril deficiency.

Conclusion
Microfibril deficient mice could be used as a glaucoma model for further investigation of glaucoma pathogenesis and treatment.

Reference
Iris Parameters in Open Angle Eyes Measured with Swept Source Fourier Domain Anterior Segment Optical Coherence Tomography (ASOCT)

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1 The University of Texas Medical School at Houston
2 Robert Cizik Eye Clinic

Purpose/Relevance
Accurate and reproducible measurements of iris anatomy are limited by conventional imaging modalities, and standard reference ranges for iris parameters in a normal population have yet to be established. Newer generation ASOCT instruments, including the CASIA SS-1000 (Tomey Corporation, Nagoya, Japan), utilize swept source Fourier domain technology to produce rapid and high resolution measurements of the entire iris. The purpose of this study is to evaluate the distribution of iris parameters in the dark for open angle eyes using images taken with the Casia SS-1000 and establish a reference range for this population.

Methods
Ninety-eight participants with gonioscopically open angles previously imaged with ASOCT were included1 and stratified into 5 age groups (18-35, 36-45, 46-55, 56-65, and 66-79 years). An experienced reader used the Anterior Chamber Analysis and Interpretation software to mark the scleral spur landmark.2 Iris surface area, iris radius, and pupil radius were then determined. Iris volume was calculated from iris surface area and iris radius using Pappus’s centroid theorem formula. Iris parameters were summarized for all eyes in each age group with descriptive statistics, and means between age groups were compared using one-way analysis of variance (ANOVA).

Results
The study included 55 White (56%), 23 Black (23%), 10 Hispanic (10%), and 10 Asian (10%) participants. Fifty-nine eyes (50%) were women. The mean (±SD) age was 50 (±15) years (range 21-79 years). The mean (±SD) for iris parameters in all eyes and in eyes of each age group are shown in Table 1. SD=standard deviation

Discussion
Both pupillary radius (P<0.001) and iris radius (P=0.007) decreased with age. Iris volume was not affected by age (P=0.625).

Conclusion
These results are the first to establish reference values for iris parameters in the dark in an open angle population and will be integrated into future studies examining iris changes in the pathogenesis of primary angle closure.

References

Table 1. Iris parameters (Mean [SD]) in open angle eyes in the dark

<table>
<thead>
<tr>
<th>Iris Parameter</th>
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<tbody>
<tr>
<td></td>
<td>All (N=98)</td>
<td>≤ 35</td>
<td>36 - 45</td>
<td>46 - 55</td>
<td>56 - 65</td>
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<tr>
<td>Pupillary</td>
<td>2.25 (±0.45)</td>
<td>2.56</td>
<td>2.35</td>
<td>2.25</td>
<td>2.13</td>
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<tr>
<td>Radius, mm</td>
<td>4.09 (±0.28)</td>
<td>4.23</td>
<td>4.14</td>
<td>4.15</td>
<td>4.01</td>
</tr>
<tr>
<td>Iris Volume, μL</td>
<td>38.6 (±5.1)</td>
<td>37.2</td>
<td>39.3</td>
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<td>38.0</td>
</tr>
</tbody>
</table>
22 A Novel Testing Sequence for RAPDx Pupillography

ALICE WILLIAMS¹, Xuanchu Duan¹, Priyanka Gogte¹, Michael Waisbourd¹, Lisa Hark¹, George Spaeth¹
¹ Wills Eye Hospital

Purpose/Relevance
The presence of a relative afferent pupillary defect (RAPD), traditionally detected with the swinging flashlight method, is a sign of optic nerve pathology but is necessarily subjective. An objective tool that could identify and quantify the degree of an RAPD could be useful in identifying and staging patients with glaucoma.¹ The purpose of this study is to compare the standard testing sequence on the Konan RAPDx pupillograph to a customized sequence. This new sequence evokes a pupil response curve which more closely resembles that produced by the swinging flashlight method and allows for the measurement of a novel pupillary response parameter, the duration of maximum constriction (MC).

Methods
Nineteen patients with glaucoma underwent Humphrey visual field testing and RAPDx testing using a standard sequence and a custom sequence. Exclusion criteria included active inflammation of the eye, recent intraocular procedure, and any non-glaucomatous condition that may cause an RAPD, anisocoria or corectopia. RAPDx testing results included the response amplitude asymmetry (RAA), response latency asymmetry (RLA), and MC. These parameters were correlated with the visual field mean deviation (MD).

Results
Higher RAA for both the standard (r=−0.51, p=0.03) and custom sequences (r=−0.52, p=0.02) was significantly correlated with worse average MD between the fellow eyes. Higher RAA for the custom sequence was significantly correlated with greater asymmetry of MD between the fellow eyes (r=0.48, p=0.04). This association was not significant for the standard sequence (r=0.43, p=0.07). Correlations between MD values and the other pupillary response parameters, RLA and MC, failed to reach significance.

Discussion
RAA, a quantitative measure of asymmetric pupillary response between the two eyes, correlates with disease severity as measured by visual field MD in a group of patients with glaucoma. Standard and custom testing sequences were similar in this regard. The custom testing sequence may produce RAA values that correlate more closely to MD asymmetry than those produced by the standard testing sequence.

Conclusion
A novel testing sequence for the RAPDx pupillograph provides an objective, quantitative measure of pupillary dysfunction that correlates with disease severity. Further research is needed to determine the most useful testing sequences and combinations of clinical and pupillary response parameters for detecting and staging glaucoma.

References
23 Refined Frequency Doubling Perimetry Analysis Reaffirms Central Nervous System Control of Chronic Glaucomatous Neurodegeneration

WILLIAM SPONSEL1, Analaura Villareal2, Matthew Reilly2, Ted Maddess3
1 WESMDPA, UTSA, UIW, and ARCCEVS
2 University of Texas San Antonio
3 Australian National University, Canberra

Purpose/Relevance
Refined analysis of frequency doubling perimetric data was performed to assess binocular visual field conservation in patients with comparable degrees of bilateral glaucomatous damage, to determine whether unilateral visual field loss is random, anatomically symmetric, or non-random in relation to the fellow eye.

Methods
Case control study of 41 consecutive patients with bilaterally mild to severe glaucoma; each right eye visual field locus was paired with randomly-selected co-isopteric left eye loci, performing 690,000 (10,000 complete sets of 69 loci) such iterations per subject. The potential role of anatomic symmetry in bilateral visual field conservation was also assessed by pairing mirror-image loci of the right- and left-eye fields. The mean values of the random co-isopteric and the symmetric mirror pairings were compared with natural point-for-point pairings of the two eyes by paired t-test.

Results
Mean unilateral Matrix thresholds across the entire 30-degree visual field were 17.0 dB left and 18.4 dB right (average 17.7). The better of the naturally paired concomitant loci yielded binocular equivalent mean bilateral Matrix threshold of 20.9 dB, 1.6 dB higher than the population mean of the 690,000 coisopteric pairings (t = -10.4; P<10^-12). Thus, a remarkable natural tendency for conservation of the binocular Matrix visual field was confirmed, far stronger than explicable by random chance. Symmetric pairings of precise mirror-image loci also produced values higher than random co-isopteric pairings (Δ 1.1 dB; t = -4.0; P=0.0004).

Discussion
Integrated bilateral visual field analysis should better define actual visual disability and more accurately reflect the functional efficacy of current ocular and future CNS-oriented therapeutic approaches to the treatment of glaucoma. Glaucomatous eyes provide a highly accessible paired-organ study model for developing therapeutics to optimize conservation of function in neurodegenerative disorders.

Conclusion
Integrated bilateral visual field analysis should better define actual visual disability and more accurately reflect the functional efficacy of current ocular and future CNS-oriented therapeutic approaches to the treatment of glaucoma. Glaucomatous eyes provide a highly accessible paired-organ study model for developing therapeutics to optimize conservation of function in neurodegenerative disorders.

References
Continuous Twenty-Four Hour Ocular Dimensional Profiles Using a Contact Lens Sensor in Ocular Hypertensive Patients

SAMANTHA WANG1, Tomas Grippo1, Jessica Maslin1, Chaoying Xu1, James Tsai2, Sonja Simon-Zoula3, Ji Liu1
1 Yale University School of Medicine
2 Icahn School of Medicine at Mount Sinai
3 Sensimed AG

Purpose/Relevance
To compare 24-hour ocular dimensional profiles between untreated ocular hypertensive (OHT) patients and those of healthy controls and untreated primary open angle glaucoma (POAG) patients using a contact lens sensor.

Methods
We recruited seventeen patients with a documented history of OHT to undergo a 24-hour recording session with a contact lens sensor (Triggerfish®, Sensimed AG, Switzerland).1,2 Twenty-four hour Triggerfish (TF) profiles and variables were then compared to those of age-matched healthy controls (n=16) and untreated POAG patients (n=16). OHT patients were further stratified into glaucoma converters (n=5) and non-converters (n=12) using clinical criteria.

Results
OHT patients (age range: 34-79 years, 47% males) demonstrated a greater mean number of 24-hour TF peaks compared to healthy controls (17.6±6.5 vs. 12.6±4.5, p=0.017) and POAG patients (17.6±6.5 vs. 13.4±3.7, p=0.030). OHT patients showed more nocturnal TF peaks compared to healthy controls (6.9±3.6 vs. 3.6±1.2, p=0.002) and POAG patients (6.9±3.6 vs. 4.2±1.6, p=0.010). The number of brief peaks (trough-to-peak time <30 minutes) in the nocturnal period was greater in OHT patients compared to healthy controls (8.4±7.3 vs. 4.4±3.7, p=0.009) and POAG patients (8.4±7.3 vs. 4.6±2.4, p=0.020). No significant differences in the 24-hour TF profiles were detected between converters and non-converters.

Discussion
OHT patients exhibited a higher number of TF peaks compared to healthy controls and POAG patients. The majority of these peaks occur during the nocturnal period and are brief in nature.

Conclusion
Continuous 24-hour TF recordings are different in OHT patients compared to healthy controls and untreated POAG patients. Further work is needed to better understand TF characteristics that may distinguish OHT patients at higher risk of developing glaucoma.

References
25 Intraocular Pressure, Central Corneal Thickness, and Body Mass Index as Risk Factors for Glaucoma

HIDEKI FUKUOKA¹, Chikako Tange¹, Rei Otsuka², Fujiko Ando³, Hiroshi Shimokata³
¹ National Center for Geriatrics and Gerontology
² Aichi Shukutoku University
³ Nagoya Univ of Arts and Sciences

Purpose/Relevance
Glaucoma is a multifactor optic neuropathy for which the most blamed factor is raised intraocular pressure (IOP). Some papers reported that a significant correlation was found between IOP and central corneal thickness (CCT) or body mass index (BMI). It is important for the diagnosis of glaucoma, in which, in the early to medium-advanced stages, the vertical cup-to-disc ratio (VCDR) increases earlier than the horizontal one. Herein, we report the findings of a relationship between VCDR and IOP or CCT or BMI after adjusted by age and optic disc area.

Methods
The subjects were 2,819 eyes conducted with no surgical history (788 men, 739 women; average age, 59.6 ± 11.7 years) living in the regions located at the center of Japan who had participated in the third wave (2002–2004) of the National Institute of Longevity Sciences - Longitudinal Study of Aging (NILS-LSA). VCDR was assessed using the Heidelberg Retina Tomograph II. Statistical analysis were conducted using the Analysis System (SAS) (SAS Institute, Cary, NC, USA). VCDR was set in multivariate mixed linear model analysis as objective variables. Explanatory variables were IOP, central corneal thickness (CCT), and body mass index (BMI). The data were adjusted by age and by optic disc area and analyzed by sex (male, female).

Results
VCDR significantly increased with a low BMI in male (F=7.55, p=0.0062). Meanwhile, VCDR significantly increased with a thin CCT (F=4.28, p=0.0389) and a high IOP (F=25.08, p<.0001) in female. There was no significant relationship between VCDR and CCT or IOP in male and VCDR and BMI in female.

Discussion
It was shown that the risk factors for glaucoma may be different by sex.

Conclusion
The findings of this study revealed different association with VCDR and other factors by sex.

References
26 Utilizing Fundus Photographic Images to Detect Glaucoma Based on Novel Arterial and Venous Network Biomarkers

DAVID MEADOWS¹, Mark Sherwood², Daniel Gibson³, Nick Dunbar³, Dan Dickrell², Darell Turner¹, Sunil Gupta³, Wayne Solley⁴

¹ Sentinel Diagnostic Imaging, Inc.
² University of Florida
³ Retina Specialty
⁴ Texas Retina

Purpose/Relevance
To determine if retinal vascular blood flow capacity, calculated from the vessel morphology in high-resolution fundus photography, is a robust metric for screening glaucomatous patients.

Methods
Literature reports have indicated that retinal blood flow is compromised in a meaningful percentage of glaucoma patients. Two suggested mechanisms for vascular dysfunction are increased resistance to flow and/or reduced perfusion pressure. A new method of automatically classifying blood flow capacity of retinal vascular networks into healthy or glaucoma categories has been developed (OQULUS™). It utilizes standard high-resolution color fundus photographs to characterize the morphology and geometry of arterial and venous networks. Based on connectivity and flow capacitance of individual vessel segments, the overall network flow capacities were calculated. Arterial bifurcations were carefully characterized using metrics: diameter ratios, area ratios and branching angles, etc. Vascular network flow metrics define the ability for blood to pass efficiently through the interconnected series of retinal vessels. The image sample set analyzed consisted of 30 high-resolution color fundus images from 15 healthy and 15 glaucomatous patients (http://www5.cs.fau.de/research/data/fundus-images/). Biomarkers were identified for the arterial and venous networks from each image.

Results
The analysis procedures indicated that a large difference between healthy and glaucomatous eyes was exhibited by the overall network flow rates. The healthy arterial networks had an average flow capacity of 1.50 ± 0.74 µL/kPa-s while the glaucomatous arterial networks had an average flow that was reduced by 70% to 0.43 ± 0.16 µL/kPa-s (ROC analysis: Area = 0.85, Sensitivity = 0.82, Specificity = 0.85). Strong biomarker signals were also evidenced in: vein blood flow capacity. This difference clearly highlighted the diminished flow capacity of retina vasculature in glaucomatous patients due to a global narrowing of the vessel networks.

Discussion
Ocular blood flow deficiency has been suggested as a cause of optic nerve damage, either directly or indirectly through raised intraocular pressure, supporting the results from the dataset analysis using the OQULUS™ software. Other strong biomarker signals include: artery and vein diameter, artery tortuosity, artery and vein asymmetry index, artery bifurcation angle.

Conclusion
Results for the OQULUS™ software based on Constructal Analysis algorithms clearly identified biomarkers that enable the automated screening of glaucoma patients from color fundus imagery.

Reference
1. Meadows, D., Dickrell, D., Clark, R., ARVO 2014 National Meeting - ISIE, “Correlations between glaucoma and arterial vascular flow capacity computed from retinal fundus photographic images.”
27 Characterization of Corneal Endothelium in Glaucomatous Eyes Managed Medically and Surgically

VIKAS CHOPRA¹, Olivia L. Lee¹, Mark Breazzano², Cristina Modak³, Srinivas Sadda¹, Brian Francis¹,
¹ Doheny Eye Institute, UCLA
² Vanderbilt Eye Institute
³ Doheny Eye Institute

Purpose/Relevance
To describe the characteristics of the corneal endothelia of glaucomatous eyes by non-contact specular microscopy. To compare endothelial cell density (ECD) in eyes with medically versus surgically managed glaucoma.

Methods
Non-contact specular microscopic examination of the central cornea using Konan NSP-9900 was performed for three groups of eyes from age-matched patients: [Group 1] normal controls (n=113); [Group 2] glaucoma with medical management only (n=41); [Group 3] glaucoma with prior glaucoma surgery (trabeculectomy, tube shunt or SLT) ± concurrent medical management (n=39). Any eye with prior corneal or cataract surgery was excluded. The corneal ECD, coefficient of variation (CV) and percentage of hexagonal cells (HEX) were calculated by 2 independent, trained graders using the Konan Center method.

Results
Glaucoma patients collectively had a significantly lower ECD (2336 cells/mm² ± 476, mean ± S.D.) than controls (2679 cells/mm² ± 303), (P<0.001). Mean ECD was significantly lower in eyes with prior glaucoma surgery (2196 cells/mm² ± 557) than controls (p<0.0005). Surgically treated eyes had lower mean ECD as compared to eyes with medically treated glaucoma (2433 cells/mm² ± 366), however this difference was not statistically significant (p=0.062). There was no significant difference in CV (p=0.600) or HEX (p=0.452) between the corneal endothelia of these three groups.

Discussion
Eyes with glaucoma, particularly those with prior trabeculectomy, tube shunt or SLT, have lower corneal endothelial cell densities as compared to normal eyes. This reduction of ECD, in the absence of change in CV or HEX, may represent corneal endothelial loss from glaucoma treatment and/or glaucoma itself.

Conclusion
Eyes with glaucoma are vulnerable to endothelial cell loss. Interventions to decrease intraocular pressure in these eyes, whether medical or surgical, should be embarked upon with the risk of endothelial damage in mind.

Reference
28 Iridocorneal Angle Observation and Description in Preterm Newborn Infants with the RetCam 3

MAURICIO TURATI ACOSTA1, Jesús Jiménez-Arroyo1, Mariana Escalante-Castañón1, Itzel Perez-Gudiño1, Iqbal Ike Ahmed2, Maria Ana Martinez-Castellanos1, Magdalena Garcia-Huerta1, Félix Gil-Carrasco1, Jesús Jiménez-Román1

1 Asociacion para Evitar la Ceguera en Mexico
2 University of Toronto

Purpose/Relevance
Describe the anatomic characteristics of the iridocorneal angle in preterm newborn infants using the RetCam 3.

Methods
Observational and descriptive case series. From August 2013 to February 2014 all preterm newborns from the Hospital Materno-Infantil de Toluca were ophthalmologically evaluated at the Asociación para Evitar la Ceguera en Mexico. Images from the temporal quadrant of the angle were obtained with the RetCam 3 by a glaucoma specialist under topical anesthesia. Interpretation of the images was performed by two glaucoma specialists. Angles were graded using the Shaffer classification system.

Results
58 eyes from 29 preterm newborns were evaluated. Average gestational age was 30.7 ± 3 weeks. 76% were males, and the average birth weight was 1249 ± 448 grams. All eyes were successfully imaged, with the following results based on gestational age:

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<td>27-28</td>
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<tr>
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<tr>
<td>34-37</td>
<td>8</td>
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</tr>
</tbody>
</table>

Table 1

Discussion
In ophthalmology there are a wide variety of imaging systems for the anterior and posterior segment. Neonatal patients represent a challenge to examine and document the iridocorneal angle. The RetCam 3 was able to provide adequate visualization and evaluation of the iridocorneal angle in newborn preterm infants. This may assist the ophthalmologist in the assessment of the angle and its development in the neonate, and may provide an early detection possible anomalies.

Conclusion
Using the RetCam 3, we were able to obtain high quality images that permitted adequate evaluation of the iridocorneal angle anatomy in a safe and relatively efficient manner.

References
29 Effect of Pupil Dilation on Intraocular Pressure in Patients with Open Angles

KELLY MA1, Manishi Desai1, Meenakshi Chaku1, Kate McConnell1, Saba Al-Hashimi1
1 Boston University Medical Center

Purpose/Relevance
Pupillary dilation poses a significant risk for patients with occludable narrow angles, but little has been proven with regards to its effects on intraocular pressure (IOP) in patients with open angles. Several studies have attempted to investigate IOP fluctuations after pupil dilation in normal individuals or patients with different types of open angle glaucoma (OAG); however, the vast majority of them were either small scale or focused on a particularly subset of OAG. Our aim was to perform a larger-scale study assessing the changes in IOP, if any, after pharmacologic iris dilation in healthy patients and those with or suspect for OAG.

Methods
103 patients with open angles demonstrated by gonioscopy were prospectively enrolled. IOP was measured using Goldmann applanation before and 30 minutes after dilation using phenylephrine 2.5% and tropicamide 1%.

Results
Of 103 patients (200 eyes), 39 were normal subjects, 34 were OAG suspects, and 30 had OAG. Of them, 29 patients had diabetes mellitus. 176 eyes were phakic and 24 pseudophakic. A statistically significant increase in IOP after dilation ($p<0.0001$) was found; however, this increase was not clinically relevant (0.7 ± 2.3 mmHg). Disease states affected changes in IOP ($p=0.02$). OAG and glaucoma suspect (GS) patients exhibited statistically significant changes in IOP upon dilation ($p<0.0001$; $p=0.01$), whereas patients without glaucoma did not ($p=0.38$). IOP increases were seen in both phakic and pseudophakic groups ($p=0.001$; $p=0.003$). The presence of diabetes was not significant ($p=0.88$).

Discussion
Pupillary dilation results in a statistically significant but clinically negligible rise in IOP. We found that OAG patients had the most robust increase in IOP with dilation, followed by GS patients. Patients without glaucoma did not exhibit significant changes in IOP.

Conclusion
Our data indicate that there is no added risk in dilating patients with OAG or OAG suspicion. Further studies are needed to show whether these fluctuations in IOP have an effect in the clinical course of the disease long term.

References
30 **CPAPs Effect on Ocular Pressures in Obstructive Sleep Apnea Patients**

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**Purpose/Relevance**

Several studies have shown specific correlations between obstructive sleep apnea (OSA) and primary open-angle glaucoma. However, there is controversy over whether positive pressure administered by CPAP machines significantly raises intraocular pressure (IOP). Additionally, a concurrent decrease in blood pressure will lower ocular perfusion pressure (OPP), which has been shown to be a risk factor for glaucoma progression. The primary objective of this study is to determine if increasing levels of positive airway pressure correlate with increasing levels of IOP and decreasing levels of OPP.

**Methods**

This is a prospective clinical study with a target population of OSA patients who require CPAP machine use. IOP and systemic blood pressure were measured after each of the following consecutive intervals: 0 minutes (patient upright), 15 minutes of patient lying supine, 30 minutes of supine CPAP machine use, 15 minutes of patient lying supine without CPAP, 15 minutes of patient sitting upright.

**Results**

23 subjects have completed the study. In the right eye, mean IOP increased .96 mmHg after CPAP use, and 1.04 mmHg in the left eye. OPP was found to decrease after CPAP use by .07 mmHg and .15 mmHg in the right and left eye respectively. Additionally, mean IOP increased after CPAP use in glaucoma suspects and open angle glaucoma subjects, but decreased after CPAP use in subjects without glaucoma (Figure 2).

**Discussion**

It is thought that CPAP increases IOP by elevating intrathoracic pressure, which elevates pressure in the venous circulation and reduces aqueous humor outflow. As IOP increases and OPP decreases after CPAP use, the decrease in ocular perfusion decreases oxygenation within the optic vasculature and nerves, possibly damaging the optic nerve and causing glaucomatous changes.

**Conclusion**

The increase in IOP with CPAP machine use in glaucomatous patients may suggest that more aggressive glaucoma treatment is warranted in CPAP utilizing glaucoma patients. Current data is not statistically significant, but data collection and sub-group analysis of patients with POAG vs low tension glaucoma is ongoing. Similarly, further analysis of concurrent anti-hypertensive and anti-glaucoma medications as well as an increased sample size will give more significant data.

**Reference**

31 Association of Endothelial Cell Density and Glaucoma Severity in Patients with Exfoliation Glaucoma

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Purpose/Relevance
To determine the relationship between endothelial cell density (ECD) and glaucoma severity in patients with exfoliation glaucoma (XFG).

Methods
This is a retrospective chart review of 86 eyes of 43 patients diagnosed with XFG and IOL dislocation seen at a single surgeon practice. ECD and cup-to-disc ratio (c/d) were recorded for all eyes. Glaucoma severity was determined based on c/d. Each patient had one eye assigned to a less severe glaucoma group and the other eye to a more severe group based on c/d. Patients with identical c/d in both eyes were used as controls. ECD was compared in fellow eyes with different c/d and in fellow eyes with identical c/d. Paired t-test was used for statistical analysis.

Results
Of the 43 patients, 27 had different c/d and 16 had identical c/d in fellow eyes. ECD in patients in the more severe glaucoma group was significantly lower than the less severe group (1799.92 ± 533 vs. 1603.34 ± 578, p = 0.008). ECD compared in right and left eyes of controls was not significantly different (1810.31 ± 804 vs. 1531.38 ± 604, p = 0.086).

Discussion
Previous studies have shown that eyes with exfoliation syndrome (XFS) with and without glaucoma have lower ECD than eyes without XFS. No previous group has evaluated ECD in fellow eyes of patients with XFG. Our study shows that the fellow eye with worse glaucoma is associated with a lower ECD.

Conclusion
Our data suggests that decreased ECD in patients with XFS is associated with greater glaucoma severity. Further work is needed to establish whether ECD is an independent predictor for glaucomatous progression in patients with XFS.

References
32 Rho-Kinase Inhibitor AR-12286 Ophthalmic Solution 0.5% and 0.7% Efficacy in Patients with Exfoliation Syndrome (XFS) and Ocular Hypertension (OHT) or Exfoliative Glaucoma (XFG)

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Purpose/Relevance
Elevated intraocular pressure (IOP) is the sole proven modifiable risk factor for XFG development and progression. Rho-associated protein kinase inhibitors have been studied for their ability to lower IOP, by several mechanisms including disruption of adhesions between the trabecular meshwork (TM) cells and increasing aqueous outflow. The main purpose of this study was to evaluate the efficacy of AR-12286 and evaluate its lasting effect on IOP after discontinuation.

Methods
Double-blind, interventional study. Study eye of 6 men and 4 women was randomized to AR-12286 0.5% or 0.7% adjunctive to current IOP lowering regimen for 6 months. Visits included baseline, 1 week, 1 and 3 months; at 3 months AR-12286 was discontinued for one week and was resumed at week 13. At the 6 month visit, AR-12286 was discontinued, with final visit at week 25.

Results
The study eye mean baseline IOP was 25±2.4 mmHg, mean IOP reduced to 19.1±2.3 mmHg at 1 week (P<0.001), 17.5±3.6 mmHg at 1 month (P<0.001), and 17.4±3.6 mmHg at 3 months (P<0.001), yielding an average IOP reduction of 26.8%, 35.3% and 35.8% respectively. At the 13 week visit, after AR-12286 was discontinued, mean IOP increased to 21.6±5.4 mmHg (P=0.06 compared to baseline). At 6 months, the mean IOP was 21.8±7.8 mmHg (P=0.2), and AR-12286 was discontinued. At week 25 the mean IOP was 21.3±5.3 mmHg (P=0.06).

Discussion
Rho-kinase inhibition has not yet been studied in patients with XFS or XFG. The possibility that treatment with Rho-kinase inhibitor, with concomitant transient disruption of trabecular architecture, will allow exfoliation material and pigment trapped in the trabecular space to be dislodged and result in a long-lasting increase in aqueous outflow facility and lowering of IOP has been an exciting concept.

Conclusion
AR-12286 was well tolerated and provided clinically statistical significant ocular hypotensive efficacy with XFS and OHT or XFG patients. This drug may represent a new therapeutic paradigm for the treatment of XFG.

References

Figure 1. Baseline and follow-up visits IOP measurements of the study eyes (drug discontinuation visits are marked in arrows).
Symmetry of Circadian 24-h IOP-Related Patterns in Glaucoma Patients Using a Contact Lens Sensor

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Purpose/Relevance
To study the inter-eye correlation of continuously measured circadian IOP-related patterns in untreated glaucoma patients.

Methods
Eighteen newly diagnosed and untreated patients with open angle glaucoma underwent a single session of bilateral ambulatory 24-hour monitoring of IOP-related patterns using a contact lens sensor (CLS; Triggerfish, Sensimed AG, Switzerland). The CLS measures ocular dimensional changes at the corneo-scleral junction that are assumed to be related to intraocular pressure (IOP) and volume changes. IOP was measured before and after CLS monitoring using Goldmann applanation tonometry (GAT). Inter-eye agreement of 24-hour patterns was calculated using Spearman correlation (r).

Results
Complete bilateral CLS data could be obtained in 12 patients; six patients had a less than 80% of valid CLS measurements. No serious adverse events (AE) related to CLS monitoring were recorded. Transient conjunctival hyperemia (15 patients) and blurred vision (13 patients) were the most frequent AEs. On average, inter-eye correlation was $r = 0.75 \pm 0.20$ (range, 0.16 to 0.95) and $r = 0.77 \pm 0.15$ (range 0.49 to 0.91), after excluding the three patients with incomplete recordings.

Discussion
Results show good inter-eye agreement for circadian IOP-related patterns using the CLS. These results show a higher inter-eye degree of IOP symmetry in untreated glaucoma patients than previously reported with standard static tonometry.

Conclusion
The contact lens sensor provides more thorough information regarding patterns of IOP measurement than has been noted before, and thus promises to enhance understanding and predictions guiding prognosis and treatment of glaucoma.

Reference
Continuous Intraocular Pressure Monitoring with a Wireless Contact Lens and Ocular Telemetry Sensor in Patients with Open-Angle Glaucoma: Pilot Study

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Purpose/Relevance
Report our initial clinical results with a wireless ocular telemetry sensor (OTS) for continuous intraocular pressure (IOP) monitoring in patients with open angle glaucoma.

Methods
Prospective, observational study. We included 7 patients with diagnosis of POAG. We performed a conventional IOP 24-hr monitoring with Goldman tonometer during diurnal period (8:00-17:00) and Perkins and Schiotz tonometry in nocturnal period (20:00-6:00). Then a wireless monitoring in which OTS measures changes in corneal curvature induced by variations in IOP. Patients were asked to fill a tolerability form grading their level of ocular comfort on a 10 grade scale.

Results
Mean age 57.28 ± 14.5 years, 85.7% female. The highest signals were recorded during the nocturnal period as same as in the conventional IOP monitoring. Prolonges Peaks (>1 hr) were observed in all patient outside office hours. We identify 3 different patterns in the graph record from Triggerfish with specific characteristics. No serious adverse events were reported. Patients average score for comfort was 6.5 and the most frequent symptoms were itching from the antenna patch, foreign body sensation, and redness.

Discussion
Although continuous monitoring Triggerfish® technology does not directly measure IOP, but the change in curvature of the cornea produced by it, it registers a signal during 24 hours and a graph of the intraocular pressure’s behavior is obtained. This pilot study was able to identify 3 types or patterns of tension curves in only 7 patients with primary open-angle glaucoma. Further studies are required that aim to correlate the clinical variables of each patient with curved pattern recorded by Triggerfish®.

Conclusion
We know that IOP behavior is a dynamic event in which many factors intervene. Some of these factors are: corneal thickness, biomechanical properties of the cornea. It is likely that these graphic patterns recorded by Triggerfish® are generated by several of these factors interacting among themselves.

References

Figure 1

Figure 2
Prospective Evaluation of the Safety and Efficacy of Acupuncture as Treatment for Glaucoma: A Pilot Study

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Purpose/Relevance
To prospectively evaluate the safety and efficacy of acupuncture as treatment for glaucoma.

Methods
Glaucoma patients whose intraocular pressure (IOP) had been stable without history of surgical intervention or had failed surgery >3 years prior were enrolled. All patients were randomly assigned to receive one acupuncture therapy (either with eye-related acupuncture points [eye-points] or non-eye related acupuncture points [non-eye-points], for 12 sessions over 6-12 weeks) and then crossover to receive another acupuncture therapy with a washout period of 4 weeks in between. Blood pressure (BP), heart rate (HR) and IOP were recorded before and after each session. Diurnal IOP (every 2 hours from 8AM to 4PM), best-corrected visual acuity (BCVA), visual field (VF) were measured before and after each 12-session therapy. Optic disc and retinal nerve fiber layer (RNFL) measurements were obtained before and after the entire study.

Results
24 glaucoma patients volunteered for the study and 11 patients (45.8\%) completed the study. Two patients (8.3\%) did not qualify for the study at screening. Eight patients (33.3\%) did not complete the study due to change of health condition (2 patients), moving away (2 patients), lack of transportation (3 patients), and family crisis (1 patient). Three patients (12.5\%) were withdrawn from the study due to needle sensitivity (2 patients) and IOP increase after treatment (1 patient). After each acupuncture session, mean IOP exhibited a slight increase with eye-points (increase from 12.9±1.8 to 13.6±2.0 mmHg, p=0.019) and non-eye-points (increase from 13.0±1.5 to 13.5±1.7 mmHg, p=0.073) treatment. HR, IOP, and BCVA showed no significant change after 12 sessions of either acupuncture therapy. Systolic and diastolic BP was reduced after 12 sessions of non-eye-points therapy (p=0.040 and 0.002, respectively), but no significant changes were noted with eye-points therapy. Optic disc and RNFL measurements and VF tests recorded no significant changes after the study.

Discussion
Systemic effects in terms of BP may be affected by acupuncture of certain acupuncture points, but not found in acupuncture with eye-points. Acupuncture has no overall effect on IOP reduction, and may temporally increase the IOP immediately after treatment sessions. Further studies of acupuncture on ocular circulation are warranted.

Conclusion
Acupuncture has no overall effect on IOP reduction, and may temporally increase the IOP immediately after treatment sessions. Compliance and rate of adverse events with acupuncture therapy for glaucoma were low.

Reference
36 A Novel Method for Treating Failed Glaucoma Implants

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Purpose/Relevance
To improve the success rate of the second glaucoma implant by impeding the effect of cytokines formed by the existing implant.

Methods
It has been observed in two patients that removing a failed glaucoma implant, with the simultaneous insertion of the second implant, improved the success of the second implant in both patients. Based on this observation, four patients with failed glaucoma implants had the tubes of these implants tied off to eliminate the possible effects of cytokines produced by the failed implant. The cytokine levels were measured in the blebs of the second implant, during its formation. The main outcome measure was success or failure of the second implant bleb related to the levels of TGF-β₂ and intraocular pressure (IOP) measurements.

Results
Success of the second implant, defined as IOP of 5 mmHg to 20 mmHg with adjunctive medical therapy, occurred in all four patients. Average preoperative IOP was 36 ± 4.6 mmHg. The average IOP during bleb development was 23 ± 0.9 mmHg and final IOP was 18 ± 2.9 mmHg. The average preoperative TGF-β₂ level was 22733 ± 6205 pg/ml., and postoperative TGF-β₂ was 10238 ± 1515 pg/ml. Normalized (against preoperative levels) TGF-β₂ relative concentrations reduced significantly p=0.0005 after operation. The average follow up period was 10 months.

Discussion
During the development of the second bleb, TGF-β₂ levels were low and no hypertensive phases were noted. The proposed reason for the successful outcomes of the blebs in this study is associated with the elimination of the influence of the TGF-β₂, which would have been formed by the failed bleb. All failed blebs became functional when the tube was re-opened.

Conclusion
During the development of the second bleb, TGF-β₂ levels were low and no hypertensive phases were noted. The proposed reason for the successful outcomes of the blebs in this study is associated with the elimination of the influence of the TGF-β₂, which would have been formed by the failed bleb. All failed blebs became functional when the tube was re-opened.

Reference
Minimum Rim Width Measurements by Swept Source OCT as a Predictor of Paracentral Visual Field Loss

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Purpose/Relevance
Lamina cribrosa depth (LCD) and minimum rim width at Bruch’s membrane opening (BMO-MRW) were introduced with spectral domain optical coherence tomography (OCT) to improve glaucoma detection. We assessed these parameters using swept source OCT (SS-OCT) in patients stratified by pattern of visual field loss.

Methods
Thirty two patients with open angle glaucoma (OAG), visual acuity better than 20/50, reliable Humphrey visual field (HVF) and no previous glaucoma surgeries underwent radial scans of the optic nerve head by SS-OCT (Atlantis, Topcon) and circumpapillary retinal nerve fiber layer thickness (RNFLT) measurements by spectral domain OCT (Spectralis, Heidelberg), during the same visit. Vertical LCD (VLCD), horizontal LCD (HLCD) and BMO-MRW were measured using a customized ImageJ plugin. Eyes with severe peripapillary atrophy, optic disc tilt or torsion were excluded from the analysis. HVF were classified by two masked observers (LRP, LQS) into 4 categories: no loss or pre-perimetric, isolated paracentral defect, isolated peripheral defect and combined paracentral-peripheral damage. Only one eye per patient was analyzed. Descriptive data were presented as mean ± standard deviation. One-way analysis of variance and independent t-test were used for group comparison. Statistical significance for multiple comparison tests was adjusted using Bonferroni correction.

Results
BMO-MRW measurements by SS-OCT in eyes with isolated paracentral defect and combined paracentral-peripheral damage were significantly lower than those in pre-perimetric eyes (53.2±11.0, 72.1±46.2 and 169.3±37.8µm, respectively, p<0.05 for all); whereas no significant difference was found when comparing eyes with isolated peripheral defects from pre-perimetric group. Eyes with isolated paracentral defect had the thinnest BMO-MRW measurements, and the location of BMO-MRW on the optic nerve corresponded anatomically to the HVF defect in every eye. RNFLT was significantly thinner in the isolated paracentral defect and combined paracentral-peripheral damage groups compared to the pre-perimetric eyes (45.5±7.14, 32.2±10.9, 60.2±8.9µm, respectively, p<0.05 for all) and the thinnest measurements were found in eyes with combined paracentral-peripheral damage. VLCD and HLCD measurements were not statistically different among the HVF categories.

Discussion
Both BMO-MRW and RNFLT, but not VLCD or HLCD, were good predictors of paracentral loss on HVF.

Conclusion
Analysis of new imaging parameters with SS-OCT may refine the assessment of glaucomatous optic nerve and provide evidence of how structural damage leads to functional loss.

References
Surgery

38 OAG Patients Uncontrolled on 1-3 Medications Randomized to Implantation of One, Two, or Three Trabecular Micro-Bypass Stents: Results Through 18 Months from Prospective, Randomized Study

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Purpose/Relevance
Multiple trabecular bypass for additive intraocular pressure (IOP) lowering is based on previous pre-clinical work. More recent clinical work has shown significant IOP and medication reduction from micro-invasive glaucoma surgery (MIGS) using multiple trabecular micro-bypass stents with cataract surgery. In our study the MIGS study group compared IOP reduction after 1, 2 or 3 stents implanted as a sole procedure in open angle glaucoma (OAG) subjects previously not controlled on 1-3 ocular hypotensive medications.

Methods
Prospective, randomized study of subjects with OAG and IOP 18 - 30 mmHg on 1-3 medications. Following preoperative medication washout, eligible subjects with unmedicated IOP 22 - 30 mmHg were to be randomized (1:1:1) to receive 1, 2 or 3 stents. Follow-up through 3 years is ongoing, and 119 subjects have been followed 18 months.

Results
Mean preoperative medicated IOP was 19.8 mmHg (SD 1.3), 20.1 mmHg (SD 1.6) and 20.4 mmHg (SD 1.8) in 1, 2 and 3-stent eyes, respectively. Mean preoperative IOP after a 1-month medication washout was 25.0 mmHg (SD 1.1), 25.0 mmHg (SD 1.8) and 24.9 mmHg (SD 2.2) in 1, 2 and 3-stent eyes, respectively. The three respective groups had Month 12 IOP ≤ 15 mmHg in 74%, 95% and 100%. At Month 18, the three respective groups had mean unmedicated IOP of 15.6 mmHg (SD 1.4), 13.9 mmHg (SD 1.2) and 12.3 (1.1) mmHg. Five eyes had BCVA loss due to cataract progression over the 18-month period.

Discussion
Higher proportions of multiple-stent eyes had IOP reduction ≥ 40% and IOP ≤ 15 mmHg vs. single-stent eyes. Data through 18 months found incrementally greater IOP reduction in multiple-stent eyes, with no significant safety events in any group.

Conclusion
In this series, results through 18 months showed significant IOP reduction after implantation with a single stent, further IOP reduction to ≤ 15 mmHg mmHg with multiple stents, reduction in drug burden in all patients, and an overall favorable safety profile in patients with OAG not controlled on preoperative medication.

References
Prospective, Randomized Evaluation of Micro-Invasive Glaucoma Surgery (MIGS) with Two Trabecular Micro-Bypass Stents vs. Prostaglandin in Open-Angle or Pseudoexfoliative Glaucoma or Ocular Hypertension Naïve to Therapy

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Purpose/Relevance
Ocular hypotensive medical therapy has been a conventional first-line therapy for open-angle glaucoma (OAG), patients with medication intolerance or adherence limitations may benefit from micro-invasive glaucoma surgery (MIGS) as an alternative. Previous studies have shown safe and effective outcomes after multiple stents implanted either during cataract surgery or as a sole procedure.1,2 The MIGS study group compared 2-stent therapy to medication therapy in patients with OAG, pseudoexfoliative glaucoma (PEX) or ocular hypertension (OHT) naïve to therapy.

Methods
Prospective, randomized study in 98 qualified phakic eyes with IOP ≥ 21 mmHg and ≤ 40 mmHg, and CD ratio ≤ 0.9. Subjects were randomized (1:1 ratio) to receive two stents (Glaukos) or prostaglandin, with post-therapy addition of medication to either group if IOP exceeded 21 mmHg. Clinical parameters through 60 months include IOP, medication use, fundus/optic nerve exam, slit-lamp, gonioscopy, surgical/postoperative complications and best corrected visual acuity. All subjects have now been followed through 2 years.

Results
Ninety-eight qualified eyes underwent stent implantation (n=50) or received travoprost (n=48). Mean preoperative IOP was 25.7 ± 2.5 mmHg in the stent group and 25.0 ± 4.6 mmHg in the travoprost group. By Month 12, medication had been added to 3 subjects in each group; mean IOP was 13.8 ± 1.7 mmHg in the stent group and 13.9 ± 1.5 mmHg in the travoprost group. By Month 24, mean IOP was 13.9 ± 1.3 mmHg in the stent group (0 eyes on medication) and 15.0 ± 1.4 mmHg in the travoprost group (3 subjects on 1 additional medication), and 1 subject per group had undergone cataract surgery. No other complications were reported.

Discussion
Significant postoperative decrease in IOP with favorable safety was shown through two years after either implantation of 2 stents as the sole procedure or medical therapy in OAG, PEX or OHT naïve to treatment.

Conclusion
These data suggest 2 trabecular micro-bypass stents provide efficacy and safety similar to medical therapy with a prostaglandin in newly diagnosed OAG, PEX or OHT.

References
40 Prospective Randomized Study of Two Different Models of the Ahmed Glaucoma Valve in Eyes with Neovascular Glaucoma

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Purpose/Relevance
Evaluate IOP lowering and complications of the Ahmed Glaucoma Valve (AGV) model M4 (High density porous polyethylene plate; Medpor) compared with the model S2 (Polypropylene plate) in neovascular glaucoma.

Methods
Prospective randomized comparative trial. Inclusion criteria were patients with neovascular glaucoma with uncontrolled IOP on maximal medical therapy. Patients were randomized to receive either the M4 or the S2 AGV. No adjunctive procedures or antimetabolites were used. Main outcome measure was postoperative IOP; secondary measures being postoperative glaucoma medication and complications. Follow-up was planned for one year. Failure was defined as IOP >20 or progression to NLP vision.

Results
42 eyes of 42 patients were enrolled; 21 randomized to the M4 group and 21 to the S2 group. Preoperative IOP in the M4 group reduced from 43.5 ± 11.8 mmHg to 18.9 ± 9.7 mmHg at 1 year postoperative (p<0.0001), and from 42.3 +/- 12.84 mmHg to 16.4 ± 9.7 mmHg (p<0.0001) in the S2 group. There was no statistical difference in postop IOP between both groups (p=0.07). S2 group were on more postoperative glaucoma medications than the M4 group (2.5 ± 1.3 vs 1.7 ± 0.8 average medications, p=0.02). There was no difference in failure rates between both groups (NS). Complications were rare and similar in both groups.

Discussion
A valved glaucoma drainage device such as AGV provides moderate control of IOP with protection against hypotony in the immediate postoperative period. Recently, a porous plate design (M4) of the AGV was introduced as an alternative to the polypropylene S2 model. In this study of the AGV models in neovascular glaucoma, both designs provide significant IOP lowering and similar failure rates. However, M4 eyes were on less glaucoma medications postoperatively.

Conclusion
At one year follow-up, both M4 and S2 AGV were found to provide significant IOP-lowering in neovascular glaucoma. Patients with the S2 model were on more postoperative glaucoma medications.

References
41 Gonioscopy-Assisted Transluminal Trabeculotomy for the Treatment of Primary Congenital Glaucoma and Juvenile Open-Angle Glaucoma: A Preliminary Report

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Purpose/Relevance
To introduce a novel ab interno 360-degree trabeculotomy for treating primary congenital glaucoma (PCG) and juvenile open angle glaucoma (JOAG) and report preliminary results.

Methods
A retrospective chart review of 14 eyes of 10 consecutive patients who presented to Glaucoma Associates of Texas patients who underwent the Gonioscopy Assisted Transluminal Trabeculotomy (GATT) by 4 of the authors (O.S., D.S.G., R.L.F., D.G.G.) between October 2011 and October 2013 was done. The surgery was performed in patients less than 30 years old with a dysgenic anterior segment angle and uncontrolled PCG or JOAG. All the patients had at least 12 months follow-up. The main outcome measures obtained were Intraocular pressure (IOP), glaucoma medications, visual acuity and intra-operative as well as post-operative complications.

Results
Fourteen eyes of 10 patients underwent GATT with follow-up of greater than 12 months (12-33 months; mean 20.4). Patients ranged in age from 17 months to 30 years (mean=18.4 years) and 5 (50%) were female. Post-operative hyphema occurred in 5 (36%) of the eyes, and was all cleared by one month. The mean IOP decreased from 27.3 mmHg to 14.8 mmHg and the mean number of medications required decreased from 2.6 to 0.86. Five eyes had a drop in IOP greater than or equal to 15 mmHg (range 15-39). None of the operated eyes required subsequent pressure lowering surgery.

Discussion
The use of circumferential suture or catheter assisted trabeculotomy has largely replaced limited segmental metal trabeculotomy and is now considered by some specialists to be the gold standard for primary congenital glaucomas. The GATT procedure improves upon conventional ab externo trabeculotomy by avoiding conjunctival and scleral incisions.

Conclusion
The preliminary results and safety for GATT, a minimally invasive conjunctival sparing circumferential trabeculotomy, are promising and at least equivalent to previous results for ab externo trabeculotomy for the treatment of PCG and JOAG. All eyes in the study were considered a clinical success.

References
**Purpose/Relevance**
We compared intraoperative supplemental anesthesia requirements and post-operative patient-reported outcomes (including post-operative pain scale and postoperative pain medication) between patients receiving retrobulbar block (RB) versus topical (T) anesthesia during glaucoma filtering surgery under monitored anesthesia care.

**Methods**
A retrospective, interventional, comparative cohort study. We included 275 patients undergoing glaucoma and combined glaucoma with cataract surgery under monitored anesthesia care performed by two surgeons at a large academic center. The main outcome measures were the difference in intraoperative anesthesia supplements and the post-operative pain scale (1, low, to 5, high) between eyes undergoing topical vs. retrobulbar anesthesia. A secondary analysis was performed between eyes undergoing combined glaucoma vs. cataract surgery and glaucoma surgery alone. Ordered logistic regression analysis was performed using pain score as dependent variable and type of procedure as independent variables and medications used postoperatively.

**Results**
The RB group reported a lower post-operative pain scale than the T group (p=0.024). The amount of IV anesthetics used intraoperatively was also greater in the T group (midazolam, P=0.042; fentanyl, P<0.001; propofol, P<0.001). However, RB patients took more post-operative pain medications (P<0.001). There was no difference in pain scale between eyes undergoing combined vs. glaucoma surgery alone (P=0.707) and also no difference in the amount of IV anesthetics (all P>0.350). They also did not differ in terms of post-operative pain medication (P=0.673).

**Discussion**
Topical anesthesia was associated with a statistically significant higher patient pain scale score average and greater need for intraoperative IV anesthetics. The choice for combined glaucoma surgery did not affect pain scale or intraoperative use of anesthetics.

**Conclusion**
Surgeons should be encouraged to discuss the pros and cons of these procedures with regard to postoperative pain and use of pain killers.

**Reference**
43 Risk Factors for Further Intervention After Initial Angle Surgery for Developmental Glaucoma

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Purpose/Relevance
Evaluate known and unknown risk factors for requiring further intervention after initial angle surgery for infantile developmental glaucoma.

Methods
A retrospective chart review was conducted of 58 eyes from 58 patients undergoing initial angle surgery for infantile glaucoma at Bascom Palmer Eye Institute from January 2005 until July 2012. In bilateral cases, the right eye was selected for analysis. Patients that required glaucoma surgery other than angle surgery (trabeculotomy, goniotomy, or Trabectome) as the initial procedure, and those with non-developmental or aphakic glaucoma were excluded. The main outcome measure was time to failure, and failure was defined as either reoperation (criterion 1) or any intervention (medication or reoperation; criterion 2). Risk factors analyzed included data from baseline examination under anesthesia (EUA), procedural data, and initial followup EUA, including diagnosis, age of presentation/surgery, baseline corneal diameter, presence of corneal edema, extent of angle treated, type of surgery, and intraocular pressures (IOP), axial length (AL), and cup-to-disc ratio (CDR) both before and after surgery. Paired t-tests were used to analyze risk factors for both failure criteria 1 and 2. Kaplan-Meier survival curves of time to failure were also constructed for several variables.

Results
The mean age at surgery was 3.5 (2.7) months. Male/Female ratio was 34/24. The ethnic mix was black (20), caucasian (26), latino (9) and other (3). The diagnoses were primary infantile (46) and secondary infantile (12). There were 52 trabeculotomies, 5 goniotomies, and 1 Trabectome procedure. In the risk factor analysis, reversal of cupping and reversal of axial length on follow-up exams and an initial 360-degree treatment were all associated with a statistically significant (p < 0.05) reduced risk for requiring reoperation and/or medication (both criteria 1 and 2). A diagnosis of primary infantile glaucoma also resulted in lower risk of some intervention (criterion 2), but not reoperation alone (criterion 1).

Discussion
EUA is currently necessary for follow-up of infantile glaucoma patients. In addition to the immediate risk, high cost and inconvenience of EUA, there is growing concern about the long term effects of repeat anesthesia. We have had little data to guide us on the optimal frequency of EUA. In our patients that received 360-degree trabeculotomy, and those who exhibited reversal of cupping or reduction in axial length after surgery, very few required further intervention, and all within one year of initial surgery. We hope this data may help guide clinicians in planning EUAs for their patients.

Conclusion
An initial 360 trabeculotomy resulted in a lower rate of requiring additional intervention for developmental infantile glaucoma. Reversal of cupping and reversal of axial length after treatment were associated with a reduced risk of further intervention. A diagnosis of primary infantile glaucoma conferred reduced risk of further intervention as a whole, but not reoperation alone. This data may help guide clinicians in counseling patients and planning frequency of EUA.

Kaplan Meier = 360 vs < 360 treatment
(p = 0.004, log rank test)

Kaplan Meier = Reversal of Cupping
(p = 0.037, log rank test)
References


44 IOP Lowering Efficacy of Phacoemulsification Cataract-Extraction with Intraocular Lens Implantation Alone (Phaco) Versus Plus Excimer Laser Trabeculotomy (Phaco-ELT) Versus Plus Ab Interno Trabeculotomy with the Trabectome® (Phaco-AIT) – 1 Year Results

MARC TOETEBERG-HARMS¹, Lidija Jozic², Joachim Magner², Jens Funk³
¹ University Hospitals, Dept. of Ophthalmology
² Eye Clinic Ballindamm, Hamburg, Germany
³ University Hospitals Zurich

Purpose/Relevance
The aim of this study is to compare the IOP lowering efficacy among the three procedures within a follow-up period of 1 year.

Methods
This is a prospective case-controlled comparative series. Inclusion criterion was diagnosis of mild and moderate open-angle glaucoma or ocular hypertension with a coexisting and visual impairing cataract. Only one eye of each patient was included, and if both eyes underwent the procedure, one was randomly chosen. Eyes underwent either phaco alone or combined phaco-ELT or phaco-AIT. Primary outcome measures were IOP, number of hypotensive medications (AGD), and Kaplan-Meier survival. Definition of failure was IOP >21 mmHg or <20% reduction of IOP below baseline, hypotony (IOP ≤5 mmHg), or loss of light perception vision.

Results
38 eyes (16 OD = 42.1%; 17 males = 44.7%; mean age 76.0±7.4 years, preop IOP = 16.7±3.8 mmHg; preop AGD = 1.1±0.6) in the phaco, 105 eyes (58 OD = 55.2%; 38 males = 36.2%; mean age 74.8±6.0 years; preop IOP = 17.8±4.3 mmHg; preop AGD = 1.4±0.7) in the phaco-ELT, and 102 eyes (54 OD = 52.9%; 25 males = 24.5%; mean age 74.3±4.9 years; preop IOP = 19.3±4.6 mmHg; preop AGD = 1.3±0.8) in the phaco-AIT group were included (P = 0.375; P = 0.045; P = 0.271; P = 0.004; P = 0.207 respectively). At 1 year, IOP was lowered by 1.5±4.0 mmHg in the phaco alone group, by 4.3±5.6 mmHg in the phaco-ELT group, and by 5.3±4.5 mmHg in the phaco-AIT group, respectively. AGD were lowered by 0.1±0.8 in the phaco alone group, by 0.9±0.8 in the phaco-ELT group, and by 0.8±0.7 in the phaco-AIT group, respectively. The difference in IOP and AGD from baseline to 1 year was highly significant (P < 0.001) when comparing the phaco-ELT or phaco-AIT group with the phaco alone group, but not significant comparing the phaco-ELT with the phaco-AIT group (P > 0.05). Mean time to failure was 13.2±0.4 months in the phaco alone, 20.6±1.0 months in the phaco-ELT, and 12.9±0.6 months in the phaco-AIT group (P < 0.001).

Discussion
The phaco-ELT and phaco-AIT groups had significantly lower mean IOP and required fewer AGD compared with the phaco alone group. Mean IOP and AGD were not significantly different in the phaco-ELT and phaco-AIT groups. However, mean time to failure was significantly longer in the phaco-ELT group.

Conclusion
Phaco-ELT and phaco-AIT are reasonable considerations in mild and moderate cases of glaucoma and ocular hypertension with a coexisting cataract. Phaco-ELT seems to have better long-term survival.

References
45 One-Year Results of an Ab-interno Gelatin Stent in Combination with Mitomycin C for the Treatment of Glaucoma

**DAVINDER S. GROVER**, 1 Juan Batlle 2

1 Glaucoma Associates of Texas
2 Laser Center in Santo Domingo

**Purpose/Relevance**
To establish the safety and efficacy of a minimally-invasive ab-interno gelatin stent in combination with mitomycin C in reducing IOP and glaucoma medications in patients presenting with glaucoma. Mean IOP, IOP change, reduction in medications, and safety were recorded in 122 subjects through 12 months.

**Methods**
In this prospective, non-randomized, multi-center evaluation, enrolled outside the US, safety and efficacy parameters were evaluated using IOP, visual acuity, and assessment of complications. Patients were diagnosed with moderate to severe glaucoma. Types of Glaucoma included Primary Open Angle, Pigmentary, and Pseudoexfoliative. In combination with cataract surgery or as a standalone procedure, a trans-scleral gelatin stent is placed through a self-sealing corneal incision using a preloaded injector similar to those used in IOL procedures. Once in place, the permanent implant is designed to connect the anterior chamber to the non-dissected Tenon’s and subconjunctival space, thereby creating diffuse dispersion of aqueous while bypassing potential outflow obstructions. Effectiveness was assessed by comparing baseline IOP and glaucomatous medications to postoperative values through 12 months.

**Results**
No major adverse events were reported, and 3 patients were converted to incisional glaucoma surgery (Tube (1)/Trabeculectomy (2)) through 12 months. The mean preoperative (best medicated) IOP was 22.2 mmHg. The mean postoperative IOPs were: 14.9 at 6 months, 14.7 at 9 months, and 13.6 at 12 months. The mean decrease in IOP was -8.1 (~33% reduction) at 6 months, -8.1 mmHg (~34% reduction) at 9 months, and -9.6 (~38% reduction) at 12 months. At 6 and 9 month visits anti-glaucomatous medications were reduced by 69% from the preoperative mean of 3.1 (patients not washed out pre-surgery), and by ~63% at 12 months. Figures 1 and 2 summarize the clinical results.

**Discussion**
The preliminary results for this subconjunctival gelatin implant are promising and seem to provide a relatively safe method for controlling IOP in patients with open-angle glaucoma with and without concurrent cataract surgery. In eyes with longer follow up, there appears to be a sustained IOP lowering effect of this implant. Long term data to follow.

**Conclusion**
The clinically proven ab-interno subconjunctival pathway (i.e. trabeculectomy and tube surgeries) combined with the minimally invasive conjunctiva sparing approach of this broadly adoptable implant procedure may provide a safe and effective approach to controlling IOP and reducing medications in patients with glaucoma.
In Combination w/ Cataract

Mean IOP Over Time and Mean % Change in IOP from Best Medicated

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<td>12 Months</td>
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# of Meds | n=65 | n=65 | n=61 | n=55 | n=46 | n=40 | n=22 | n=20 |
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XEN Procedure Only

Mean IOP Over Time and Mean % Change in IOP from Best Medicated

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# of Meds | n=79 | n=79 | n=74 | n=65 | n=60 | n=56 | n=32 | n=25 |
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Reference
46 Long-Term Outcomes and Complications of Pars Plana Baerveldt Implantation in Children with Glaucoma

KATEKI VINOD1, Joseph Panarelli1, Ronald Gentile1, Paul Sidoti1
1 New York Eye and Ear Infirmary

Purpose/Relevance
To report long-term outcomes and complications of Baerveldt glaucoma implant surgery with pars plana tube insertion (ppBGI) in children with glaucoma.

Methods
The medical records of consecutive children (< 16 years) who underwent ppBGI between 1990 and 2013 were retrospectively reviewed. Main outcome measures were visual acuity, intraocular pressure (IOP), and number of required glaucoma medications. Associated anterior segment and posterior segment ocular complications were also noted. Failure was defined as an IOP less than 5 or greater than or equal to 21 mm Hg (with or without glaucoma medications), loss of light perception, or need for additional glaucoma surgery.

Results
Thirty-seven children were identified with a mean age 6.0 ± 4.7 years (range 4 months to 14.5 years). Mean follow-up after ppBGI was 94.4 ± 46.6 months (range 6 months to 16.6 years). The mean IOP for patients with successful IOP control was 12.7 ± 4.0 mm Hg and the mean number of glaucoma medications was 2.0 ± 1.4 at most recent follow-up. Life-table (survival) analysis revealed 1, 5, and 7 year success rates of 97%, 70%, and 43%, respectively. Complications included tube exposure in 1 patient (2.7%), tube obstruction in 8 patients (21.6%), and retinal detachment in 9 patients (24.3%). A total of 18 patients (48.6%) were considered failures due to inadequate IOP control, of whom 9 (24.3%) required additional glaucoma surgery.

Discussion
Despite high success rates during the first few years, ppBGI in children appears to be associated with gradual elevation in IOP in the presence of a functional shunt, consistent with progressive capsular fibrosis. Twenty-four percent of children required a second shunt to achieve IOP control. Long-term complications, such as tube occlusion and retinal detachment, related to delayed posterior hyaloid separation were not uncommon.

Conclusion
Although ppBGI minimizes complications related to anterior chamber placement, such as tube-cornea touch, and is initially safe and effective for managing uncontrolled glaucoma in children in whom angle surgery has failed or is not feasible, surgeons must be aware of the potential need for additional glaucoma surgery and/or posterior segment complications long-term.

Reference
47 Outcomes Two Years After MIGS with Two Trabecular Micro-Bypass Stents, One Suprachoroidal Stent and Travoprost in Patients with Refractory OAG and Prior Trabeculectomy

JONATHAN MYERS
Wills Eye Hospital, Philadelphia, PA,

Purpose/Relevance
Trabecular bypass stent surgery has been shown to be a titratable therapy to manage intraocular pressure (IOP) to ≤15 mmHg in OAG.1 While such therapy can restore natural physiologic outflow, suprachoroidal stents can use the uveoscleral outflow pathway to improve aqueous outflow. Use of trabecular bypass with either a suprachoroidal stent or a topical glaucoma medication may be considered for additional IOP reduction, when needed, such as in refractory open angle glaucoma (OAG). In this study by the Micro-Invasive Glaucoma Surgery (MIGS) Study Group, we reviewed outcomes through 2 years following implantation of 2 trabecular bypass stents and 1 suprachoroidal stent, with postoperatively prescribed travoprost, in eyes with refractory OAG.

Methods
This prospective study enrolled phakic or pseudophakic OAG subjects with IOP >18 mmHg and <45 mmHg on 1-3 hypotensive medications and with prior trabeculectomy. Additionally, unmedicated IOP, following 1-month washout >21 mmHg and <45 mmHg. Subjects received 2 iStents and 1 iStent supra (Glaukos), and were then prescribed travoprost. Postoperative IOP was measured both with medication, and annually following 1-month medication washout periods. Evaluation through 5 years includes BCVA, slit-lamp and optic nerve evaluation, and adverse events (AEs).

Results
Eighty subjects underwent uncomplicated stent implantation, and 34 subjects have reached Month 24. Mean preoperative IOP was 22.0 ± 3.1 mmHg on a mean of 1.2 ± 0.4 medications, and 26.4 ± 2.4 mmHg after medication washout. Mean IOP was 13.6 ± 1.5 mmHg at Month 12 (n=78) and 12.7 ± 1.3 mmHg at Month 24 (n=33), with post-washout IOP of 17.1 at both Months 13 and 25. Six eyes had BCVA loss ≥1 line from baseline due to cataract progression, 1 of whom underwent cataract surgery.

Discussion
Data through 24 months show substantial IOP and medication reduction with a low rate of adverse events.

Conclusion
In this series, sustained reduction in IOP and drug burden and an overall favorable safety profile was shown following 2 trabecular bypass stents, 1 suprachoroidal stent and 1 postoperative medication in subjects with refractory OAG and prior trabeculectomy.

Reference
The Efficacy of Cataract Surgery Combined with Either Endoscopic Cyclophotocoagulation (ECP) or Microbypass Stent, and Cataract Surgery Alone in Open Angle Glaucoma Patients

AVNEET SODHI¹, Bradley Hansen¹, Talisa De Carlo¹, Susan Liang¹, Cynthia Mattox¹

¹ New England Eye Center/Tufts Medical Center

Purpose/Relevance
To compare the effect on IOP and medication use after phacoemulsification alone or combined with 360 degree ECP or single iStent.

Methods
Retrospective chart review of open angle glaucoma patients undergoing cataract surgery between 2008 to 2014. Eyes with similar preop characteristics were treated with either ECP or iStent. Exclusion criteria were co-current filtering surgery, complex surgery, intraop complication, or co-existing disease influencing postop care. Only eyes with minimum 6-month follow-up were included. Glaucoma type, glaucoma control, visual acuity, IOP, number of medications were recorded pre and post op.

Results
A total of 172 eyes of 111 patients were included. After excluding NTG, the preop and 6 month postop mean IOP were 17.8 ± 4.3 and 14.9 ± 2.0 for the phaco alone group; 16.7 ± 3.8 and 15.8 ± 3.9 for ECP; and 15.0 ± 3.8 and 13.3 ± 2.5 for iStent. The absolute IOP reductions from baseline (percent) at 6 months were 3.0 (13.3%) for phaco alone, 0.8 (2.8%) for ECP, and 2.5 (13.5%) for iStent. Phaco alone and iStent has a statistically significant decline in IOP; however, there was no difference in the % IOP change when comparing the groups. Percent of eyes on medication preop and postop 6 were for phaco alone 90.0% and 71.0%; for iStent were 92.7% and 31.5%; and for ECP were 98.0% and 51.3%, respectively. In the phaco alone group, the mean number of medications reduced postop (-0.25 ± 0.13 at 6 months) was not statistically significant, while in both the iStent and ECP groups, there was a similar statistically significant reduction in mean number of meds and % of eyes on meds. Eyes “controlled” preoperatively were more likely to have fewer or no medications after surgery, while eyes that had poor control had a greater % IOP reduction.

Discussion
Reducing medication burden is an important outcome for patients. Preop level of glaucoma control may be able to predict the postop effect on IOP and medication use after surgery.

Conclusion
iStent eyes had significantly decreased IOP and medication use in the short term. Phaco alone reduced IOP but did not reduce medication use.

Reference
49 MicroPulse Trans-scleral Cyclophotocoagulation (mTSCPC) for the Treatment of Glaucoma Using the MicroPulse P3 Device

NATHAN RADCLIFFE1, Steven Vold2, Jeffrey Kammer3, Iqbal Ike Ahmed4, Parag Parekh5, Robert Noecker6, Anup Khatana7

1 New York University
2 Vold Vision
3 Vanderbilt
4 University of Toronto
5 Laurel Eye Clinic
6 Yale School of Medicine
7 Cincinnati Eye Institute

Purpose/Relevance
Standard Trans-scleral Cyclophotocoagulation, performed with the 810 nm diode laser, is an efficacious treatment for refractory glaucoma, however concerns for adverse outcomes such as macular edema, hypotony, and phthisis bulbi have limited widespread adoption of this nonincisional glaucoma therapy. This study evaluated a new glaucoma laser concept intended to deliver MicroPulse laser energy transcerally. The system includes a new laser and a device called the MicroPulse P3 (MP3, Iridex Corporation, Mountain View, CA). In MicroPulse laser mode, brief (e.g., 0.5 ms) laser bursts are followed by slightly longer (e.g., 1 ms) rest periods repeatedly delivered over a longer envelope of time (e.g., 50 sec). This laser application mode theoretically inhibits thermal spread and collateral thermal damage, may lead to enhanced uveoscleral outflow and may be safer and more efficacious than continuous wave. Trans-scleral Cyclophotocoagulation. In this retrospective case series, we present outcomes of patients who have mTSCPC with an 810 nm laser (Iridex) and MicroPulse P3 device (MP3).

Methods
This retrospective series included patients who underwent mTSCPC for glaucoma. Patients received retrobulbar anesthesia followed by two 50-90 second treatments over the superior and inferior hemispheres, sparing the temporal most clock hour. The laser was set on MicroPulse mode with a duty cycle of 31.3% (0.5ms laser bursts followed by 1.1ms rests, repeated throughout the 50-90 second laser application per hemisphere). Topical steroids were prescribed postoperatively and intraocular pressure was monitored.

Results
Forty-two eyes of 39 patients underwent mTSCPC procedure. Mean preoperative IOP was 26.2 ± 11.1 mmHg (42 eyes). Follow up IOP was 17.8±9.0 mmHg at week 1 (n=26, p<0.001), 17.9±6.4 mmHg at month 1 (n=18, p<0.01) and 16.5±6.7 mmHg at month 3 (n=15, p<0.05). IOP reduction ranged from 31.8% at week 1 to 38.1% at month 3. Ocular hypotensive medication usage was reduced from 3.2±1.7 pre-operatively to 2.5±1.6 by postoperative month three (p<0.001). No cases of visually significant hypotony, macular edema or phthisis bulbi were observed, however one patient experienced a > 2 line reduction in visual acuity from worsening of a pre-existing cataract.

Discussion
In this retrospective series mTSCPC had an excellent safety profile for the treatment of glaucoma. While treatment efficacy is difficult to determine in single armed retrospective studies, the effects seen in this series are in line with the pressure reduction achieved from standard TSCPC with less observed post-operative inflammation.

Conclusion
We conclude that the mTSCPC procedure is a new treatment modality that may have promise as a safe treatment for glaucoma and further study is warranted.

Reference
50 Meta-Analysis of Trabeculectomy Ab-Interno Outcomes

NILS A. LOEWEN1, Kevin Kaplowitz2, Igor Bussel1, Joel Schuman1
1 University of Pittsburgh
2 Stony Brook University

Purpose/Relevance
To analyze all of the published English language scientific literature on trabeculectomy ab interno with the Trabectome (Neomedix, Irvine, CA). The primary goal was to determine the overall average Intraocular Pressure (IOP) reduction following the procedure. Secondary goals included calculating complication rates to evaluate the rate of vision-threatening complications.

Methods
For the IOP results, PubMed was searched for “trabectome” and “trabeculectomy ab interno”, and all available papers in any language that had an English language abstract were reviewed and references retrieved. Of the 42 manuscripts on trabectome, only 19 contributed IOP data, and only 12 appeared to have non-overlapping data sets and were included. We performed a meta-analysis on IOP and medication reduction using a random-effects model to achieve conservative estimates and assess statistical heterogeneity. To investigate the rate of serious complications, the expanded search also included all abstracts from AGS, ASCRS and ARVO.

Results
The overall arithmetic mean baseline IOP in the literature for standalone trabectome was 26.71 mmHg ± 1.34 mmHg and decreased by 10.5 ± 1.9 mmHg (39% decrease) on 0.54 ± 0.99 fewer medications. For combined phacoemulsification and trabectome, from an overall mean reported baseline IOP of 21 mmHg ± 1.31 mmHg, the mean decrease was 6.24 ± 1.98 mmHg (27% decrease) on 0.35 ± 0.76 fewer medications. The weighted mean difference (WMD) in IOP from baseline to study endpoint was 9.77 mmHg (95%CI: 8.90 - 10.64) standalone and 6.04 mmHg (95%CI: 4.95 - 7.13) for combined cases (figure). These estimates were statistically significant with marked heterogeneity, likely due to clinical trial variation in sample size, glaucoma subtype, duration of follow-up, and baseline IOP. In terms of serious complications, there were 4 cases of aqueous misdirection (0.039% of all published cases), 6 cases of cyclodialysis cleft (0.058%) with only one noted to require further treatment, 3 postoperative IOP spikes associated with hyphema requiring surgical intervention (0.029%), one choroidal hemorrhage (0.01%) and one case (0.01%) of endophthalmitis after a combined phacoemulsification where the culture grew Enterococcus faecalis.1,2

Discussion
Trabectome can be expected overall to lower the IOP by approximately 31% to a final average IOP of approximately 15 mmHg, with a low rate of serious complications.

Figure: Weighted-mean difference (WMD) of the reduction in IOP between baseline and final measurements by trabectome alone (a), phacoemulsification combined with trabectome (phaco-a), and the trial which only reported one set of results for both standalone and combined cases (combined).
Conclusion

Trabeculectomy ab interno with the trabectome is a mature surgical technique with an extensive body of experience since 2004. The rate of visually-threatening complications is <1%.

References


The Effect of No-Sponge vs. Sponge Placement of Mitomycin C on Outcomes of Trabeculectomy with Ex-PRESS Shunt: Interim Report

Amanda Kielty, Ninita Brown, Sandra Stinnett, Leon W. Herndon, Jr., MD
Duke Eye Center

Purpose/Relevance
To present interim results of an investigation into the impact of mitomycin-C (MMC) placement technique on Ex-PRESS trabeculectomy outcomes.

Methods
This is a prospective randomized study of 100 eyes undergoing trabeculectomy with Ex-PRESS shunt. Sub-Tenon’s MMC is applied by either infusion through a limbal peritomy or placement of 4 soaked sponges; surgical technique is otherwise uniform. Inclusion criteria are chronic open-angle or angle-closure glaucoma, phakia or pseudophakia, and suitability for superonasal Ex-PRESS trabeculectomy. Patients are classified by age, pre-operative intraocular pressure (IOP), and simultaneous cataract extraction, and assessed 1 day, 2 & 4 weeks, and 2, 3 & 6 months post-operatively. The primary outcome is surgical failure, defined as (a) anatomical bleb failure, (b) IOP >15, (c) restarting IOP-lowering medications or (d) requiring needling. Other outcomes are IOP, bleb morphology described with the Indiana Bleb Morphology Grading Scale, need for laser suture lysis, and complications.

Results
To date, 30 patients have enrolled, of whom 16 are ≥65y, with pre-op IOP <28, undergoing concurrent cataract extraction. Only these are considered in this interim analysis. Average ages at study entry are 70.6(±5.2) and 75.3(±3.6) years, pre-operative IOPs 18.86(±6.12) and 14.44(±3.32) mmHg, and MMC application times 2.3(±0.8) and 2.4(±0.9) minutes in the no-sponge and sponge groups respectively; none of these differences is statistically significant. Failure rates in the two groups are not significantly different: 1/7 and 2/9 for no-sponge and sponge cases. There is a trend towards greater IOP lowering in the no-sponge group, with average IOP reduction 7.7(±2.3) mmHg vs. 2.7(±5.1)mmHg at 3 months; this difference is statistically significant at 2 months (p=0.048). 4/7 no-sponge blebs have required suture lysis, compared to 3/9 sponge blebs; this difference is not significant. Likewise, bleb morphology does not differ significantly between the groups. Complications have been uncommon and do not differ significantly between the groups.

Discussion
The impact of MMC application technique on trabeculectomy outcomes has not been well-characterized. In this interim analysis, we find greater IOP lowering at 2 months with a no-sponge technique and no difference in rates of failure or complications.

Conclusion
Placing MMC via sub-Tenon’s infusion rather than sponges may improve IOP reduction.

References
52 Baerveldt Glaucoma Implant Comparison Study (250-mm² vs 350-mm²)

ABRAHAM SUHR¹, Charisma Evangelista¹
¹ San Antonio Military Medical Center

Purpose/Relevance
To compare surgical outcomes of two differently sized glaucoma drainage devices.

Methods
This retrospective study compared the outcomes of two glaucoma drainage devices (Baerveldt Glaucoma Implant (BGI) 250-mm² vs 350-mm², Abbott Medical Optics Inc.) implanted by a single surgeon in adult patients from Jan 2007 – Nov 2013 at the San Antonio Military Medical Center. Outcome measures were intraocular pressure (IOP), visual acuity, number of glaucoma medications and frequency of postoperative complications. Surgical success was defined as intraocular pressure (IOP) ≥ 6 mm Hg and ≤ 21 mm Hg, no further glaucoma surgery, and no loss of light perception postoperatively. Complete success was defined as above without glaucoma medications.

Results
105 eyes met the inclusion criteria. Among these, 57 received the 250-mm² implant, while 48 received the 350-mm² implant. The mean follow-up was 21.4 (SD ± 15.7) months. At one year after surgery, there was no statistical difference in mean IOP in both implants (13.5 ± 4.3 in the 250-mm² group vs 13.5 ± 4.5 in the 350-mm² group, p = 0.804). Cumulative success rates were similar at one year (77.9% ± 5.7% in the 250-mm² group vs 78.2% ± 6.1% in the 350-mm² group) as well as complete success rates (17.5% in the 250-mm² group and 14.5% in the 350-mm² group). Visual acuity, number of glaucoma medications, and complications between implants were also not statistically different (p>0.05).

Discussion
At one year after surgery, the postoperative outcomes of the 250-mm² and 350-mm² implants were similar.

Conclusion
It has been suggested in the past that a larger end plate surface area of a glaucoma drainage implant may result to more IOP reduction. However, there appears to be an upper limit beyond which an increase in surface area may not improve success rates. We found that at one year after tube shunt surgery, the smaller BGI (250-mm²) appeared to show similar postoperative outcomes as the larger implant (350-mm²). This is the first study directly comparing the outcomes of these two implant sizes in a diverse population.

Reference
The Interaction of Primary Human Trabecular Meshwork Cells with Metal Alloy Candidates for Micro-invasive Glaucoma Surgery

CINDY HUTNIK¹, Kelsey Watson², Wendy (Wan) Wang², Hong Liu², Amin Rizkalla², S. Jeffrey Dixon²
¹ Ivey Eye Institute
² Western University

Purpose/Relevance
To determine the effect of candidate metal alloys for ab-interno microstenting on human trabecular meshwork cell (HTMC) morphology, viability and function.

Methods
HTMCs were cultured on the surface of titanium and a titanium-nickel (nitinol) alloy, with glass as control substrata. Fluorescent imaging studies were conducted to assess cell morphology and spread. Additionally, a lactate dehydrogenase (LDH) cytotoxicity assay, cell death detection ELISA, Caspase 3 cellular apoptosis assay, fibronectin ELISA, BrdU cell proliferation assay, and MTT cell proliferation assay were conducted to assess cell viability and function.

Results
Cells cultured on the sandblasted titanium surface had significantly greater cell spreading (p=0.012) than the cells cultured on other substrata. HTMCs on the nitinol and HydrusTM Microstent surface showed little spread. Moreover, HTMCs cultured on the machine polished titanium and nitinol followed a parallel growth pattern along the surface grooves. Cell death by both necrosis (p=0.0131) and apoptosis (0.0121) was greater on the nitinol compared to titanium surfaces. Also, less cellular metabolic activity (p = 0.0194) and proliferation (p=0.0429) occurred on the nitinol surface than titanium or glass. Finally, HTMCs on both titanium and nitinol produced higher amounts of fibronectin than cells grown on the glass control (p=0.0033).

Discussion
Small metallic stents are now being inserted into the trabecular meshwork via an ab interno approach to increase the drainage of aqueous humour. It has been predicted that this microsurgical stent approach may become an important option in glaucoma management due to its favourable side effect profile. Remarkably, there have been no published studies on the effect of the metal alloys used in the stents on human trabecular meshwork cells (HTMCs). This study reports on the biocompatibility of two common metal alloys with primary cultures of human trabecular meshwork cells.

Conclusion
The elemental composition and texture of a metal surface impact the functional and morphological properties of HTMCs and identify cellular effects that may influence short- and long-term function of micro-invasive glaucoma shunts.

References
SACHI R. PATEL, Anna Silverman, Shamil Patel, George Reiss

1 George R. Reiss, MD PC

Purpose/Relevance
To compare the surgical outcomes of the Baerveldt 250 mm² shunt and the Molteno 185 mm² shunt.

Methods
Retrospective, dual surgeon comparative case series of 223 eyes that underwent glaucoma shunt surgery for uncontrolled glaucoma (all diagnoses included). 128 eyes underwent placement of a Molteno 185 mm² shunt, and 95 eyes underwent placement of a Baerveldt 250 mm² shunt. The primary outcomes measured were change in intraocular pressure, change in postoperative medications, complication rates, and surgical success. Surgical success was defined by an IOP between 5 mmHg and 21 mmHg and a reduction in medications greater than 20%, without additional surgical intervention or loss of light perception vision.

Results
Average follow up was 13.23 ± 9.50 months for the Baerveldt 250 mm² group and 7.27 ± 5.25 for the Molteno 185 mm² group. The mean IOP reduction was 44.81% ± 30.23 for the Baerveldt group and 36.57% ± 46.59 for the Molteno group. The mean medication reduction was 54.27% ± 54.27 for the Baerveldt group and 51.34% ± 50.27 for the Molteno group.

Comparison analysis by Tukey-HSD and T- test demonstrated no significant difference in mean intraocular pressure, change from baseline intraocular pressure, adjunctive use of glaucoma medications, complication rates, or surgical success rates at current follow-up duration. When stratified based on race and age, 2 significant differences were found between the two groups. The Molteno shunt significantly reduced medication dependence in the “Other” ethnicity group in comparison with the Baerveldt shunt. The Baerveldt shunt had a statistically significant greater percent reduction in IOP for patients over the age of 65 in comparison to the Molteno group. There was no difference in comfort or diplopia rates between the groups.

Discussion
Surgical outcomes after insertion of the Molteno 185 mm² and Baerveldt 250 mm² are not statistically different in regards to mean IOP reduction, medication reduction, and complication rates at this follow up interval.

Conclusion
The Baerveldt 250 mm² and Molteno 185 mm² shunts offer similar success rates. Given the ease of insertion and lack of muscle manipulation, Molteno 185 mm² may be used without concern of reduced success in the short-term in comparison to the Baerveldt 250 mm². The Baerveldt 250 mm² did achieve statistically greater IOP reduction in patients above 65. Further, long-term follow up will help further stratify patients that may respond better to a particular shunt model. Long-term follow up will be continued to determine stability of success rate.

Reference
55  Supra-Tenon Capsule Placement of Baerveldt Implant

**AILEEN SY**, George Tanaka
1 California Pacific Medical Center

**Purpose/Relevance**
Placement of glaucoma drainage devices (GDD) has traditionally been beneath the Tenon capsule. Freedman and associates have reported that supra-Tenon placement of the Molteno glaucoma implant reduces fibrotic reaction from the Tenon tissue at the filter site and is effective in patients with previously failed implants, with improved intraocular pressure control and more effective bleb formation. No studies have investigated supra-Tenon versus infra-Tenon placement of the more widely used Baerveldt GDD. The aim of this study was to compare the efficacy of supra-Tenon capsule placement of the 250 sq mm Baerveldt implant to traditional infra-Tenon capsule placement of the 350 sq mm Baerveldt in the management of refractory glaucoma patients.

**Methods**
A retrospective chart review was performed on patients having Baerveldt GDD surgery by a single surgeon (G. Tanaka).

**Results**
Thirty-one cases of infra-Tenon (IT) Baerveldt GDD placement were identified from June 2012 to June 2013. Twenty-nine cases of supra-Tenon (ST) placement were identified from March 2013 to March 2014. There were no statistical differences in pre-operative age, gender, intraocular pressure (IOP), visual acuity (VA), number of IOP lowering medications, or follow-up time between the two groups. Mean post-operative IOP was 12.2 (median 12) in the ST group and 13.6 (median 13) in the IT group ($p=0.32$), and mean number of postoperative medications required was 0.86 (median 0) in the ST group and 1.45 (median 1) in the IT group ($p=0.11$). A 0.22 logMAR improvement in VA was seen post-operatively in ST group, whereas a 0.23 logMAR worsening in VA was seen post-operatively in IT group ($p=0.04$).

**Discussion**
The preliminary results demonstrate supra-Tenon capsule placement of the Baerveldt implant not only adequately controls IOP, but may result in improved VA outcomes with a trend towards lower IOP and fewer IOP lowering medications post-operatively.

**Conclusion**
The results of this study suggest supra-Tenon capsule placement of the Baerveldt implant may be superior to traditional infra-Tenon capsule placement.

**References**
56 Treatment Outcomes of Micropulse Transscleral Cyclophotocoagulation in Advanced Glaucoma

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1 Wills Eye Hospital

Purpose/Relevance
To describe our experience with micropulse transscleral cyclophotocoagulation (MP-TSCPC).

Methods
A pilot case series of 11 consecutive patients with advanced glaucoma who underwent MP-TSCPC. Laser settings were 2000mW of 810nm infrared diode laser on micropulse delivery mode (IRIDEX IQ810 Laser Systems, CA). The laser was delivered over 360° for 100-160s. The duty cycle was 31.3%, which translated to 0.5ms of “on” time and 1.1ms of “off” time. Total energy delivered to each eye ranged from 62.6-100.2J. The last four patients in the series had a paracentesis for short-term intraocular pressure (IOP) control. IOP, pain, number of glaucoma medications, visual acuity (VA) and complications were assessed at postoperative visits.

Results
Eleven patients ranging from 59 to 86 years underwent MP-TSCPC with 1 to 4 months follow up. Mean IOP dropped from 38.9mmHg preoperatively to 15mmHg at last follow up, representing a 61.4% decrease. Mean number of glaucoma medications decreased from 2.64 preoperatively to 1.55 postoperatively. No patient reported pain. No patient lost vision. One patient had persistently elevated pressures and required subsequent tube shunt surgery. One patient had hypotony without associated complications.

Discussion
Traditionally TSCPC is reserved for end-stage glaucoma due to the higher rate of serious complications. Micropulse delivery allows energy to build up to the coagulative threshold in targeted pigmented tissues during the “on” cycles. Adjacent non-pigmented tissue cools during the “off” cycle and does not reach the coagulative threshold. Collateral tissue damage is minimized, resulting in fewer complications without sacrificing efficacy.1,2 Our series is limited by small sample size and short follow up, however our preliminary results are favorable and agree with the results of Tan et al.1

Conclusion
Preliminary experience with MP-TSCPC for advanced glaucoma is encouraging and warrants further long-term evaluation and comparison to the traditional continuous mode.

References
**57 Intermediate-term Results of the GATT Procedure in Eyes with Prior Incisional Glaucoma Surgery**

**DAVID GODFREY**, Davinder Grover, Ronald Fellman, Oluwatosin Smith, Michelle Butler, Matthew Emanuel

1 Glaucoma Associates of Texas

**Purpose/Relevance**
To describe results of the GATT procedure in eyes with prior incisional glaucoma surgery. Additionally, to investigate the IOP lowering effect, risk profile, and postoperative complications in this group.

**Methods**
This retrospective, IRB-approved chart review at Glaucoma Associates of Texas analyzed data of 35 eyes that underwent a GATT procedure for the treatment of refractory glaucomas, including eyes with prior trabeculectomy (n=17), prior tube (n=13), prior Trabectome (n=4), Express Shunt (n=4), and prior ECP (n=5). Intraocular pressure (IOP), number of IOP lowering medications, visual acuity, complications, and secondary procedures were recorded at baseline, 1 day, 1 week, and 1, 3, 6, 12, 18, 24, and 36 months postoperatively.

**Results**
The pre-operative mean (SD) IOP was 25.7 (6.5) mmHg on 3.2 (1.0) medications, which decreased to 15.9 (4.0) mmHg \(p=0.001\) on 2.3 (1.5) medications \(p=0.004\) at 18 months. Mean follow-up time is 21.2 (range 6-31) months. At post-operative week one, 12 (34%) eyes had a transient layered hyphema (the most common complication), and one eye had a vitreous hemorrhage at 1 month. There was no difference between pre- and post-operative visual acuity. Eyes with prior cataract extraction were at higher risk for failure \(p=0.051\). Cumulative proportions of failure (with either reoperation and IOP not lowered by 20%) were 6, 20, and 30% at 6, 12, and 18 months respectively.

**Discussion**
The GATT procedure, a minimally invasive conjunctival sparing circumferential trabeculotomy, is effective in lowering IOP in primary glaucomas. Options for eyes that fail external filtration surgery include further trabeculectomy or drainage implants, or cyclodestruction. Eyes having the GATT procedure after prior incisional glaucoma surgery fared well with good IOP control and low complications, offering a minimally invasive alternative for refractory glaucomas.

**Conclusion**
The GATT procedure is effective in reducing IOP in patients with refractory glaucomas, with an excellent safety profile.

**References**

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**58 Trabeculotomy Ab-Interno (Trabectome) in Patients with Very High Pre-operative Intraocular Pressure**

**BRIAN FRANCIS, Ramya Swamy**

1 UCLA

**Purpose/Relevance**
To evaluate the safety and efficacy of Trabectome procedure in patients with pre-operative IOP of 30 mmHg or higher.

**Methods**
All patients that had undergone Trabectome stand alone or Trabectome combined with phacoemulsification were included. Those that had pre-operative IOP of less than 30 mmHg or less than 6 months of follow-up were excluded. Main outcome measure included IOP, number of glaucoma medications and secondary glaucoma surgery, if any. Survival analysis was performed by using Kaplan-Meier and success was defined as IOP\(\leq 21\) mmHg, 20% or more IOP reduction from baseline for any two consecutive visits after 3 months and no secondary glaucoma surgery.

**Results**
A total of 49 cases were included with an average age of 66 (Range: 13-91). Majority were Caucasians (63%) diagnosed with POAG (49%). 28 cases had Trabectome stand-alone and 21 cases had Trabectome combined with phaco. Mean IOP was reduced from a baseline of 35.6±6.3 mmHg to 16.8±3.8 mmHg (53% reduction) at 12 months \(p<0.01^*\), while number of medications were reduced from 3.1±1.3 to 1.8±1.4 (42% reduction; \(p<0.01^*\)). Survival rate at 12 months was 80%. 9 cases required secondary glaucoma surgery and 1 case was reported with hypotony at day one, but resolved within one week.

**Discussion**
The reduction in IOP and number of glaucoma medications were found to be statistically significantly different. IOP on average was reduced by 53% after 12 months and number of glaucoma medications was reduced by 42%. Other than secondary glaucoma surgery and hypotony at post-operative day one, no serious complications was reported.

**Conclusion**
Trabectome appears to be safe and effective in patients with pre-operative IOP of 30 mmHg or greater. Even in this cohort with high pre-operative IOP, the end result is a mean IOP in the physiologic range.

**Reference**
59 Safety and Efficacy of Trabectome in Uveitic Glaucoma

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2 Edward S. Harkness Eye Institute

Purpose/Relevance
Glaucoma secondary to uveitis is a serious complication of intraocular inflammation and consequent chronic steroid use. Uveitic glaucoma is a challenge to manage clinically and surgically. The study provides evidence about the use of a minimally invasive procedure that is effective at lowering intraocular pressure.

Methods
All patients diagnosed with uveitic glaucoma and with at least 12 months follow-up were included in the study. All patients have received Trabectome alone or combined with phacoemulsification. Major outcomes include intraocular pressure (IOP), number of glaucoma medications and need for secondary glaucoma surgery. Kaplan-Meier was used for survival analysis and success was defined as IOP $\leq 21$ mmHg, at least 20% IOP reduction from baseline for any two consecutive visits after 3 months and no secondary glaucoma surgery and no additional glaucoma medication.

Results
A total of 31 cases with an average age of 52 (Range 30-74) were included in the study. Majority were Hispanics (48%) and underwent Trabectome alone (77%). IOP was reduced from 30.2±7.1 mmHg to 18.4±6.2 mmHg at 12 months (p<0.01*), while number of glaucoma medications were reduced from 3.9±0.9 to 3.0±1.5 (p=0.1). Survival rate at 12 months was 71%. 8 cases required secondary glaucoma surgery and no other serious complication was reported.

Discussion
Uveitic glaucoma is a complex condition that is often difficult to manage. Additionally traditional surgical procedures such as trabeculectomy with mitomycin-C and aqueous drainage implants have lower rates of success in cases of uveitic glaucoma when compared to other forms of glaucoma such as primary open angle glaucoma. Trabectome offers a minimally invasive method for controlling IOP in this population with additional benefit of lowering number of IOP lowering topical medications.

Conclusion
The Trabectome procedure appears to be effective in reducing IOP in uveitic glaucoma patients since IOP was significantly reduced from prior. Additionally a trend was noted towards decreased glaucoma medications in the group that underwent treatment.

References
60 Phaco-iStent No Steroids Study: How Does Topical Corticosteroid Therapy Affect The Early Postoperative IOP Profile of Patients Undergoing Combined Cataract Surgery and Trabecular Micro-bypass Surgery?

AARON WINTER1, Cody Li2, Paul Harasymowycz3, Hady Saheb4
1 Dalhousie University
2 Queen’s University
3 University of Montreal
4 McGill University

Purpose/Relevance
To evaluate and compare the early postoperative outcomes of trabecular micro-bypass stents and concomitant cataract surgery with and without postoperative corticosteroid therapy.

Methods
Retrospective interventional matched comparative case series comparing outcomes of open angle glaucoma patients that underwent trabecular micro-bypass stents and concomitant cataract surgery with and without postoperative corticosteroid therapy. Subjects were matched for preoperative intraocular pressure (IOP) at a 1:1 ratio, within prespecified 3mmHg intervals. Primary endpoint: IOP changes up to 6 months postoperatively. Secondary endpoints: number of postoperative medications, IOP spikes, peripheral anterior synechiae (PAS) and visual acuity (VA) improvements.

Results
104 patients (52 per group) were analyzed. Mean IOP in mmHg at baseline, 1 week, 3 weeks, 3 months, and 6 months were 16.1 ± 3.9, 16.8 ± 7.0, 16.3 ± 6.5, 14.5 ± 3.1, 13.5 ± 2.9 in non-steroid group and 16.4 ± 5.1, 17.4 ± 8.1, 16.1 ± 5.1, 14.3 ± 5.3, 14.1 ± 4.3 in the steroid group; no significant difference was found at individual time points between groups. IOP at 6 months decreased significantly from baseline (P<0.01 for both). Steroid group had higher number of IOP spikes (n=9) compared to non-steroid group (n=3, P=0.05). There was no significant difference in postoperative PAS; steroid group (n=9) vs. non-steroid group (n=11, P=0.3). Mean number of medications decreased from 2.5 ± 1.3 at baseline to 0.5 ± 1.0 at 6 months in the non-steroid group and from 2.4 ± 1.3 to 0.8 ± 1.0 in the steroid group (P<0.01 for both). VA in logMar improved from 0.27 ± 0.28 to 0.14 ± 0.10 in the non-steroid group (P<0.01) and from 0.21 ± 0.23 to 0.16 ± 0.26 in the steroid group (P=0.02).

Discussion
Trabecular micro-bypass stents and concomitant cataract surgery appears to decrease IOP and number of glaucoma medications. The use of steroid therapy in the early postoperative period may predispose to more IOP spikes; however it does not appear to cause significant differences in IOP or number of glaucoma medications.

Conclusion
Use of steroids for postoperative control of inflammation does not appear to lead to negative IOP and medication use outcomes following combined cataract and trabecular micro-bypass surgery.

Reference
Comparison of Post-operative Intraocular Pressure Spikes in Femtosecond Laser-assisted Cataract Surgery to Phacoemulsification Alone in Glaucomatous and Non-glaucomatous Eyes

PHILIP NILES¹, Charles Niles²
¹ University of Iowa
² State University of New York at Buffalo

Purpose/Relevance
Elevated intraocular pressure (IOP) is the most frequent postoperative complication demanding treatment following phacoemulsification. Our study compares the risk of IOP spikes on the post-operative day 1 between glaucomatous and non-glaucomatous eyes that underwent femtosecond laser-assisted cataract surgery (FLCS) to those that underwent phacoemulsification cataract extraction alone.

Methods
100 consecutive eyes that underwent FLCS and 100 consecutive eyes that underwent phacoemulsification alone were monitored for post-operative changes in IOP. IOP was measured within the month preceding surgery and on post-operative day 1. An IOP spike was defined as an increase of ≥ 10 mmHg.

Results
23 glaucomatous eyes and 77 eyes without glaucoma underwent FLCS. 22 glaucomatous eyes and 78 eyes without glaucoma underwent phacoemulsification alone. The average IOP increases were: 0.21 mmHg in eyes without glaucoma and phacoemulsification alone, 0.04 mmHg in eyes without glaucoma that underwent FLCS, 0.41 mmHg in eyes with glaucoma and phacoemulsification alone and 2.43 mmHg in eyes with glaucoma and that underwent FLCS (p > 0.05). The incidences of IOP spikes were: 1.3% in non-glaucomatous eyes that underwent phacoemulsification alone, 2.6% in non-glaucomatous eyes that underwent FLCS, 13.6% in glaucomatous eyes that underwent phacoemulsification alone and 17.4% of glaucomatous eyes that underwent FLCS (p > 0.05).

Discussion
Though our data did not reach statistical significance, our data suggests that glaucomatous eyes that underwent FLCS may have an increased risk of experiencing a post-operative IOP spike compared to eyes that underwent phacoemulsification alone.

Conclusion
Our study suggests that there may be a greater risk of experiencing a spike in IOP with FLCS compared to phacoemulsification alone in glaucomatous patients. Further investigation with a larger sample size may be warranted to determine if there is a greater risk of experiencing a spike in IOP with FLCS, and whether this should affect patient selection.

References
Use of Subconjunctival 5-Fluorouracil Injections to Rescue a Failing Ahmed

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¹ Stony Brook University
² Center for Advanced Eye Care Westchase
³ Yale
⁴ NY Eye and Ear Infirmary of Mount Sinai

Purpose/Relevance
Unlike for trabeculectomy, intraoperative antimetabolite use did not improve long-term Intraocular Pressure (IOP) outcomes for aqueous shunts in at least 2 major studies.¹,² Although needling with antimetabolites has been demonstrated to improve the IOP with a failing aqueous shunt,³ previous studies have been relatively small with short follow-up. Once an aqueous shunt begins to fail, common options include revising the plate or reoperating. The purpose of this study is to determine if subconjunctival 5-Fluorouracil (5-FU) injections over an Ahmed plate can prolong survival and rescue a failing Ahmed.

Methods
This retrospective chart review included all patients with an Ahmed FP-7 implantation by a single surgeon (JCT) from 2007-2013. Exclusion criteria included usage of another type of aqueous shunt or <3 months of follow-up. The control group received Ahmed FP-7 without 5-FU or needling. The indication for 5-FU was determined on a case-by-case basis but usually done for an IOP>21 on >2 medications. The standardized 5-FU injections consisted of 0.75mg injected over the plate with a 30-gauge ½” needle. The main outcome measure was IOP. Success was defined as final IOP >=20% below baseline and < 21 mmHg, while avoiding reoperation.

Results
The mean age of the control group (n=45) was 72.5±16.6 years and 63.7±18.8 in the 5-FU group (n=44), p=0.04. Mean preoperative IOP with 5-FU was 31.9±9.0 on 3.3±0.9 medications and 31.5±7.1 mmHg on 3.1±1 medications in the control group, p=0.86. The mean time between surgery and first 5-FU injection was 137 days. Five years following aqueous shunt implantation, the control group IOP averaged 12.9±7.1 mmHg (53% decrease from preoperative IOP) on 1.4±1.1 medications while the 5-FU group averaged 17.2±4.9 mmHg (46% decrease from preoperative IOP, 32% decrease from pre 5-FU IOP) on 2.7±0.8 medications (Table). The IOP at 5 years in the 2 groups was statistically similar, p=0.23. Kaplan-Meier survival curves at 5 years trended higher with 5-FU (77% vs 67%, p=0.38).

Discussion
Subconjunctival 5-FU injections were able to rescue a failing Ahmed shunt, sustaining a 32% IOP decrease from pre 5-FU IOP and a 46% decrease from preoperative IOP after 5 years.

Conclusion
Subconjunctival 5-FU injections were able to rescue a failing Ahmed shunt with a 77% success rate at the end of 5 years, and represent a viable alternative to tube revision or reoperation.

Survival defined as >20% IOP reduction with IOP <21mmHg comparing Controls to 5FU Cases

Figure 1
<table>
<thead>
<tr>
<th>Time</th>
<th>Controls</th>
<th></th>
<th>5-FU</th>
<th>P-value</th>
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<tr>
<td></td>
<td>n</td>
<td>IOP (mmHg)</td>
<td>95% CI</td>
<td>n</td>
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<tr>
<td>Preop</td>
<td>45</td>
<td>31.5±11.0</td>
<td>28.2, 34.8</td>
<td>44</td>
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<tr>
<td>Pre 5-FU</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>44</td>
</tr>
<tr>
<td>6 months</td>
<td>44</td>
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<td>11.9, 15.1</td>
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<td>12 months</td>
<td>37</td>
<td>13.1±5.2</td>
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<td>48 months</td>
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<td>60 months</td>
<td>7</td>
<td>12.9±7.1</td>
<td>6.3, 19.4</td>
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</table>

Table – Intraocular Pressure (IOP) in Ahmed implantation with versus without 5-FU injections

References
63 The Effect of Mitomycin C and 5-Fluorouracil Adjuvant Therapy on the Outcomes of Ahmed Valve Implantation

QI CUI1, Yen-Cheng Hsia1, Nitisha Mehta1, Ayman Naseri1, Ying Han1
1 University of California, San Francisco

Purpose/Relevance
To examine the effect of adjunctive mitomycin c (MMC) and/or 5-flourouracil (5-FU) on intraocular pressure (IOP) control and treatment outcomes following Ahmed valve implantation.

Methods
Electronic medical records from patients who received Ahmed valve implantation from 1999–2014 in the San Francisco Veteran’s Administration hospital were reviewed. None of the Ahmed valves implanted before and during 2011 received adjuvant treatment with anti-fibrotic agents whereas all valves implanted after 2011 received injections of MMC and/or 5-FU. IOP, BCVA, and the number of glaucoma medications were recorded and compared between groups at the pre-operative visit, and at post-operative time points of one month, 3 months, 6 months, and one year. The number and types of early (occurring ≤ one month post-operation) and late (occurring > one month post-operation) complications were also recorded. The rates of treatment failure, defined as reoperation for glaucoma, or as two consecutive visits after 3 months in which the patient had inadequately reduced IOP (IOP > 21 mm Hg or < 20% reduction below pre-operative baseline), were calculated for each group.

Results
The +injection group included 38 patients and 44 eyes, and the -injection group included 21 patient and 22 eyes (Table 1). Pre-operative IOP and the number of glaucoma medications were comparable between groups (Table 2). At post-operative month one, IOP and the number of glaucoma medications were significantly lower in the +injection group (p=0.04 and 0.002, respectively) compared to the -injection group (Table 2). The rates of treatment failure were similar between groups (Table 2). The rates of early and late complications were also similar between groups (Table 2). The average logMAR visual acuity at post-operative month one was significantly lower in the +injection group compared to the -injection group (p=0.008). The average number of glaucoma drops at post-operative month one was significantly lower in the +injection group compared to the -injection group (p=0.002).

Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of subjects/Number of eyes</th>
<th>Age (Mean ± SD; years)</th>
<th>Sex (Male/Female)</th>
<th>Laterality (OD/OS)</th>
<th>Diagnosis (POAG/MMG/CACG/PMG/Other)</th>
<th>Previous Glaucoma surgery (eyes)</th>
<th>Number of MMC/5-FU injections (Mean ± SD)</th>
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<tr>
<td>MMC or 5-FU (+injection)</td>
<td>38/44</td>
<td>70.8 ± 10.3</td>
<td>38/0</td>
<td>25/19</td>
<td>28/3/2/3/8</td>
<td>10</td>
<td>4.5 ± 2.0</td>
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<tr>
<td>None (-injection)</td>
<td>21/22</td>
<td>70.6 ± 13.7</td>
<td>20/1</td>
<td>14/8</td>
<td>13/2/2/1/4</td>
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Table 2

<table>
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<th>None (-injection)</th>
<th>P-Value</th>
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<tr>
<td></td>
<td>Number of eyes</td>
<td>Average IOP</td>
<td>SD IOP</td>
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<tr>
<td>Pre-operation</td>
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<td>28.23</td>
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<tr>
<td>1 month</td>
<td>44</td>
<td>13.62</td>
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<tr>
<td>Pre-operation</td>
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<td>Average logMAR</td>
<td>SD logMAR</td>
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<tr>
<td>1 month</td>
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<td>0.53</td>
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<td>3 months</td>
<td>0.58</td>
<td>0.57</td>
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<td>6 months</td>
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<td>12 months</td>
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<td>Pre-operation</td>
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<td>Average number of glaucoma drops</td>
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<td>12 months</td>
<td>1.2</td>
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respectively). IOP and the number of glaucoma medications were comparable between groups at all other post-operative times points. The rates of early complications were comparable, with 16 (36%) and 10 (45%) eyes in the +injection and -injection groups, respectively. While 5 eyes (12%) experienced late complications in the +injection group, a single (5%) late complication was noted in the -injection group (p<0.05). For eyes with follow-up duration of 12 months, treatment failure occurred in 7 eyes in both groups (20% for +injection and 37% for -injection; p<0.05).

Discussion
Compared to patients who did not receive either MMC or 5-FU injections, the use of anti-fibrotics was associated with blunting of the hypertensive phase and fewer treatment failures but more late complications during a follow-up duration of 12 months.

Conclusion
This study suggests that anti-fibrotics may have a role in Ahmed valve implant surgery.

References
64 Ahmed Valve Revision in Pediatric Glaucoma

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Purpose/Relevance
Encapsulation of the Ahmed glaucoma valve (AGV) plate is a common cause for postoperative elevation of intraocular pressure. Many reports describe the outcomes of AGV revision in adults by the outcomes of revision in children are poorly documented. The study was designed to determine the short-term outcomes of AGV revision in children.

Methods
A retrospective chart review of patients less than 15 years in age who underwent AGV revision with a minimum postoperative follow-up of six months. Outcomes measures included reduction in intraocular pressure from baseline and reduction in the number of glaucoma medications. Postoperative complications were also noted. Complete success was defined as an IOP of 21 mmHg or less without medications, and qualified success was defined as an IOP of 21 mmHg or less with medications.

Results
A total of 44 eyes which met the inclusion criteria with the diagnosis of congenital Glaucoma (35 eyes; 79.5%), Aphakic Glaucoma (4 eyes; 9.1%), and Peter’s anomaly associated Glaucoma (1 eye; 2.3%). The mean number of previous surgery was 1.4, and the mean age was 6.7 years (range 1.9 – 13 years) with a median follow up 12 month, ranges from 6 to 24 months. The IOP was reduced from a preoperative mean of 30.4 ± 10.3 to 24.9 ± 10.6 mmHg at 6 months postoperatively, with an overall success rate of 55 %; qualified success rate of 50% and complete success in 5% at the last visit. The most common complication was reformation of encapsulated cyst with elevated IOP (15.9%). Other complications included Hyphema (n=3), Endophthalmitis (n=1) wound leak (n=1) and Choroidal detachment (n=2).

Discussion
Through the complete success rate of AGV revision in children was not encouraging, a modest qualified success was noted short term considering the complex surgical history in these eyes. A study by Tsai et al. in adults showed that shunt revision was useful in patients with malposition or extrusion, but was less effective in patients with encapsulation.

Conclusion
AGV revision in pediatric Glaucoma appears to be a safe procedure. Though the success rate of AGV revision may not be high, it may be an effective and safe method to lower intraocular pressure in conjunction with medications at least for a short term in these complex eyes.

Reference
65 Comparison of Surgical Outcome of Non-perforating Deep Sclerectomy Between Pseudoexfoliative and Open-Angle Glaucoma Patients

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Purpose/Relevance
To evaluate the outcome of non-perforating deep sclerectomy surgery (NPDS) between pseudoexfoliative glaucoma (PXG) and open angle glaucoma (OAG) patients.

Methods
A case control study reviewing of 154 cases of non-perforating deep sclerectomy surgery in PXG and OAG patients. Change in intraocular pressure (IOP), number of medications (Meds), rate of goniopuncture (GP), time of goniopuncture, rate of suturolysis, rate of glaucoma reoperation, rate of subconjunctival bevacizumab and 5-fluorouracil (5-FU) injections were analyzed and compared between both groups.

Results
Overall, the PXG group and the OAG included 77 cases. All the pre operative (PREOP) and baseline characteristics of each group were similar. The average rate of IOP reduction was lower in the PXG group at post-operative (POSTOP) day 1 and week 1 with a p value of <0.001 for both. However IOP reduction at postop 1month, 3months and 6months were similar between both groups with a p value >0.05. At 6months, the rate of GP was 9.1% higher in the PXG group and was performed on average 15 days earlier. Reduction in meds at 6months was lower in the PXG with a p value of 0.001. However the rate of subconjunctival injections of bevacizumab and 5-FU, the rate of reoperation, needling were all similar in both groups with p value >0.05.

Discussion
Clinicopathology studies have demonstrated that pseudoexfoliation material can be found in descemet’s membrane and trabecular meshwork in PXG patients. Thus infringing on the filtration of NPDS. Our results support this finding because the PXG group initially had lower IOP reduction. However the IOP reduction between both groups was similar at 1 month, which is around the period where we performed a GP. Our study also demonstrated that the PXG group required more GP (9.1%) and were performed earlier (15 days) then the OAG group. Although this difference is clinically significant, the p value remained >0.05 because of our sample size.

Conclusion
NPDS performed on PXG have initially lower IOP reduction, requiring a higher rate of GP, which are performed earlier, than OAG patients. However a larger sample size would have been necessary to obtain statistically significant results.

References
Purpose/Relevance
To evaluate the intraocular pressure (IOP) reduction achieved by cataract surgery with implantation of a trabecular micro-bypass device in patients with open angle glaucoma.

Methods
Forty-seven eyes with open angle glaucoma underwent cataract surgery with implantation of a trabecular bypass device (iStent, Glaukos Corp.). All eyes had at least 6 months of follow-up. Data recorded included preoperative and postoperative IOP and the glaucoma medication requirement. The pre-operative IOP was the mean of the 2 IOP readings before surgery. The post-operative IOP was the mean of the last 3 IOP readings. The preoperative pressure was used to stratify the patients into four groups: IOP ≤ 15 mmHg, IOP > 15mmHg and ≤ 18mmHg, IOP >18mmHg and ≤ 21mmHg and IOP > 21mmHg.

Results
The average IOP reduction in all patients was 3.18 ± 3.74 mmHg (p < 0.001). There was a significant correlation between the magnitude of pressure reduction and preoperative pressure (r = 0.7002, p<0.001). In patients with IOP >15 mmHg and ≤ 18 mmHg, the IOP reduction was 1.96 ± 2.91 mmHg (p < 0.001). If the IOP was >18 mmHg and ≤ 21mmHg, the IOP reduction was 3.08 ± 1.12mmHg (p < 0.001). In patients with IOP greater than 21 mmHg, the IOP reduction was 7.53 ± 4.04 mmHg (p < 0.001). Overall, 81% of patients had a decreased pressure after surgery. If the IOP was ≥ 19 mmHg, 100% had an improved IOP.

Discussion
This study stratified patients by the pre-operative IOP. There was a strong correlation between the pre-operative IOP and how much pressure reduction was achieved by the surgery.

Conclusion
Cataract surgery with implantation of a trabecular micro-bypass device reduced the IOP in patients with open angle glaucoma. The pressure-lowering effect was greater in eyes with higher pre-operative IOP.

67 Is There an Optimal Timeframe for YAG Goniopuncture After Canaloplasty?

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Purpose/Relevance
To determine if there is an optimal timing to YAG Goniopuncture (GP) following Canaloplasty.

Methods
Retrospective chart review of patients undergoing Canaloplasty only and those who had Canaloplasty with subsequent adjunctive YAG Goniopuncture. Patients included those with primary open angle, secondary open angle, low-tension, and pseudoexfoliation glaucoma. Primary outcome measures include IOP pre and post YAG Goniopuncture, weeks to YAG GP – within 4 weeks, 4-8 weeks, and > 8 weeks, and their respective success (IOP < 21 mm Hg). Secondary outcome measures included success (last follow up IOP < 21 mm Hg) based on age, % IOP reduction, % medication reduction, cannulation rate, and subsequent surgeries.

Results
Of the 131 eyes in the study, 57 eyes underwent YAG GP. Pre-YAG GP mean IOP was 23.39 ± 8.98 mm Hg and post-YAG GP mean IOP was 14.80 ± 7.27 mm Hg. Success of YAG GP based on timing: < 4 weeks – 88.46% (N=26), 4-8 weeks – 94.44% (N=17), and > 8 weeks – 75% (N=6). Analysis of Variance (ANOVA) resulted in no statistical difference between YAG GP timing at these three time intervals (p>0.05). All eyes in the study (N=131) had an average IOP reduction of 9.84 ± 9.10 mm Hg at last follow up. Mean age of success for YAG GP was 70.1 ± 12.85 years. Patients who had a > 20% medications reduction was 85.5% with average medication reduction of 68.5% ± 35.09 (2-3 medications). Cannulation rate was 96.18%. Subsequent surgeries included AC restoration (N=9), tube shunt placement (N=6), and iridoplasty (N=5).

Discussion
At this time, our data does not support a statistically optimal timing of YAG GP following canaloplasty. Data suggests better IOP response if YAG GP is completed within 2 months post canaloplasty.

Conclusion
YAG GP following canaloplasty does statistically lower IOP successfully. However, there is not an optimal timing for the completion of YAG GP. Long-term follow up and continued data collection will help ensure stability of findings and success rate and may help us better understand the timing of YAG GP.

References
Three Year Follow-up of Intraoperative Subconjunctival Mitomycin C Injection with Lidocaine in Conjunction with Placement of Express Minishunts for Treatment of Glaucoma

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Michael Pokabla
Robert Noecker

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2 Albany Medical College
3 Ophthalmic Consultants of Connecticut

Purpose/Relevance
To evaluate the operative efficiency, and long term safety and efficacy of subconjunctival mitomycin C with lidocaine injection as a surgical adjunct for placement of Express minishunt devices for the treatment of glaucoma.

Methods
A retrospective chart and video review was performed on cases of glaucoma Express minishunts performed using this technique with at least three years of post-operative follow-up. This technique used subconjunctival mitomycin 0.2 mg/cc diluted in a 50:50 dilution with lidocaine 2% with epinephrine. In this technique, the subconjunctival injection of a mean volume of 0.2 cc was performed superiorly 10 mm posterior to the limbus at the beginning of the case. Following the injection, the case proceeded normally with a conjunctival incision with no other additional maneuvers. Post-operative visual acuity, medication use, and complications were evaluated.

Results
Eighty two cases were identified that had at least three years of post-operative follow-up. The average case time was 16.5 minutes. The mean pre-op IOP was 22.3 mm Hg. At last follow-up, the mean post-op IOP was 13.4 mm Hg. There were two cases of limbal wound leaks in the immediate post-operative period which resolved with conservative management. There were two cases of long term post-operative hypotony (IOP < 5 mm Hg). Needling and suture lysis were performed on 10 cases.

Discussion
Anti-proliferative agents such as mitomycin C have been used in conjunction with trabeculectomy to inhibit fibroblastic activity and modulate wound healing at the bleb site. Prior studies have demonstrated a significant improvement in success rates with decreased post-operative scarring at the bleb site and improved IOP values with the use of mitomycin C. Various methods of delivery have been described previously including the application of sponges soaked in anti-metabolite applied to the subconjunctival, sub-Tenon’s and underneath the scleral flap. Recently, intraoperative injection of mitomycin C has been described. Our study demonstrates that subconjunctival injection of mitomycin C and lidocaine to augment Express minishunt surgery is efficient, safe and effective.

Conclusion
This surgical technique of applying mitomycin C and lidocaine appears to be efficient, safe and effective.

References
Three-year Follow-up of a One-Suture Technique for Placement of Glaucoma Drainage Devices

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Purpose/Relevance
To evaluate the operative efficiency, and long term safety and efficacy of a novel surgical technique for placement of glaucoma-drainage devices.

Methods
A retrospective chart and video review was performed on cases of glaucoma drainage device surgeries using the one suture technique with at least three years of clinical follow-up. This technique was used to implant Molteno, Baerveldt, and Ahmed valve devices. This technique used no sutures on the device plate, patch graft or conjunctiva. A single vicryl suture was used to cinch the tube when indicated and vent and secure the anterior tube to the sclera to prevent migration of the device. Fibrin glue was used to adhere other tissues. IOP, visual acuity, medication use, and complications were evaluated.

Results
Sixty cases were identified that had at least three years of follow-up. The average case time was 15.5 minutes. The mean pre-op IOP was 29.3 mm Hg. At last follow-up, the mean post-op IOP was 18.7 mm Hg. There were no cases of plate migration. There were two cases of post-operative diplopia. There was one case of patch graft exposure, which required suturing.

Discussion
This technique demonstrates an alternative way for surgeons to place glaucoma drainage devices safely and efficiently. The technique can be easily adapted by surgeons.

Conclusion
This surgical technique of implanting glaucoma drainage devices appears to be efficient, safe and effective.

Reference
70  A Pilot Case Series of Consecutive Patients Undergoing Ab Interno Trabeculotomy

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2 Drexel University, College of Medicine

Purpose/Relevance
To describe our experience with a recently introduced ab interno trabeculotomy technique termed gonioscopy-assisted transluminal trabeculotomy (GATT).1

Methods
A pilot case series of 11 consecutive patients with primary or secondary open-angle glaucoma (OAG) who underwent GATT. The technique involves a conjunctiva-sparing, sutureless circumferential trabeculotomy performed with a flexible illuminated microcatheter (iScience Interventional Corp, Menlo Park, CA) via a clear corneal incision. Intraocular pressure (IOP), number of glaucoma medications, visual acuity (VA), and complications were assessed at postoperative visits.

Results
Eleven patients with an age range of 25 to 85 years underwent GATT with a mean follow up of 2 months (range 1 to 3 months). Mean IOP preoperatively was 29 mmHg (range 16 to 49 mmHg), and mean IOP at last follow up was 16 mmHg (range 10 to 33 mmHg), representing a 45% decrease in IOP. Mean number of glaucoma medications decreased from 3.3 preoperatively to 1.2 postoperatively. Mean visual acuity decreased by 0.4 Snellen lines. At last follow up, no patients had required further glaucoma surgery. The most common complications were transient hyphema, which occurred in 90% of patients, and transient IOP spike above 30 mmHg, which occurred in 64% of patients.

Discussion
Though adult trabeculotomies have previously shown poor long-term outcomes, results have improved with newer techniques, perhaps due to 360-degree, more accurate anatomical cleavage through the trabecular meshwork.1,2 The procedure preserves the conjunctiva for future glaucoma surgeries if necessary and avoids many potential problems of filtering procedures, such as bleb-related complications. Our case series is limited by small sample size and short follow up, though our preliminary results have been promising and agree with the results of Grover et al.1

Conclusion
GATT effectively reduced IOP in patients with OAG. Hyphema and IOP spikes occurred in most patients and resolved within the early post-operative period. Further long-term evaluation of the procedure is warranted.

References
71 Trabeculodialysis for Uveitic Glaucoma

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2 Glaucoma Center of San Francisco

Purpose/Relevance
To describe outcomes of trabeculodialysis in uveitic glaucoma.

Methods
Retrospective review of patients with uncontrolled uveitic glaucoma who underwent trabeculodialysis. Patients with less than 6 months follow-up were excluded unless failure occurred earlier. Success was defined as complete when intraocular pressure (IOP) was 5-21 mmHg, with at least 30% reduction from baseline and with no further surgery and no major complications. Success was defined as qualified when IOP lowering medications were required to achieve the IOP reduction criteria. Outcomes were also analyzed with alternative upper IOP limits of 18 and 15 mm Hg.

Results
10 eyes of 8 patients were included. Mean age was 33.9 ± 22.3 years (range 6.9 to 76.1 years). Cause of uveitis was Juvenile Idiopathic Arthritis (40%), herpetic disease (20%) and idiopathic (40%). Mean defect on Humphrey visual field was -5.81 ± 3.43 dB. Two eyes had active uveitis prior to surgery. Mean follow-up was 5.4 ± 5.9 years (range 1.1 months to 20.3 years). Mean IOP decreased from a preoperative level of 25.9 ± 3.1 to 14.0 ± 4.3 mm Hg at the last follow-up (p=0.005) and the mean number of glaucoma medications decreased from 3.0 ± 1.3 to 1.9 ± 1.7 (p=0.047). At last follow-up, 7 eyes (70%) were successful, 3 eyes (30%) achieved complete success and 4 eyes (40%) achieved qualified success. Three eyes (30%) failed due to further glaucoma surgery. Success rates were unchanged when analyzed using alternative upper IOP limits of 18 and 15 mm Hg. Five eyes (50%) had self-limiting hyphema, 1 eye required a 2-staged trabeculodialysis due to bleeding. No late complications were observed.

Discussion
See below.

Conclusion
Trabeculodialysis was successful in 70% of eyes in this small series with relatively short follow-up. Given the favorable safety profile of this minimally invasive and conjunctiva-sparing procedure, it may be considered prior to traditional glaucoma surgeries such as filtering procedures and aqueous drainage devices. Longer follow-up in a larger series is required to clarify the role of this procedure in the management of uveitic glaucoma.

References
Outcomes of Bleb Needling with Mitosol After Ex-PRESS Shunt Surgery

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Purpose/Relevance
Investigate efficacy and safety of bleb needling using mitosol in comparison to mitomycin C after Ex-PRESS shunt surgery.

Methods
We performed chart reviews of 41 consecutive eyes from 40 patients with previous Ex-PRESS shunt surgery who underwent subsequent bleb needling with Mitosol. The mean follow-up time was 7.32 months. The primary outcome measure was surgical success. Secondary outcomes included visual acuity (VA), intraocular pressure (IOP), number of medications, and complications.

Results
Thirty-nine eyes had open angle glaucoma (95.1%). Overall success for the post-operative period was 73.2%. At six months, average visual acuity was 0.55 and average IOP was 12.9 on an average of 0.67 medications. No major complications were reported.

Discussion
The surgical outcomes are comparable to those outcomes reported in literature with mitomycin C.

Conclusion
Mitosol for use in bleb needling in eyes with an Ex-PRESS shunt is as safe and efficacious as Mitomycin C. Further research with larger sample size and longer follow-up is needed to confirm these results.

References
73 Surgical Outcomes in Patients with Primary Congenital Glaucoma

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¹ Asociacion para Evitar la Ceguera en Mexico

Purpose/Relevance
To evaluate the surgical results of Primary Congenital Glaucoma at our hospital and to identify how many procedures are needed to control this disease’s progression.

Methods
We reviewed the files of all patients with Primary Congenital Glaucoma that attended the Glaucoma Service at the Asociación para Evitar la Ceguera en México, from January 1st, 1997 and December 31, 2013; and identified which surgical procedures were performed, how many surgeries were needed, and the results of each technique, as reflected in the IOP control.

Results
We reviewed the files of 80 patients (132 eyes); Forty nine (61%) were males and 31 (39%) females, with a mean age at diagnosis of 17.45 ± 24.82 months (range, 0.46 – 129.51 months). At the time of diagnosis the mean IOP was 26.25 ± 7.3 mmHg (range, 9.4–50.6 mmHg) on an average of 0.96 ± 1.06 medications (range, 0–4). One hundred and twenty three eyes required surgical management. Median age at the initial surgery was 6.79 months. Goniotomy was the most common initial procedure (66 eyes) followed by trabeculectomy (35 eyes), Ahmed Valve implant (14 eyes) and trabeculo-trabeculectomy (2 eyes). In total, 293 procedures were done (2.37 ± 1.65 surgeries per eye). The mean follow-up period was 4.20 ± 4.17 years (range, 3 days–16.79 years, median 2.87 years). The mean final IOP was 13.92 ± 5.56 mmHg on an average of 1.30 ±1.29 medications.

Discussion
Goniotomy was the most common procedure performed in patients with Primary Congenital Glaucoma. Most patients required more than one surgical procedure to obtain an adequate IOP and attempt to control the disease’s progression.

Conclusion
Primary congenital glaucoma is a challenging disease that often requires more than one surgery to achieve IOP control; but the glaucoma specialist’s job must not stop at this, it must also address issues like ametropia and amblyopia and facilitate visual rehabilitation to achieve the best possible visual outcomes for these children. Inter-institutional efforts must be made to carry out multicenter clinical trials with long term follow-ups to identify the best surgical procedure for treating this condition.

References
2. Ben-Zion, I, Tomkins, O, Moore, DB, and Helveston, EM. Surgical results in the management of advanced primary congenital glaucoma in a rural pediatric population. Ophthalmology 2011; 118 (2) : 231-5.
74 Challenges in Tube Surgery Technique in Patients with PROSE Scleral Lenses

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Purpose/Relevance
Management of concurrent ocular surface disease and glaucoma can be challenging, especially in patients requiring surgical treatment for glaucoma. The aim of this study was to describe the difficulties of fitting the Prosthetic Replacement of the Ocular Surface Ecosystem (PROSE) device in patients with glaucoma drainage implants (GDI) and the surgical management of patients where both GDI and PROSE lens fitting are indicated.

Methods
Six cases that required PROSE lens wear and Baerveldt glaucoma implant surgery were retrospectively reviewed. Group A consisted of 2 patients where PROSE lens wear was problematic due to scleral surface irregularities following tube shunt placement. Group B consisted of 2 patients where previously placed GDI led to challenging lens fittings. In Group C, 2 patients already fitted with the PROSE lens were able to continue lens wear after placement of the GDI in the pars plana and insertion of the tube through a tract formed with a 23-G needle, 3.0 to 3.5mm from the limbus.

Results
In group A, the PROSE lens could not be fitted due to changes in ocular surface morphology caused by the elevated scleral patch graft tissue adjacent to the corneal limbus in one patient and the presence of two anteriorly located shunts in the other. In group B, the lens fit was compromised due to the proximity of the lens edge to the scleral patch graft. In Group C, the posterior location of the tube allowed for a good fit of the lens.

Discussion
Surface irregularities introduced by the presence of an anterior chamber tube shunt and an anteriorly located elevated scleral patch graft can prevent the PROSE lens from achieving a complete seal with the ocular surface. A poor lens fit is associated with persistent air bubble formation, decreased vision, discomfort and increased risk of tube erosion and infection. The pars plana approach for aqueous shunt implantation allows for better PROSE scleral lens positioning and fitting.

Conclusion
Placement of a tube shunt in the anterior chamber tube can interfere with scleral lens wear. Pars plana GDI with posterior placed scleral patch graft should be considered for PROSE scleral lens dependent patients.

Reference
75 Which is Better? (1) Pre- or (2) Post-Cataract iStent Implantation

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Purpose/Relevance
The iStent (Glaukos, Laguna Hills, CA) was FDA approved in 2012 for treatment of mild to moderate open-angle glaucoma in combination with cataract surgery. Implantation timing has been recommended following successful cataract surgery. Yet in complex cases (white or brunescent cataracts, small pupil, floppy iris syndrome pseudoxfoliation glaucoma), the authors have considered iStent placement preceding cataract surgery. The objective of this study is to describe the surgical experience with iStent placement either pre- or post-cataract extraction/IOL implantation.

Methods
Retrospective medical chart review (n=46) of patients (n=43) undergoing cataract surgery combined with iStent implantation from April 2013 – October 2014. Surgical videos were also reviewed.

Results
Pre-Cataract implantation (Group 1; n=21). Post-Cataract implantation (Group 2; n=25). Group 1 (n=8) and Group 2 (n=3) were classified as complex (i.e. Capsular Tension, Malyugin ring; sulcus or ACIOL). Implantation success rate: Group 1 (25/25); Group 2 (22/25). The iStent was aborted (n=3) in Group 2 due to poor angle visibility; corneal edema: s/p femtosecond laser (n=1); diffuse corneal edema following prolonged cataract extraction (n=2).

Discussion
Based on the risk of corneal decompensation noted in Group 2, Implantation of iStent before cataract extraction has several potential advantages: 1) optimal corneal clarity of the angle and trabecular meshwork; 2) optimization of both topical and intra-cameral anesthetics with i.v. sedation at the initiation of surgery to facilitate patient tolerability of safe and deliberate iStent implantation while manipulating the eye with the surgical goniolens; 3) unaltered ocular integrity to facilitate ease of iStent implantation; and 4) ability to implant the device in complex cases or before potential complicated cataract surgery that may compromise subsequent implantation difficult due to corneal decompensation.

Conclusion
In this series of patients, Group 2 had a 100% success rate in iStent implantation vs. Group 1. Consideration should be given in placing the iStent prior to cataract surgery.

Reference

76 Ex-PRESS Shunt Surgery Following Failed Canaloplasty: An Update

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Purpose/Relevance
Some surgeons do not utilize canaloplasty given its use of conjunctiva and potentially higher risk for failure of subsequent filtering surgery. Our goal was to expand and investigate our previous cohort of patients undergoing Ex-PRESS shunt surgery after failed canaloplasty.

Methods
A retrospective review was performed of 42 consecutive eyes requiring filtration surgery after failed canaloplasty (13.2%, 42/318). All patients had open angles at time of canaloplasty. The primary outcome measure was surgical success. Laser suture lysis and bleb needling were not considered surgical failure. Secondary outcomes included visual acuity, intraocular pressure (IOP), number of medications, and complications.

Results
Mean follow-up time post-Ex-PRESS was 562 ± 302 days. Mean time from canaloplasty to Ex-PRESS shunt surgery was 321 ± 190 days. Pre-operative IOP and number of medications were 29.4 ± 9.6 and 2.6 ± 1.4, respectively. Surgical success at final follow-up was 71.4%. Bleb needling was performed in 23.8% patients. 23.8% required further glaucoma surgical intervention for uncontrolled IOP and 4.8% required intervention for prolonged hypotony. At final follow-up, mean IOP and number of medications were 12.9 ± 7.6 and 0.8 ± 1.1. No major complications were reported.

Discussion
Canaloplasty offers a lower risk profile in managing IOP than filtration surgery but does utilize conjunctiva. Fortunately, our study suggests that surgical success of Ex-PRESS shunt surgery after failed canaloplasty is similar to tube versus trabeculectomy study.1,2 Additionally, Ex-PRESS shunt surgery after failed canaloplasty is safe and efficacious.

Conclusion
Glaucoma specialists need not fear that good canaloplasty candidates will have worse IOP control should a filter be needed. Further prospective research with longer follow-up would aid in investigating this matter.

References
Efficacy of Combined Phacoemulsification and iStent Implantation

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Purpose/Relevance
To evaluate the efficacy of combined phacoemulsification cataract extraction (phaco) and iStent (Glaukos, Laguna Hills, CA) implantation.

Methods
This was a retrospective review of all patients who underwent combined phaco/iStent at the University of Colorado from November 2012 through August 2014. Outcomes were reviewed up to 12 months postoperatively, including visual acuity, intraocular pressure (IOP), and use of IOP-lowering medications. Patients with less than three months follow-up were excluded from analysis. Failure was defined as IOP ≥ 21 mmHg or ≤ 5 mmHg, IOP not decreased ≥ 20% from baseline on two consecutive visits and no reduction in IOP-lowering medications, loss of light perception vision, or re-operation for glaucoma within one year.

Results
Seventy patients with visually significant cataracts and glaucoma underwent phaco/iStent surgery during the study period. Of these, 6 were excluded due to inadequate follow-up. The mean age of the 64 patients included in the analysis was 67.6 ± 8.8 years old. The preoperative mean IOP was 14.7 ± 3.2 mmHg on a mean of 1.8 ± 1.1 IOP-lowering medications (range 0-4). Success was achieved in 87.5% of patients. One patient failed due to IOP >21 mmHg and 7 patients failed due lack of reduction in IOP or medication usage. Over the course of follow-up, mean IOP was 14.6 ± 3.7 (p=0.96) at 1 month, 14.3 ± 3.5 (p=0.22) at 3 months, 14.6 ± 3.5 (p=0.29) at 6 months, and 13.7 ± 3.1 mmHg (p=0.09) at 1 year. Mean number of IOP lowering medications was 1.2 ± 1.2 (p<0.01) at 1 month, 1.0 ± 1.2 (p<0.01) at 3 months, 1.2 ± 1.5 (p<0.01) at 6 months, and 1.6 ± 1.6 (p= 0.06) at 1 year of follow-up.

Discussion
This study investigates the outcomes of combined phaco/iStent implantation at our tertiary care center. The iStent device is a trabecular micro-bypass stent that is implanted at the time of phacoemulsification in patients with glaucoma. In our study, the majority of patients achieved either a ≥20% IOP reduction or decline in medication use. However, the mean IOP was not significantly lower at any studied time point, while mean medication use was reduced up to 6 months post-operatively. Limitations of this study include its retrospective nature, absence of control group, and the lack of standardized treatment protocols.

Conclusion
Combined phaco/iStent surgery demonstrates a modest decrease in IOP and medication burden in many patients with coexisting cataract and glaucoma. The reduction in medication usage appears to dissipate with longer follow-up. Additional studies are needed to determine the efficacy over a longer period of follow-up and further subgroup analysis may help identify patient characteristics most likely to benefit from phaco/iStent surgery.

Reference
**78 Two-Year Outcome of Trabectome Procedure by Single Surgeon**

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**Purpose/Relevance**
To evaluate safety and efficacy of Trabectome procedure by single surgeon.

**Methods**
A total of 297 cases were included in the study. Patients without pre-operative IOP or having less than 3 months of follow-up were excluded. All surgeries were performed by a single surgeon (MCS). Outcome measures include IOP, number of medications and secondary glaucoma surgery, if any. Kaplan-Meier was used for survival analysis and success was defined as IOP ≤ 21mmHg, IOP reduced by 20% or more from baseline on any two consecutive visits after 3 months and no secondary glaucoma surgery.

**Results**
Mean age of the study group was 71 years old. Majority were Caucasians (85%) diagnosed with primary open angle glaucoma (68%). Average baseline IOP was 22.1±6.3 mmHg with 2.4±1.2 glaucoma medications. At 12 months, the IOP was reduced to 15.8±3.6mmHg (p<0.01) and number of medications was 1.3±1.1 (p<0.01). At 24 months, the average IOP was 16.3±3.4 mmHg (p<0.01) and average number of medications was 1.5±1.0 (p<0.01). Survival at 24 months was 83%. 23 cases (8%) required additional glaucoma surgery. One case of hypotony was noted on post-op day one, but it was quickly resolved. In POAG cases (n=203), the IOP was reduced from 20.2±5.4 to 16.6±3.7mmHg (p<0.01) at 24 months and the number of medications was reduced from 2.3±1.1 to 1.5±1.1. In pseudoexfoliative glaucoma cases (PEX, n=50), the IOP was reduced from 22.0±6.3 to 15.2±2.4mmHg and the number of medications remained about the same (1.6±1.2 to 1.5±1.0 at 24 months). The survival rate at 24 months was 85% and 88% for POAG and PEX cases respectively.

**Discussion**
Patients showed statistically significant reduction in IOP and number of glaucoma medications. No serious complication was observed. The low risk profile also makes Trabectome a viable alternative to traditional glaucoma surgery.

**Conclusion**
Trabectome appears to be safe and effective for glaucoma patients.

**Reference**

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**79 The Effect of Proper Anatomic Placement of an iStent on Intraocular Pressure and Medications During Cataract Surgery in Patients with Open Angle Glaucoma and Cataract**

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**Purpose/Relevance**
To assess the intraocular pressure (IOP) lowering and medication reduction following confirmatory anatomic placement of 1 iStent during cataract surgery in patients with mild to moderate glaucoma.

**Methods**
Consecutive iStent cases combined with cataract surgery (n=43) were reviewed. Data from the last pre-op visit was assessed for medication use and IOP. One iStent (Glaukos, Laguna Hills, CA) was implanted in each eye during cataract surgery. Post-op goniophotomicrographs were reviewed to evaluate angle placement as an inclusion criterion prior to conducting data analysis. To assess the IOP lowering effect of the iStent, a washout was initiated by discontinuing all pre-op glaucoma meds after surgery. Medications were restarted if IOP ≥ 21 mm Hg. Data for patients taking ≥ 1 pre-op medication with a minimum 3-month to 1-year follow up (n=16) was analyzed.

**Results**
All subjects had photomicrograph confirmation of stent placement in Schlemm’s Canal (SC). Mean (SD) age: 72 (8.1) years; male (n=20); female (n=23); Caucasian (n=34), African-American (n=8) and Hispanic (n=1). Pre-op mean (SD) IOP in 46 patients: 17 (6.1) mmHg; Pre-op mean (SD) number of 2 (0.9) medications. For n=16 eyes, the pre-op IOP was > 14 mmHg. Mean (SD) IOP decreased 6.2 (7.0) mmHg [24%]; mean (SD) number of meds decreased 0.2 (0.4) [92% reduction]. Pre-Op Meds (1-3): n=7 (1); 6 (2); 3 (3). Post-Op Meds on last visit: 13 (0); 3 (1).

**Discussion**
It is critical to anatomically confirm proper iStent placement within SC. This could be achieved using goniophotography. This location serves as an indirect measure of post-trabecular aqueous flow to the collector channels. This interim study is an attempt to provide meaningful evidence based data analysis. Consideration should be given to establish a standardized documentation of angle based procedures when interpreting post-surgical data.

**Conclusion**
In this series of eyes, following goniophotographic confirmation of proper iStent placement, there was a substantial drop in IOP, medications or both.

**Reference**
Injection of Perfluoropropane Gas and Viscoelastic as Rescue Therapy for Ocular Hypotony Following Glaucoma Filtering Surgery

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Purpose/Relevance
To explain an innovative technique involving injection of a non-expansive concentration of perfluoropropane gas, octafluoropropane 14% (C₃F₈), with viscoelastic material into the anterior chamber to treat hypotony and shallow anterior chamber following glaucoma fistulizing surgery.

Methods
This is a retrospective chart review of thirteen patients who underwent glaucoma drainage surgery with subsequent hypotony and shallow anterior chamber. The parameters measured were the pre and postoperative intraocular pressures (IOP), the frequency of repeat injection, the rate of cataract formation in the phakic patients, and postoperative complications. Success was defined as maintenance of IOP five or above without the need for further surgical intervention.

Results
The placement of a 14% C₃F₈ gas bubble with viscoelastic in the anterior chamber was 92% successful in treating hypotony in the postoperative period without causing significant complications.

Discussion
The advantage of the combination of viscoelastic material with the gas is that it decreases the amount of the gas needed and thereby reducing the theoretical risk of lens contact and cataract formation. Furthermore, the addition of the gas decreases the need for large quantities of viscoelastic material to maintain the chamber reducing the risk for IOP spikes and increases the time the chamber is formed. In our case series, C₃F₈ with viscoelastic injection used to reform the anterior chamber helped to improve hypotony in twelve of the thirteen eyes, a 92% success rate. The advantage of this technique is that it is a simple method that can be performed in the office setting. If hypotony should reoccur, this procedure can be easily repeated as it was in four of the patients in this study.

Conclusion
In patients who experience hypotony and shallow anterior chamber due to overfiltration following recent glaucoma filtering surgery, the injection of 14% C₃F₈ with viscoelastic can be a safe and effective method of treatment.

References
81 Glaucoma Mini-Shunt Implantation After Keratoplasty

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Purpose/Relevance
To report the outcomes of patients who underwent miniature glaucoma shunt implantation after secondary glaucoma due to keratoplasty.

Methods
A retrospective, non-comparative study of clinical consecutive cases who underwent mini-glaucoma shunt (Ex-PRESS device, Alcon Laboratories, TX) following keratoplasty were included. Briefly, a fornix based conjuntival flap was performed, approximately 50% thickness scleral flap. Mitomycin-C 0.2% placed under Tenon’s capsule. A 25-gauge needle creates entry for mini-shunt. Ex-PRESS model P-50 was inserted. Scleral flap and conjunctiva were closed with 10-0 Nylon. STATA 8.0 and paired t-test were used for statistical analysis.

Results
15 eyes of 15 patients with a mean age of 40.13 years (SD: 19.20, range: 18 to 76). Nine cases after penetrating keratoplasty, 3 cases after triple procedure, 2 after deep anterior lamellar keratoplasty, and 1 following endothelial keratoplasty. Most of the keratoplasty indications were keratoconus (53.33%), 3 cases of herpetic keratitis (20%), 3 due to endothelial failure (20%) and one case of post-LASIK ectasia (6.66%). Mean preoperative IOP was 37.46 mmHg (SD: 9.94, range: 18-55) decreasing to 11.73 mmHg postoperatively (SD1: 3.32, range 6-20) [P = 0.001] with or without antiglaucomatous medications. Mean follow-up after mini-glaucoma shunt implantation was 10.66 months (SD: 7.40). UDVA, CDVA and endothelial cell count did not presented statistically significant differences during follow-up.

Discussion
Glaucoma after keratoplasty is found in around 10% to 53% following keratoplasty. Mini-shunt implantation could offer adequate intraocular pressure control and lower corneal tissue damage. Few studies using these implants after keratoplasty have shown promising results. In our study, we found a significant intraocular pressure reduction and minor complications with this technique.

Conclusion
Ex-PRESS miniature glaucoma shunt could be an alternative treatment in post-keratoplasty glaucoma resistant to medical treatment. This technique may be helpful, in trying to avoid corneal damage produced by conventional glaucoma procedures.

References
Staying Away from the Optic Nerve: A Formula for Modifying Glaucoma Drainage Device Surgery in Pediatric and Other Small Eyes

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Purpose/Relevance
A previous study¹ of adult autopsy eyes has provided guidelines for optimal placement of glaucoma drainage devices (GDDs) to avoid contact between the optic nerve (ON) and posterior edge of the GDD plate. It is unclear to what extent these findings are utilized in clinical practice, and established guidelines for safe implantation of GDDs in small eyes are currently lacking.

Methods
We conducted an anonymous survey of GDD positioning practices among glaucoma attendings at Duke. We have developed a simple formula to estimate limbus-to-ON distance in small eyes, which one of the authors (SFF) has used extensively for modifying GDD surgery in pediatric glaucoma. We are currently validating the formula in pediatric autopsy eyes.

Results
The GDD Positioning Survey was completed by 9 Duke glaucoma faculty. 4/9 (44%) did not alter GDD placement in small eyes; 5/9 (56%) used a variety of GDD surgical modifications, but only 1/9 (11%) had a systematic approach for adjusting GDD size depending on eye axial length. Here we present a formula that calculates the limbus-to-ON distance based on eye axial length, anterior chamber depth, corneal diameter, and GDD quadrant, thus estimating the available “real estate” for GDD placement in small eyes. We are currently validating the formula in pediatric autopsy eyes (axial lengths 15 to 19 mm), with preliminary data showing good agreement between measured and predicted values.

Discussion
Our survey results and published reports confirm a paucity of quantitative algorithms for modifying GDD surgery in small eyes, even in a university-based, multi-faculty glaucoma group. We developed a formula for adjusting GDD size/position in small eyes in order to prevent contact between the posterior edge of the GDD and the optic nerve. Given the multiple anatomic assumptions needed for its derivation, this formula should be considered as heuristic rather than exact. Nonetheless, we hope this method provides helpful guidance for clinicians needing to implant GDDs in a small eye, be it pediatric, highly hyperopic or nanophthalmic.

Conclusion
To the best of our knowledge, this is the first set of guidelines developed to promote safe implantation of GDDs in small eyes.

Reference
**83 Long-term Bleb-related Infections: Incidence, Risk Factors and Impact of Bleb Revision**

**EUN AH KIM**, Ji Woong Lee, Anne Coleman, Simon Law, Kouros Nouri-Mahdavi, JoAnn Giaconi, Fei Yu, Esteban Morales, Joseph Caprioli

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**Purpose/Relevance**
To report the long-term incidence of late-onset bleb-related infections, to calculate the hazard ratios of potential risk factors, and to evaluate the influence of surgical bleb revision on the risks of bleb-related infections.

**Methods**
Bleb related infections (BRI) were defined as either blebitis, endophthalmitis, or blebitis with endophthalmitis. A total of 1959 eyes of 1423 patients who underwent trabeculectomy with either intraoperative mitomycin-C or intraoperative 5-fluorouracil and who were followed for ≥1 year were included. Kaplan-Meier survival analysis (10 years), a generalized estimating equation, and Cox proportional hazard models were used. The influence of surgical bleb revision was evaluated by calculating hazard ratios among 3 groups (Group 1: eyes without risk factors; Group 2: eyes with risk factors who had surgical revision; and Group 3: eyes with risk factors with no revision having been performed). Risks included a history of late leak prior to the diagnosis of bleb-related infection, hypotony accompanied by either hypotony maculopathy or chronic choroidal detachment, and large or high blebs.

**Results**
Twenty-four eyes were diagnosed with BRI; 15 eyes were presented with blebitis and 9 eyes presented with endophthalmitis. Among 15 eyes with blebitis, 2 eyes developed endophthalmitis under treatment. The Kaplan-Meier estimated incidence of bleb-related infections was 2.0% at 10 years and the cumulative incidence of bleb-related infections increased linearly. Significantly high hazard ratios were demonstrated in eyes with pigmentary glaucoma, juvenile glaucoma, history of bleb leakage, eyes with sustained intraocular pressure below the target pressure, chronic blepharitis and punctal plugs. The hazard ratio of Group 2 to Group 3 was 0.0 (95% confidence interval: 0.0-0.2, P<0.01).

**Discussion**
This large case series with long-term follow-up demonstrates the incidence of bleb-related infections to be less than 2%, and describes the risk factors associated with bleb-related infections, which include pigmentary glaucoma, juvenile glaucoma, history of bleb leakage, low intraocular pressure, chronic blepharitis, and punctal plugs. We also report a probable protective effect of surgical bleb revision.

**Conclusion**
Clinicians should be continuously vigilant for, and patients made aware of, the possibility of bleb-related infections long after trabeculectomy, especially in the presence of identified risk factors.

**Reference**
The Economic Burden of Glaucoma Over a Five-Year Period

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Purpose/Relevance
To determine the economic burden on patients diagnosed with open-angle glaucoma over a 5 years period.

Methods
Open angle glaucoma patients with at least 5 years of follow up were included in this retrospective review. Data on glaucoma treatment, number of hospital visits, diagnostic studies, and laser or surgical treatments for each patient were collected and analyzed, as well as current employment status, monthly income and monthly cost of glaucoma drops. Direct and indirect costs for each patient were calculated over the 5 years period.

Results
Data from 462 patients were included in this study. The total cost of glaucoma drops per patient over 5 years was $2,899.69 ± $1,771.15. Prostaglandins analogues were the most commonly prescribed therapy at diagnosis and fixed combinations were most common class used at the end of 5-year period. Total cost of glaucoma care per patient over the 5 years period, including direct and indirect costs (transportation cost) was $6,634.13 ± $2,744.28. The income of each patient over a 5 years period was $15,959.20 ± $233.76. Only 245 patients (53%) surveyed were unemployed and 51 patients (11%) were disabled and unable to work directly due to visual dysfunction from glaucoma. The cost of drops and surgeries represents 47.78% and 36% of all costs respectively over the 5 years period.

Discussion
About 41% of the total income of patients with glaucoma in this study was spent on treatment of this single disease over a 5 year period. The economic burden on the glaucoma patient should be considered when counseling patients on the use of their medications.

Conclusion
Laser trabeculoplasty and utilization of early surgical intervention should be explored as potential methods to decrease the overall cost of care.

References
Epidemiology and Clinical Studies

85 Prospective Study of Flavonoid Intake and Risk of Primary Open-Angle Glaucoma

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Purpose/Relevance
Flavonoids may improve nitric oxide mediated endothelial function, which has been hypothesized to be impaired in glaucoma. We prospectively examined the association between diet intake of total flavonoid intake and five subclasses of flavonoids (flavones, flavanones, anthocyanins, flavonols, flavan-3-ols) in relation to the risk of primary open-angle glaucoma (POAG).

Methods
We followed 79,789 women from the Nurses’ Health Study and 41,816 men from the Health Professionals Follow-up Study who were at least 40 years of age, did not have glaucoma at baseline, and reported undergoing eye examinations from 1980 (NHS) / 1986 (HPFS) to 2010. Information on consumption of dietary flavonoids and various confounders was repeatedly ascertained using validated follow-up food-frequency questionnaires. Cases of incident POAG were confirmed with supplementary questionnaire and medical record review of self-reported diagnoses. Multivariate rate ratios (RRs) and 95% confidence intervals (CIs) for the risk of POAG were calculated in each cohort and then meta-analyzed.

Results
During 24+ years of follow-up, a total of 1590 incident POAG cases were identified. In multivariable analyses, higher intake of total flavonoids was associated with lower risk of POAG, although trends were not significant (p for trend [p-trend]=0.08; the RR for lowest [<171 mg/day] to highest quintile [>455 mg/day] was 0.87 [95% CI=0.73,1.03]). We did not observe associations with intake of the flavonoid subclasses of flavonols (p-trend=0.15), flavanones (p-trend=0.21), flavones (p-trend=0.31) or anthocyanins (p-trend=0.44). We observed that higher intake of flavan-3-ols was associated with a lower risk of POAG (p-trend=0.04; the RR for lowest [<14.3 mg/day] to highest quintile [>63.7 mg/day] was 0.86 [95% CI=0.72,1.02]). The food that contributed most to the variation in flavan-3-ols was tea; we observed that with every one cup increase in tea consumption, the risk of POAG decreased by 9% (p-trend=0.05).

Discussion
Tea-derived bioflavonoids attenuate retinal ischemia / reperfusion injury in animal models. There is evidence that oral bioflavonoids lower IOP and stabilize retinal function.

Conclusion
Greater consumption of flavonoids, particularly flavan-3-ols that are found in teas, may be associated with lower risk of POAG; these results need confirmation.

References
Evaluation of PG324, a Fixed Dose Combination of AR-13324 and Latanoprost, in Patients with Elevated Intraocular Pressure in a Double-Masked, Randomized, Controlled Study

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2 Aerie Pharmaceuticals
3 PharmaLogic Development, Inc.

Purpose/Relevance
To evaluate the safety and ocular hypotensive efficacy of PG324 Ophthalmic Solution, 0.01% and 0.02% relative to the active components AR-13324 Ophthalmic Solution, 0.02% and Latanoprost Ophthalmic Solution 0.005%, all dosed q.d., in the evening.

Methods
After washout of ocular hypotensive medication (if required), patients received a baseline eye examination that included measurement of IOP. Qualified patients (unmedicated IOP ≥ 24 mm Hg at 08:00 hours) were randomized to one of four treatments, which they instilled for 28 days.

Results
Enrolled were 298 patients from 23 centers. Mean unmedicated diurnal IOP (average of all measurements on Day 1, prior to study medication) was 25.1, 25.1, 26.0 and 25.4 in the PG324 0.01%, PG324 0.02%, latanoprost and AR-13324 0.02% groups, respectively. On Day 29, PG324 0.01% and PG324 0.02% demonstrated statistical superiority in mean diurnal IOP relative to latanoprost (p=0.0071 and p <0.0001, respectively) and AR-13324 0.02% (p=0.0002 and p < 0.0001), with mean diurnal IOP decreased to 17.3, 16.5, 18.4, and 19.1 mm Hg, respectively. PG324 0.02% also demonstrated superiority in mean IOP relative to latanoprost and AR-13324 0.02% at each of the 9 post-dose timepoints, with PG324 achieving IOPs that were 1.6-3.2 mm Hg lower than latanoprost (p <0.05). The most frequently reported adverse event was conjunctival hyperemia with an incidence of 41% (30/73), 40% (29/73), 14% (10/73) and 40% (31/78), respectively.

Discussion
PG324 Ophthalmic Solution combines AR-13324, a new ocular hypotensive drug that inhibits both Rho kinase and the norepinephrine transporter, with latanoprost, a prostaglandin FP receptor agonist. This study demonstrates that co-administration of AR-13324 with latanoprost produces statistically significantly greater IOP lowering than latanoprost alone. Both concentrations of PG324 were well tolerated. For the most part, the events were mild and transient. Note that the addition of latanoprost to AR-13324 in PG324 did not seem to increase the incidence of conjunctival hyperemia beyond that of AR-13324 alone.

Conclusion
The fixed-dose combination of AR-13324 0.02% and latanoprost 0.005% in PG324 Ophthalmic Solution provides clinically and statistically superior ocular hypotensive efficacy relative to its individual active components. The only safety finding of note was transient, self-limiting conjunctival hyperemia, which for the majority of patients was of trace or mild severity.

Reference
87 Proportion of Non-responders to Beta-Blockers and Prostaglandin Analogos in OHTS, CIGTS, and Enrollees in a United States Managed Care Plan

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Purpose/Relevance
To estimate the proportion of patients diagnosed with ocular hypertension or open angle glaucoma who do/do not respond following initial treatment with either topical beta-blockers (BB) or prostaglandin analogs (PGA).

Methods
We analyzed three datasets - the Ocular Hypertension Treatment Study (OHTS), (1994-1996)1, the Collaborative Initial Glaucoma Treatment Study (CIGTS), (1993-1997)2, and the i3 InVision Data Mart Database (2001-2009). For OHTS and CIGTS, percent intraocular pressure change (%∆IOP) was calculated by [(treated IOP – baseline IOP)/baseline IOP]*100. Non-response was defined as %∆IOP less than -15%. For the InVision dataset, patients were identified by ICD 9 codes and an initial prescription for BB or PGA. Non-response was defined as the addition of ocular hypotensive medication, incisional or laser surgery, or cessation of treatment within 1 year.

Results
The initial treatment for most of the OHTS and CIGTS subjects was BB. In the 741 OHTS subjects started on BB, 27% were non-responders at the 6-month visit. Among the 286 CIGTS subjects started on BB, 17% were non-responders at the first follow up visit. In the InVision dataset, 39% of the 1,392 patients started on a BB were classified as “non-responders.” Of the 12,154 patients started on PGA, 29% were “non-responders.”

Discussion
Despite differences in OHTS, CIGTS and InVision patient samples and differences in “non-responder” definition, the proportion of non-responders to BB were surprisingly in a similar range (17-39%) that correlates with clinical experience. Analysis is underway to assess the economic impact of the non-responder compared to the responder in the first year of treatment.

Conclusion
Understanding the causes for non-responders to BB and PGA will enable an individualized treatment approach for each patient. Given the success of quantitative trait analysis of IOP, studies are in progress to identify genetic causes for BB and PGA IOP-based drug response variations.

References
**88 Lens Position Parameters as Predictors of Intraocular Pressure Reduction After Phacoemulsification Cataract Surgery**

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**Purpose/Relevance**
To evaluate the relationship of lens position parameters with intraocular pressure (IOP) reduction after cataract surgery in non-glaucomatous eyes.

**Methods**
In this prospective study, non-glaucomatous eyes underwent phacoemulsification and lens implantation. IOP was measured preoperatively and 1.5 months after surgery. Change in IOP and its relation to lens biometric parameters, which were measured by LENSTAR LS 900 (Haag-Streit, Inc., Koeniz, Switzerland) preoperatively, including lens position (LP; defined as anterior chamber depth [ACD] + 1/2 lens thickness [LT]) and relative lens position (RLP; defined as LP/axial length [AXL]) were evaluated. In addition, preoperative IOP, lens thickness, AXL, ACD, and anterior depth (AD) were assessed as predictors. The main outcome measure was IOP change after phacoemulsification.

**Results**
Among the 60 consecutively enrolled patients (23 male, 37 female), 76 eyes were included in the analysis and the overall mean age was 72.8 ± 9.0 years. The average IOP reduction was 2.75 ± 2.28 mmHg, from a preoperative mean of 15.49 ± 3.26 mmHg, at 1.5 months after cataract surgery. The amount of IOP reduction was significantly greater in more anteriorly positioned lenses; LP (Spearman’s correlation coefficient; Rho = 0.397; p = 0.018) and RLP (Rho = 0.407, p = 0.024) both showed statistically significant correlation with IOP reduction. In multivariate linear regression analysis, higher preoperative IOP was significantly associated with IOP decrease (p < 0.001); shallower ACD (p = 0.09) and smaller AD (p = 0.075) showed moderate, but not statistically significant association.

**Discussion**
Our findings of significant associations between lens position parameters (LP, RLP) and IOP reduction after phacoemulsification cataract surgery suggests that lens position might be a predictor of the amount of post-op IOP decrease. LENSTAR uses the precision of optical low-coherence reflectometry, may provide a convenient, non-contact measurement of these parameters.

**Conclusion**
The amount of IOP reduction after cataract surgery in non-glaucomatous eyes is significantly greater in more anteriorly positioned lenses. Future studies will show whether similar relationships exist in glaucomatous eyes undergoing cataract surgery.

**References**
89 Relationship of Structural and Functional Rates of Change as a Function of Glaucoma Severity

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1 UCLA

Purpose/Relevance
To investigate the longitudinal relationship between structural and functional rates of change in patients with different stages of glaucoma severity.

Methods
This study included 360 eyes of 278 patients. All patients had 3 or more good-quality confocal scanning laser ophthalmoscopic (CSLO) examinations and 4 or more reliable visual field (VF) examinations. A pointwise exponential regression was used to perform trend analysis on thresholds at each VF test location. The test locations were ranked according to their decay rates and were partitioned into slow and fast clusters. The mean rates of change of the slow (SR) and fast clusters (FR) were measured. Linear regressions of the mean deviation (MD), Visual Field Index (VFI) and global rim area (RA) as measured with CSLO were performed against time. The longitudinal relationship between structure and function was assessed with two methods: 1) correlation between structural and functional rates of change were calculated with bivariate correlation analyses, 2) a linear mixed model was built to explore the adjusted associations of structural change with the functional parameters.

Results
Seventy one eyes of glaucoma suspect, 90 eyes of preperimetric glaucoma, 134 eyes of early glaucoma and 63 eyes of moderate to advanced glaucoma were included. RA rate was positively correlated with MD rate, VFI rate, and FR in preperimetric and early glaucoma (all P<0.05); the highest correlations were observed between the RA rate and FR. However, RA rate was not correlated with SR in any of the severity groups. Change in RA was directly associated with MD and VFI in preperimetric and early glaucoma (all P<0.05). Change in RA was directly associated with visual sensitivities of FR cluster regardless of baseline severity of glaucoma (all P≤0.019). Visual sensitivities in SR cluster were not associated with change in RA in any groups.

Discussion
Change in global rim area was significantly associated with FR cluster regardless of baseline severity of glaucoma. The global indices MD and VFI were associated with change in global rim area in certain stages of glaucoma.

Conclusion
We conclude that the identification of FR cluster can help clinicians measure and predict rates of glaucoma progression, and is a more robust measure of change than are the global indices MD and VFI.

Reference
90 A Randomized, Prospective Comparison of 360 Degree Selective Laser Trabeculoplasty (SLT) vs. 577 nm Micropulse Laser Trabeculoplasty (MLT) in Eyes with Open-Angle Glaucoma

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Purpose/Relevance
The purpose of this study was to compare the efficacy, safety, and patient comfort with SLT vs. MLT treatment (tx).

Methods
48 Patients with open angle glaucoma and need for additional intraocular pressure (IOP) reduction were enrolled and randomly assigned to either SLT (n=23) or MLT (n=25). Patients with angle closure, neovascular, or end-stage glaucoma were excluded. All patients were surveyed on procedure and post-operative pain.

Results
The average pre-tx IOP for SLT and MLT groups were 16.7 mmHg and 18.3 mmHg respectively. The average IOP 1 hour, 1 week, 4-6 weeks, and 8-16 weeks post-tx was 15.6, 15.2, 12.9, and 13.1 mmHg for the SLT group and 14.3, 16.4, 15.6, and 15.7 mmHg for the MLT group. 3 patients in the SLT group and 1 patient in the MLT group had a post procedure IOP elevation (IOP rise >6 mmHg) but all post procedure IOPs were ≤20 mmHg. Average IOP reduction at 4-6 weeks post-tx was 3.2 mmHg for the SLT group and 3.1 mmHg for the MLT group (p=0.86). Average IOP reduction at 8-16 weeks post treatment was 2.5 mmHg for the SLT group and 3.0 mmHg for the MLT group (p=0.71). No adverse reactions occurred in either group. Average pain reported during the procedure was 3/10 for SLT group and 1.2/10 for MLT group (p=0.0063).

Discussion
There was no statistically significant difference in IOP reduction between the SLT and MLT groups at both 4-6 weeks and 8-16 weeks post treatment. Both lasers were safe but MLT was more comfortable for most patients. Additionally, there was a trend towards earlier IOP reduction at post-tx week 1 in the MLT group but this was not statistically significant.

Conclusion
MLT is as effective in lowering IOP as SLT with an equivalent safety profile. It also offers more patient comfort both during and after the procedure. Given these results, further investigation of this unique form of laser therapy is warranted.

References
91 Fellow Eye Treatment Refusal in CIGTS Participants

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Purpose/Relevance
To examine refusal of fellow eye (FE) treatment among participants in the Collaborative Initial Glaucoma Treatment Study (CIGTS).

Methods
CIGTS participants who were randomized to initial medication or initial surgery and whose FE (better eye) was eligible for treatment were studied. Demographic data and characteristics, surgical data from the study eye (SE) trabeculectomy, and reported quality of life were compared between groups that refused and received treatment in their FE.

Results
FEs eligible for treatment at baseline included 39.3% (118/300) in the group randomized to trabeculectomy and 39.7% (122/307) in the group randomized to medical treatment. Refusal of FE treatment occurred in 14.4% (17/118) of participants within the surgery group and 0.8% (1/122) of participants within the medicine group (Fisher’s exact test p<0.0001). FEs initially eligible for treatment in those that refused (n=17) and received (n=74) surgery did not differ on demographic data, visual field data, post-operative complications, symptoms, or Visual Activities Questionnaire results. Baseline intraocular pressure (IOP) in the SE and FE were lower in those subjects refusing FE surgery vs. those receiving surgery (SE: 25.5 vs. 29.7 mmHg, t-test p=0.0134; FE: 24.4 vs. 28.1 mmHg, t-test p=0.0015).

Discussion
Refusal of FE treatment was far more common in participants randomized to the surgical arm of the CIGTS. There were no differences in post-operative complications, symptoms, or other quality of life survey results between surgery-randomized participants who refused trabeculectomy in their initially eligible FE and those who received trabeculectomy. Intraocular pressure was lower in participants who refused surgery, suggesting elevated IOP influenced the decision to have FE surgery.

Conclusion
CIGTS participants were more likely to refuse bilateral surgical treatment than medical treatment. Lower IOP may be associated with refusal of fellow eye surgery.

Reference

92 Change in Vision-Related Quality of Life in Patients with Early and Suspected Glaucoma

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Purpose/Relevance
To determine whether changes in visual field sensitivity are related to vision-related quality of life over time.

Methods
Participants in the Portland Progression Project, a longitudinal study of patients with early or suspected glaucoma, performed biannual visual field testing (SITA 24-2) and completed at least two 25-item National Eye Institute Visual Function Questionnaires (VFQ-25) during the course of the study. We compared the association of mean deviation (MD) to VFQ-25 composite score.

Results
We included 161 participants with a mean interval of 3.35 years (2.53 to 3.94, median= 3.43) between the first and last testing time points. The VFQ composite score decreased by 0.58 points (-24.37 to 18.49, median = -0.38). The MD declined by an average of 0.09 dB (-3.83 to 3.55, median = -0.02). VFQ-25 was associated with MD at first and last testing time points (p<0.05). However, we found no significant association between the change in VFQ and the change in MD (P = 0.29).

Discussion
Visual field changes affect quality of life in patients with glaucoma1,2 but few studies examine longitudinal changes in these measures. The cross-sectional analysis showed significant associations of vision-related quality of life to visual field sensitivity. However, the longitudinal analysis did not show a relationship to mean deviation over a short-term period in patients with early or suspected glaucoma. This may have occurred because of small changes in both MD and VFQ-25 composite score over time, and/or poor sensitivity of VFQ-25 composite score to small changes in visual field.

Conclusion
Visual field sensitivity is associated with vision-related quality of life. Longer follow-up may be required to detect changes in vision-related quality of life as assessed by the VFQ-25 composite score with declines in visual field sensitivity.

References
93 The Association Between Serum Manganese Level and the Prevalence of Glaucoma in the South Korean Population

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**Purpose/Relevance**
We investigated the association between serum manganese level and glaucoma diagnosis.

**Methods**
We included right eyes from 2556 participants with serum manganese level data in the 2008-2009 Korean National Health and Nutrition Examination Survey, a cross-sectional population study. Serum manganese levels and demographic, comorbidity, and health-related behavior information were assessed. The definition of glaucoma was based upon criteria established by the International Society for Geographical and Epidemiological Ophthalmology (ISGEO).

**Results**
Serum manganese level is negatively associated with the odds of having glaucoma after adjustment for potential confounders (mean level 1.23ug/dl and 1.35ug/dl in glaucoma and non-glaucoma group, respectively; odds ratio [OR] 0.39, 95% confidence interval [CI] 0.19-0.83).

**Discussion**
Manganese (Mn) is an essential trace metal present in all tissues and is required for the maintenance of proper cell function. It is a cofactor of many enzymes such as superoxide dismutase (SOD), which inhibits neuronal death presumably by interfering with a superoxide signal for apoptosis. An animal study revealed retinal Mn levels were significantly deficient in 10-month old glaucomatous DBA/2J mice compared to aged-matched C57BL/6J mice and 5-month old DBA/2J mice. Another previous study has also demonstrated neuroprotective effects and superoxide scavenging activity of Mn-corrole in vitro and in vivo. While high Mn-induced toxicity seems more prevalent, the alteration of normal physiological function from Mn deficiency shouldn’t be overlooked.

**Conclusion**
A lower serum manganese level was associated with greater odds of glaucoma in a representative sample of the South Korean population. Future studies are needed to further explore its potential neuroprotective effects.

**References**

94 Randomized, Controlled Trial to Compare Safety, Tolerability and Efficacy of Pattern Scanning Laser Trabeculoplasty (PSLT) to Selective Laser Trabeculoplasty (SLT)

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2 Geneva University Hospitals

**Purpose/Relevance**
To compare safety, tolerability, and efficacy of a new computer-guided treatment modality, pattern scanning laser trabeculoplasty (PSLT), to standard selective laser trabeculoplasty.

**Methods**
Twenty-three patients with untreated open angle glaucoma were randomized to undergo SLT in one eye and PSLT in the contralateral eye. The Streamline 577 (Topcon Medical Systems, Japan) device was used for PSLT and the Ellex Tango (Ellex, Australia) for SLT. All 4 quadrants were treated in a single session. The comfort level of each laser procedure was evaluated immediately following the intervention using the visual analogue scale (VAS). Efficacy of laser treatment was evaluated at 2 months. Complete success was defined as an IOP reduction of ≥ 20% without medications.

**Results**
No serious adverse events were recorded. One patient in each group experienced a transient IOP spike of ≥ 10 mmHg immediately after laser intervention. Comfort was rated as superior with PSLT (25±21 mm) compared to SLT (49±27 mm; p<0.0001). IOP was from a baseline of 20.3±5.5 mmHg to 15.4±5.2 (-24%) with PSLT and from 20.9±6.4 mmHg to 14.9±4.4 mmHg with SLT (-28%) (p=0.163) at 2 months.

**Discussion**
Laser trabeculoplasty is a valid treatment open for glaucoma. PSLT may be a valid treatment option with potential advantages over standard SLT.

**Conclusion**
PSLT provided a similar safety and efficacy profile to SLT in glaucoma patients. It was perceived as more tolerable compared to SLT.

**Reference**
Analysis of a Novel Physician-Led Team-Based Care Model for the Treatment of Glaucoma

NELSON WINKLER¹, Gena Damento¹, David Hodge¹, Sunil Khanna¹, Cheryl Khanna¹
¹ Mayo Clinic

Purpose/Relevance
A novel physician-led team-based care model was implemented at our institution for the treatment of patients with glaucoma. Our purpose was to retrospectively study the efficacy of this model for improving compliance with the American Academy of Ophthalmology Preferred Practice Patterns for glaucoma management.

Methods
A total of 600 patients with a new diagnosis of glaucoma based on ICD-9 codes were studied before and after protocol implementation from 2005-2010 and this data was compared to a control site without a glaucoma care process model over the same time period. Charts were divided into sub-groups for analysis based on provider type including optometry, general ophthalmology, and glaucoma specialists. Outcomes included completion of testing and recording of a specific diagnosis. Glaucoma severity at time of diagnosis was also analyzed by sub-group.

Results
The control site had no significant changes in testing completion over the time period studied, and glaucoma type and severity were similar between locations. The team care group at the intervention site had a global improvement in testing completion, with the largest improvement in fundus photos (29% increase), gonioscopy (27% increase) and recording target IOP (24% increase).

Discussion
Implementation of a physician-led care model at our institution resulted in significant improvement in compliance with the American Academy of Ophthalmology Preferred Practice Patterns for glaucoma treatment.

Conclusion
This is the largest study of this type to date, and our protocol has the potential for widespread adoption to improve glaucoma care.

References

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Table 1. Comparison of Mayo Clinic Rochester (MCR) post-protocol (team care) to previous compliance
96 Concentration Accuracy of Compounded Mitomycin C for Ophthalmic Surgery

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Purpose/Relevance
To determine if the measured concentration differs from the expected concentration of 0.4 mg/ml mitomycin C (MMC) used in ophthalmic surgery. We rely on accurate concentrations of MMC to titrate intraocular pressure control with trabeculectomy surgery.¹

Methods
We acquired 60 samples of 0.4 mg/ml MMC from a wide spectrum of common compounding and storage techniques (refrigeration, freezing, and immediately compounded dry powder) and a variety of pharmacies (academic hospital, community hospital, and independent PCAB-accredited pharmacy). We used C18 reversed-phase high performance liquid chromatography (HPLC) to measure the absolute MMC concentration of all samples. We used pure MMC (Medisca Inc., Montreal, Canada) to generate a calibration curve and sulfanilamide as an internal standard. We calculated MMC concentration using a calibration curve by dividing MMC peak area by internal standard peak area and plotting the area ratio against the calibrant concentrations. We separately retested 6 MMC samples at 4 different time-points over 24 hours to verify satisfactory precision of MMC quantification. We compared the measured concentration against the expected 0.4 mg/ml concentration for all samples.

Results
The measured concentration of expected compounded 0.4 mg/ml MMC was 0.35 ± 0.04 mg/ml (p < .001, t-test) with a wide range between 0.26 to 0.46 mg/ml. Calibration curves for MMC (normalized to internal standard) demonstrated acceptable linearity and a mean correlation coefficient of $r^2 = 0.99$. Repeat measurements of 6 separate MMC samples also showed little variability in measured concentration (mean coefficient of variation 1.4%, range 0.7% - 2.6%), also indicating good precision for measurements associated with the HPLC method.

Discussion
The concentration of MMC used in ophthalmic surgery has lower accuracy and a wider range than expected.

Conclusion
Surgeons should consider these inaccuracies when titrating MMC concentration for their patients. These differences in concentration may result from compounding technique and MMC degradation.

Reference

Figure. Box plots of measured concentrations of expected 0.4 mg/ml MMC using a variety of storage techniques and sources. Shaded box areas indicates 25th and 75th percentiles. Vertical lines show concentration ranges.
The Association Between Visual Field Abnormalities and the Use of Antihypertensive Medications in the United States

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2 University of Michigan
3 Stanford University

Purpose/Relevance
To investigate the relationship between visual field defects and the use of antihypertensive medications in a nationally representative sample.

Methods
This cross-sectional study included 5406 participants in the National Health and Nutrition Examination Survey (NHANES) between 2005 and 2008, age ≥ 40 years, who demonstrated presence or absence of a visual field defect determined by the NHANES 2-2-1 Algorithm for Frequency Doubling Technology (FDT) N-30-5. Multiple blood pressure measurements were obtained for participants who were interviewed regarding the use of antihypertensive medications. Demographic, comorbidity, and health-related behavior information was obtained via interview. Multivariate logistic regression analysis was used to determine the association between the use of antihypertensive medications and visual field defect prevalence among subpopulations defined by systolic blood pressure (SBP) cut-offs ≤120mmHg, ≤110mmHg, and ≤100mmHg, and diastolic blood pressure (DBP) cut-offs ≤80 mmHg, ≤70mmHg, and ≤60 mmHg.

Results
Participants who reported the use of antihypertensive medications, regardless of blood pressure reading, had significantly greater odds of having a visual field defect compared to those who did not report use of antihypertensives (unadjusted OR 2.28, 95% CI 1.83-2.83; adjusted OR 1.33, 95% CI 1.07-1.65). Among participants with DBP ≤80mmHg, those taking antihypertensives had significantly higher odds of having visual field defects compared to participants not taking antihypertensives (unadjusted OR 2.31, 95% CI 1.81-2.96; adjusted OR 1.33, 95% CI 1.03-1.70).

Discussion
Our finding of significantly increased odds of a visual field defect among participants who were being treated with medications for hypertension within the subpopulation of participants with a DBP ≤80mmHg suggests that a decrease in diastolic blood pressure through the use of antihypertensives may be a risk factor for the development of glaucomatous disease. Such an effect can be hypothesized to be a consequence of decreased ocular perfusion and resultant optic nerve injury.

Conclusion
The use of antihypertensive medications was associated with increased prevalence of visual field defect adding support to the theory that poor ocular perfusion is a risk factor for glaucomatous disease.

Reference
98 Quantitative Trait Analysis of Timolol Response—A Combined Analysis

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Purpose/Relevance
To quantitate the variations in timolol response based upon the pharmacodynamic outcomes of aqueous humor flow, or “flow”, and intraocular pressure (IOP).

Methods
This is an ongoing combined analysis of 2 groups of normal subjects. One group (n=53) was studied in an inpatient setting to determine timolol response.1,2 The second group (n=28) is part of a prospective, multicenter quantitative trait study of aqueous humor dynamic characteristics (ClinicalTrials.gov NCT01677507). Morning flow was assessed by fluorophotometry at baseline conditions (no treatment) and after treatment with timolol 0.5%. In the second group, IOP was measured by rebound tonometry. The primary outcome measure is percent change flow (Δflow) in response to timolol. The secondary outcome measure is percent change IOP (ΔIOP) in response to timolol. These outcomes were calculated as [(baseline flow or IOP) – (treated flow or IOP)]/(baseline flow or IOP). A treatment response, Δflow and ΔIOP, of greater ≥ 15% was considered clinically significant; conversely <15% response was considered as a “non-responder”.

Results
81 subjects (39.6±15.3 years, 42.5% males) were available for analysis. Morning flow decreased from 2.6 ± 0.8 µl/min to 1.7 ± 0.4 µl/min (p<0.05) after timolol. ΔFlow decreased by ≥ 15% in 66/80 of subjects (82%) after treatment with timolol, therefore there was a non-responder rate of 18%. In the second group, there was a decrease in IOP from 13.4 ± 3.4 mmHg to 11.6 ± 3.9 mmHg (p<0.05) after timolol. ΔIOP decreased by ≥ 15% in 15/28 subjects (54%), the remaining 13/28 patients (46%) were classified as non-responders.

Discussion
This combined analysis provides evidence of variation in timolol treatment outcomes of Δflow and ΔIOP. There were 18% Δflow non-responders and 46% ΔIOP non-responders to timolol. This variation in response is not only influenced by the variables of the Goldmann equation, but also by yet to be identified genetic and environmental factors.

Conclusion
While past glaucoma pharmacology studies emphasized the average IOP response, there is growing evidence that IOP is a quantitative trait.3 Additional analyses will determine the concordance between Δflow and ΔIOP in response to timolol in an individual, will examine covariates of drug response, and will identify genetic factors that affect drug response.

References
99 Costs of Glaucoma Care to Patients and Their Families

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Purpose/Relevance
Office visits required for routine glaucoma care cost billions in direct costs1, but the costs of these visits to the patient and their companions (patient cost) have not been assessed in the United States. Knowledge of the patient cost of glaucoma monitoring is critical to assess the cost-effectiveness of alternative models of glaucoma health care delivery.

Methods
To evaluate the patient cost of glaucoma care, we designed and distributed a cross-sectional survey to 300 patients in hospital-based and community-based glaucoma subspecialty clinics. The survey included demographic factors, disease severity, and all patient and companion costs related to the visit including cost of transportation, time, child care, and lost wages. We calculated the mean cost per visit and yearly costs per patient. We collected both demographic and clinical data. We determined predictors of mean and yearly cost using univariate and multivariate analysis.

Results
Of the 300 patients, 187 (62%) were female, 171 (57%) were African American, and 114 (38%) were Caucasian. The mean age was 65 ± 14 years. The mean patient cost of each visit was $38.02 ± $73.15. The mean yearly cost of all visits was $176.09 ± $327.23. The mean cost of the visit including leisure time lost was $44.09 ± $72.67. The mean yearly cost of the visit including leisure time lost was $210.41 ± $333.32. Patients with companions paid significantly more ($51.42 ± $90.65 vs $26.60 ± $51.58, P ≤ .001) and retired patients paid significantly less ($21.64 ± $25.67 vs $51.42 ± $93.89, P = .038). Mean cost per visit did not vary with age (P = .340), gender, (P = .409) or race (P = .274). Median household income (P = 0.005) and presence of companion (P ≤ 0.001) were significant predictors for increased yearly cost. No relationship between mean cost and disease severity (P = .928) or education (P = .084) was noted.

Discussion
The cost of glaucoma care is significant to both the patient and their companion. Our study is the first to comprehensively assess these costs in the United States. We determined that patients with companions and those currently employed paid significantly more per visit.

Conclusion
Patients spend a substantial amount to attend glaucoma-care appointments. These results show the need to potentially reevaluate the frequency of visits or perhaps utilize telemedicine to reduce the patient cost.

Reference
Comparing Medication Possession Ratio (MPR) Versus Electronic Monitors to Evaluate Glaucoma Medication Non-adherence

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Purpose/Relevance
Poor adherence to a prescribed glaucoma medication regimen may lead to preventable blindness. Medication adherence can be quantified by various methods but strengths, weaknesses and relationships between these methods are poorly understood. We compared MPR, a widely used adherence measure with the advantage of easy accessibility in a closed pharmacy system, to the proportion of prescribed doses taken according to an electronic monitor.

Methods
Eligible patients from the VA hospital with medically-treated glaucoma were given electronic medication monitors containing one of the prescribed eye drops. Pharmacy records were queried for refill requests for glaucoma medications over the study period. The medical record was abstracted to determine the prescribed dosing regimen including frequency and laterality. The MPR was derived, defined as the number of prescribed doses divided by the number of doses available to the participant over the study period. To determine the number of doses in individual bottles, we consulted the specific manufacturer, the local VA pharmacy, and counted drops ourselves.

Results
The number of drops available in a given bottle differed as estimated by the pharmacy, the manufacturer, and our count. Due to these discrepancies, we used the number of drops/ml by our count to calculate MPR. The average MPR for the 79 Veteran participants over ≥6 month ranged 0.1-5.3, mean 1.5, SD 0.8, median 1.5. The proportion of prescribed doses taken according to the electronic monitor over the same period ranged 7.8-104.9, mean 79.8, SD 24.4. MPR was not associated with the proportion of prescribed doses taken according to the monitor (p=0.052). We considered that participants in possession of the greatest excess of medication may exhibit worse adherence behavior, as evidenced in other chronic disease conditions and categorized the participants according to MPR.

Discussion
On average, participants possessed approximately 150% of the amount of the glaucoma medication required according to their prescribed regimen; MPR was not associated with the proportion of doses taken according to the electronic monitor. The study was conducted in a closed pharmacy system without access to samples and no co-pay requirements for some participants, which may have contributed to a higher MPR than reported previously.

Conclusion
While MPR may be a reasonable outcome measure to capture long-term persistence with prescribed medication, MPR may not be the best outcome measure for quantifying glaucoma medication adherence over a shorter time frame.

References
101 Long-Term Outcomes of Combined Cataract and Trabeculectomy Surgery

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Purpose/Relevance
To report the long term outcomes of combined cataract and trabeculectomy surgeries.

Methods
Prospective, non-comparative database of 1741 combined cataract and trabeculectomy surgeries performed in 1281 patients between 1987 and 2014. A survival analysis and a multivariate regression analysis was performed for predictors of the need for glaucoma surgical reoperation and visual acuity and IOP outcomes.

Results
Mean visual acuity improved by 3 lines from a mean preoperative 20/80 to 20/50. Mean IOP was reduced by 5.0 mm Hg from 21.1 to 16.1 mm Hg and mean number of glaucoma medications were reduced by 1.7 from 2.3 to 0.7 medications. Cumulative glaucoma reoperation rate was 7.1%. Mean time to reoperation was 47.9 months with a range of 0.03 to 284 months. The graph of cumulative surgical reoperation by time in months fits a natural logarithmic plot, Y=a(Ln X). Some patients eyes (135 of 1741=8%) with initial successful improvement of visual acuity lost visual acuity months or years later from disorders other than glaucoma or glaucoma surgical failure such as wet or dry AMD, ERM, CRVO, and macular hole).

Discussion
Combined cataract and trabeculectomy surgery improves visual acuity, reduces IOP and reduces the need for postoperative glaucoma medication. Glaucoma reoperation can be come necessary anywhere from one day to decades after the combined surgery. Many patients with successful improvement of visual acuity after combined surgery may suffer visual acuity loss months or years later from ocular diseases other than glaucoma.

Conclusion
Glaucoma surgical outcomes, whether after trabeculectomy, glaucoma implant, MIGS or other glaucoma procedure, need to be evaluated on a long term basis in view of the continuing early, mid-term and late need for glaucoma reoperation.

References

102 Accuracy of International Classification of Diseases, Ninth Revision, Billing Code for Primary Open Angle Glaucoma in Veterans Affairs Administrate Databases: A Validation Study

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1 Michael E. DeBakey Veterans Affairs Medical Center

Purpose/Relevance
To examine the accuracy of International Classification of Diseases, Ninth Edition, (ICD-9) codes for primary open angle glaucoma (POAG) in the Veterans Affairs data.

Methods
We conducted a retrospective study comparing the Veterans Affairs (VA) administrative data with abstracted data from the Michael E. DeBakey VA Medical Center’s (MEDVAMC) medical records. We randomly selected 200 patients examined at the Eye Clinic between 2000 and 2013 and diagnosed with POAG, and 100 patients without any POAG codes. A single ophthalmologist reviewed charts to determine presence of POAG based on cup-to-disc ratio and Humphrey visual field changes.

Results
Of the first 158 randomly selected patients with at least one POAG code, 63.9% were confirmed to have POAG, 27.2% were found to be POAG suspects or have ocular hypertension. Only 5.7% received the code erroneously, and 3.2% lacked sufficient documentation to determine POAG presence. We will present the sensitivity, specificity, and positive and negative predictive values for our entire study sample.

Discussion
The VA is the largest integrated healthcare provider in the United States, and as such is a valuable source for research. The accuracy of ICD-9 coding in correctly identifying the actual presence of POAG is a potentially limiting factor for studies that use administrative databases. A study done recently at two academic institutions with a review of 200 charts showed 98% accuracy for the POAG ICD-9 code.1 A validation study is needed within the VA system in order to be confident that the ICD-9 code for POAG truly represents POAG for the purposes of further studies.

Conclusion
A single ICD-9 code for POAG is highly predictive of the presence of either POAG, POAG suspect, or ocular hypertension and can reliably be used for research on these conditions. It is less useful for distinguishing between POAG suspect, ocular hypertension, or the actual presence of POAG. Additional research will be needed to determine search algorithms for specifically identifying confirmed POAG.

References
103 Ocular Surface Disease Signs and Symptoms in Patients Using Glaucoma Drops

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\(^1\) University of Miami
\(^2\) Miami Veterans Affairs Hospital

Purpose/Relevance
Evaluate the frequency of symptoms and signs of ocular surface disease (OSD) in patients using versus not using glaucoma medications. There is a high frequency of dry eye symptoms in patients using glaucoma medications and further elucidating the characteristics of this disease process may aid in prevention and treatment.

Methods
The study is a cross-sectional survey of patients seen at the Miami Veterans Affairs (VA) eye clinics. All patients seen at the ophthalmology or optometry clinics were invited to take part in the study. Interested patients were asked about subjective OSD symptoms and completed the Dry Eye Questionnaire 5 (DEQ5). The patients were then evaluated for objective OSD signs including anterior blepharitis, lid margin telangiectasias, meibomian gland dysfunction (MGD), and superficial punctate keratitis (SPK). To date, 128 patients have responded to this ongoing study.

Results
There is no significant difference in subjective dry eye symptoms or severe DEQ5 scores (>11) between patients using and not using glaucoma medications (43% vs 62%, p=0.07; 16% vs 19%, p=0.72). There is also no significant difference in the presence of anterior blepharitis (>grade 1) and MGD (>grade 1) between patients using and not using glaucoma medications (13% vs 22%, p=0.26; 59% vs 41%, p=0.08). Patients using glaucoma medications are more likely to have SPK (50% vs 23%, p=0.004). Patients not using glaucoma medications are more likely to have lid margin telangiectasias (24% vs 6%, p=0.03).

Discussion
Patients using glaucoma drops have more OSD signs but similar symptoms to patients not using drops, as previously described. There is more SPK and a trend toward increased MGD in patients using glaucoma medications. Lid margin telangiectasias are greater in patients not using drops, but this may be confounded by difficulty rating telangiectasias in black patients. Although corneal disease has been described in detail, there is little data regarding lid margin disease.

Conclusion
Ongoing data collection may contribute to a better understanding of lid margin disease in patients using glaucoma drops.

References

104 Effectiveness of Selective Laser Trabeculoplasty (SLT) Following Failed Trabeculectomy

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Purpose/Relevance
IOP control options after failed MMC-trabeculectomy are limited. We sought to determine the effectiveness of SLT in lowering IOP after failed trabeculectomy in a Middle Eastern population.

Methods
In this retrospective study we identified eyes with failed MMC-trabeculectomy that underwent SLT using a standard protocol. The procedure was considered a success when IOP was reduced by 20% from baseline, or one or more glaucoma medications were discontinued and be able to achieve target IOP and maintain control throughout the minimum follow up period of 6 months.

Results
Forty-one eyes of 37 patients underwent SLT. These eyes included POAG (46%) & PXFG (34%) and the disease was advanced in 56%. Previous procedures included MMC-trabeculectomy (66%) and combined phaco-trabeculectomy (34%). The mean baseline IOP was 20±4.3 mm Hg on 3.2 medications. At 6 months success was recorded in 71%. A 24% IOP reduction [20 to 15 mmHg (P=0.016)], and medication reduction [3 to 2.5 (P=0.005)] was noted. Success was significantly higher in eyes with blebs (P=0.04). Failure rates increased in eyes on a greater number of medications prior to SLT (P=0.02). IOP spike was noted in one eye. Twelve patients had a greater than one year follow up. They maintained IOP reduction (at 6 months (15.8 mm Hg ±3.8) and at 12 months (14.2 mm Hg±2.7)) (P=0.20).

Discussion
SLT resulted in significant IOP lowering in 71% eyes following failed trabeculectomy. This is in contrast to a previous study with similar design which reported a 16% success and 19.5% IOP lowering. Though the baseline patient profile was similar in both studies, we had more PXFG patients. Our results demonstrated that functioning blebs with poor IOP control may benefit from SLT. In addition, multiple glaucoma surgical intervention was not associated with failure. The non-availability of long term followup was a study weakness.

Conclusion
SLT appears to provide a safe alternative to incisional surgery to control IOP over the short term in eyes with failed trabeculectomies.

References
2. Selective Laser Trabeculoplasty after Failed Trabeculectomy in OAG. Clinic Experiment Ophthalmol, 2011, 2:176
Comparative Study of Intraocular Pressure Fluctuations Between the 24-Hour Diurnal Tensional Curve, Borrone Test and the Water Drinking Test in Patients with Primary Open-Angle Glaucoma

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2 Asociación para Evitar la Ceguera en México
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Purpose/Relevance
Evaluate the intraocular pressure (IOP) fluctuations of the water drinking test (WDT) and Borrone test (BT) in patients with primary open angle glaucoma (POAG) compared to the 24 hour diurnal tension curve (DTC).

Methods
Patients with mild POAG without any glaucoma surgery were washed out and enrolled prospectively in this study. One eye was randomly selected for inclusion. Each eye underwent a 24 hour DTC, the water drinking test (WDT), and the Borrone test (BT). Goldmann tonometry in upright position during daytime, and Perkins tonometry in supine position overnight was used to measure IOP for the 24 hour DTC. Positive test was defined as an increase of 4mmHg and/or a 30% increase in IOP from baseline. The degree of IOP fluctuation for each test was compared and correlated.

Results
Thirty eyes of 30 patients were included. The average (± SD) IOP fluctuation was 4.05 ± 1.57 mmHg in the 24 hour DTC, 3.55 ± 1.5 mmHg for the WDT, and 2.55 ± 2.83 mmHg for the BT. The difference in IOP fluctuation between the DTC and BT was significant (p=0.025), but not so between the DTC and WDT. The DTC was found to be positive in 17 eyes (57%), while WDT was positive in 17 eyes (57%) and BT was positive in 11 eyes (37%). The correlations between WDT and DTC, and BT and DTC were less than 50% respectively.

Discussion
Diurnal IOP fluctuations are associated with diagnosis and progression in glaucoma patients. The 24 hour DTC is considered the gold standard for IOP fluctuation assessment, however it is tedious and difficult to perform in an ambulatory setting. Alternatives include the water drinking test and the Borrone test. In this study, we did not find a correlation between WDT or BT with DTC.

Conclusion
The Borrone test and the water drinking test had poor correlation with 24 hour diurnal IOP fluctuation.

References
Family History(ies) of Glaucoma

ANDREW PLUMMER1, David Eng1, David Seamont1, Karanjit Kooner1, Beverley Huet1, Xilong Li1
1 University of Texas Southwestern

Purpose/Relevance
To determine the prevalence of family histories of glaucoma and other diseases in patients with primary open angle glaucoma (POAG) and to evaluate overall influence of positive family history of glaucoma in this cohort.

Methods
In an IRB-approved cross-sectional study, patients with POAG were interviewed at a university-based clinic, a county hospital and a VA hospital. The following data were collected: family history (FHx) of glaucoma, cup/disc (C/D) ratio, intraocular pressure (IOP), visual field defects, medications, refraction, central corneal thickness (CCT), and average thickness of the retinal nerve fiber layer (NFLA). FHx of other comorbidities were grouped into several categories: cardiovascular, hematolgy, oncology, renal, gastrointestinal, autoimmune, metabolic, neurological, skin and psychiatric.

Results
Among 304 patients, 164 (53.9%) had FHx of glaucoma. Both groups had a similar C/D ratio, CCT and NFLA. Significantly, patients with FHx of glaucoma were diagnosed at a younger age (54.09 vs. 59.37yrs. p=.001), and had higher rates of laser surgery (62.92% vs. 37.08%, p=.05) as well as FHx of type 2 diabetes (60% vs. 40% p=.03). Patients with FHx of hypertension (HTN) had higher IOP than those without (16.00 vs. 15.00mmHg, p=.01). Among our most frequent FHx of comorbidity (HTN, type-2 DM and breast cancer), females predominated at rates of 60% or more. Our sample population was 51.3% male.

Discussion
Higher rates of the above factors and younger age at diagnosis among patients with FHx of glaucoma suggest a more severe course of POAG. Correlation between FHx of glaucoma and FHx of diabetes, as well as elevated IOP in patients with FHx of HTN, may indicate an intricate association between these diseases and the progression and severity of POAG.

<table>
<thead>
<tr>
<th>Family History of:</th>
<th>Total +FHx Patients</th>
<th>% +FHx of POAG</th>
<th>% Female</th>
<th>% Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>POAG</td>
<td>164</td>
<td>100%</td>
<td>56.10%</td>
<td>43.90%</td>
</tr>
<tr>
<td>Asthma</td>
<td>3</td>
<td>1.83%</td>
<td>33.33%</td>
<td>66.67%</td>
</tr>
<tr>
<td>Breast Cancer</td>
<td>48</td>
<td>29.27%</td>
<td>75.00%</td>
<td>25.00%</td>
</tr>
<tr>
<td>Cardiomyopathies</td>
<td>7</td>
<td>4.27%</td>
<td>85.71%</td>
<td>14.29%</td>
</tr>
<tr>
<td>Cataract</td>
<td>17</td>
<td>10.37%</td>
<td>58.82%</td>
<td>41.18%</td>
</tr>
<tr>
<td>CHF</td>
<td>11</td>
<td>6.71%</td>
<td>72.73%</td>
<td>27.27%</td>
</tr>
<tr>
<td>Depression</td>
<td>1</td>
<td>0.61%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>DM type 2</td>
<td>92</td>
<td>56.10%</td>
<td>61.96%</td>
<td>38.04%</td>
</tr>
<tr>
<td>GERD</td>
<td>1</td>
<td>0.61%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Gynecological Tumors</td>
<td>7</td>
<td>4.27%</td>
<td>71.43%</td>
<td>28.57%</td>
</tr>
<tr>
<td>HTN</td>
<td>96</td>
<td>58.54%</td>
<td>60.42%</td>
<td>39.58%</td>
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<tr>
<td>Hypercholesterolemia</td>
<td>7</td>
<td>4.27%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>4</td>
<td>2.44%</td>
<td>100%</td>
<td>0%</td>
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<tr>
<td>Lung Cancer</td>
<td>6</td>
<td>3.66%</td>
<td>66.67%</td>
<td>33.33%</td>
</tr>
<tr>
<td>Macular Degeneration</td>
<td>4</td>
<td>2.44%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>MI</td>
<td>17</td>
<td>10.37%</td>
<td>52.94%</td>
<td>47.06%</td>
</tr>
<tr>
<td>Myopia</td>
<td>6</td>
<td>3.66%</td>
<td>33.33%</td>
<td>66.67%</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>5</td>
<td>3.05%</td>
<td>80.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>Prostate Cancer</td>
<td>7</td>
<td>4.27%</td>
<td>28.57%</td>
<td>71.43%</td>
</tr>
<tr>
<td>SLE</td>
<td>1</td>
<td>0.61%</td>
<td>0%</td>
<td>100%</td>
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<tr>
<td>Stroke</td>
<td>15</td>
<td>9.15%</td>
<td>53.33%</td>
<td>46.67%</td>
</tr>
<tr>
<td>Tumors of GI</td>
<td>16</td>
<td>9.76%</td>
<td>75.00%</td>
<td>25.00%</td>
</tr>
<tr>
<td>Valvular Heart Disease</td>
<td>5</td>
<td>3.05%</td>
<td>100%</td>
<td>0%</td>
</tr>
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</table>

Table 1
Conclusion
Patients with FHx of glaucoma were diagnosed at an earlier age and required more vigorous treatment. Females in this cohort had a much higher frequency of other family histories, including HTN, DM and Breast Cancer.

References

Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>-FHx Glaucoma</th>
<th>+FHx Glaucoma</th>
<th>Total Patients</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at Dx glaucoma</td>
<td>59.37 ± 12.81</td>
<td>54.09 ± 14.99</td>
<td>139, 164</td>
<td>0.0012</td>
</tr>
<tr>
<td>ALT/SLT glaucoma Surgery</td>
<td>37.08%</td>
<td>62.92%</td>
<td>89</td>
<td>0.0575</td>
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<tr>
<td>C/D Ratio</td>
<td>0.75 ± 0.19</td>
<td>0.75 ± 0.19</td>
<td>135, 162</td>
<td>0.6965</td>
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<tr>
<td>CCT</td>
<td>539.65 ± 46.68</td>
<td>535.32 ± 45.86</td>
<td>115, 133</td>
<td>0.4834</td>
</tr>
<tr>
<td>IOP</td>
<td>17.12 ± 5.48</td>
<td>16.38 ± 6.17</td>
<td>136, 163</td>
<td>0.2781</td>
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<tr>
<td>OCT</td>
<td>68.43 ± 16.94</td>
<td>67.56 ± 20.01</td>
<td>81, 100</td>
<td>0.758</td>
</tr>
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<td>Number of Glaucoma Meds</td>
<td>3 [0, 6]</td>
<td>2 [0, 5]</td>
<td>139, 164</td>
<td>0.0804</td>
</tr>
<tr>
<td>VF Normal</td>
<td>42.86%</td>
<td>57.14%</td>
<td>28</td>
<td>0.902</td>
</tr>
<tr>
<td>VF Mild</td>
<td>43.82%</td>
<td>56.18%</td>
<td>89</td>
<td>0.902</td>
</tr>
<tr>
<td>VF Moderate</td>
<td>52.94%</td>
<td>47.06%</td>
<td>51</td>
<td>0.902</td>
</tr>
<tr>
<td>VF Severe</td>
<td>43.69%</td>
<td>56.31%</td>
<td>103</td>
<td>0.902</td>
</tr>
<tr>
<td>Astigmatism_EyeDx</td>
<td>44.74%</td>
<td>55.26%</td>
<td>38</td>
<td>1</td>
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<tr>
<td>Cataract</td>
<td>49.46%</td>
<td>50.54%</td>
<td>93</td>
<td>0.4537</td>
</tr>
<tr>
<td>Hyperopia</td>
<td>35.71%</td>
<td>64.29%</td>
<td>14</td>
<td>0.5852</td>
</tr>
<tr>
<td>Myopia</td>
<td>42.86%</td>
<td>57.14%</td>
<td>98</td>
<td>0.5379</td>
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<tr>
<td>Macular Degeneration</td>
<td>31.25%</td>
<td>68.75%</td>
<td>16</td>
<td>0.3047</td>
</tr>
<tr>
<td>BMI</td>
<td>28.33 ± 6.45</td>
<td>29.7 ± 6.67</td>
<td>126, 153</td>
<td>0.0838</td>
</tr>
<tr>
<td>Breast Cancer</td>
<td>54.55%</td>
<td>45.45%</td>
<td>11</td>
<td>0.7596</td>
</tr>
<tr>
<td>Shunt</td>
<td>42.31%</td>
<td>57.69%</td>
<td>26</td>
<td>0.8375</td>
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<td>Trabeculotomy</td>
<td>34.62%</td>
<td>65.38%</td>
<td>26</td>
<td>0.3038</td>
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<tr>
<td>FHx Breast Cancer</td>
<td>36%</td>
<td>64%</td>
<td>75</td>
<td>0.0611</td>
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<tr>
<td>FHx Cataract</td>
<td>41.38%</td>
<td>58.62%</td>
<td>29</td>
<td>0.6969</td>
</tr>
<tr>
<td>FHx DM type 2</td>
<td>40%</td>
<td>60%</td>
<td>153</td>
<td>0.0383</td>
</tr>
<tr>
<td>FHx HTN</td>
<td>42.17%</td>
<td>57.83%</td>
<td>166</td>
<td>0.1658</td>
</tr>
<tr>
<td>FHx Macular Degeneration</td>
<td>33%</td>
<td>67%</td>
<td>6</td>
<td>0.6909</td>
</tr>
<tr>
<td>FHx Myopia</td>
<td>50%</td>
<td>50%</td>
<td>12</td>
<td>0.777</td>
</tr>
</tbody>
</table>
107 Patient Attitudes Towards Novel Drug Delivery for Treatment of Glaucoma

LISA COWAN¹, Thuan Nguyen¹, Angela Turalba¹
¹ Massachusetts Eye and Ear Infirmary

Purpose/Relevance
We investigated patients’ attitudes towards different drug delivery methods for the treatment of glaucoma.

Methods
We recruited 100 patients from Massachusetts Eye and Ear Infirmary’s Glaucoma Clinic who were being treated for glaucoma or being followed as glaucoma suspects. Sociodemographic data and information regarding patients’ understanding of their disease, self-reported adherence, and willingness to accept novel drug delivery methods (combination eye drop, drug-eluting contact lens, subconjunctival insert, and injectable implant) were assessed by a questionnaire. Clinical data on patients’ diagnoses, current and prior treatment, and stage of disease were assessed through a chart review.

Results
Of the 100 patients surveyed, 88 would accept a combination drop, 31 a drug-eluting contact lens, 32 a subconjunctival drug insert, and 24 an injectable drug implant. There was a significant difference in acceptance of a contact lens between self-identified Caucasians (40%) versus African Americans (5%), (p=0.005). Patients currently on glaucoma medications were less likely to accept a contact lens (25%) versus patients not using drops (52%), (p=0.03). There was no significant difference in the acceptance of drug delivery methods between men and women, patients with advanced and less advanced glaucoma, and patients who are working and those who are not.

Discussion
Understanding patients’ attitudes to glaucoma treatment and their willingness to accept various drug delivery methods is paramount in the clinical application of new technologies. Evaluating demographic and disease burden pressures can help guide development of novel drug delivery methods.

Conclusion
A combination drop is the most widely accepted drug delivery method in our glaucoma patients. A significant proportion of patients are willing to accept a drug-eluting contact lens and subconjunctival insert for glaucoma treatment, suggesting that these are reasonable options to explore in the development of novel drug delivery for glaucoma.

Reference
108 Effect of Lidocaine on the Cytotoxicity of Mitomycin C

ABRAHAM PARK1, Valeriy Lyzogubov1, Iqbal Ike Ahmed2, Nalini Bora1, Richard Morshedi1
1 University of Arkansas Medical Sciences
2 University of Toronto

Purpose/Relevance
There has been recent interest in the intraoperative application of mitomycin C (MMC) during trabeculectomy utilizing an intra-Tenon’s injection technique rather than sponge application.1,2 However, it is currently unknown whether the addition of lidocaine to the mitomycin solution augments or diminishes its antiproliferative effect. The purpose of this study is to evaluate whether the addition of lidocaine to a MMC solution alters its in vitro cytotoxicity.

Methods
Cultured human conjunctival fibroblast cells were incubated either with 0.1 mg/mL MMC, 1% lidocaine, or a mixture of 1% lidocaine and MMC. Phosphate buffered solution (PBS) was used as a control. Samples were taken at 2, 5, 10, 30, and 60 minutes, and an MTT (3-[4,5-dimethylthiazol-2-yl]-2,5 diphenyl tetrazolium bromide) assay was used to determine cell viability.

Results
Taken across all time points, the PBS solution showed the lowest cytotoxicity. MMC was more cytotoxic than PBS (p<0.001), and both lidocaine and the lidocaine-MMC mixture were more cytotoxic than MMC and PBS (respectively, p<0.01, p<0.001, and p<0.001, p<0.001). There was no significant difference in cytotoxicity between the lidocaine and lidocaine-MMC solutions. The addition of lidocaine slightly lowered the pH of the solutions (PBS=6.94, MMC=6.97, lidocaine-MMC=6.67, lidocaine 6.32).

Discussion
The addition of 1% lidocaine without epinephrine to MMC does not seem to diminish the in vitro cytotoxicity of MMC, when measured using human conjunctival fibroblasts. In fact, the addition of lidocaine appears to augment the cytotoxic effect, which may be due to its well-documented intrinsic cytotoxic activity. It is unknown whether the small pH differences seen in this study impacted our findings, or whether larger differences in pH would yield different results.

Conclusion
Based on this in vitro study, there should not be any decreased efficacy of MMC with the addition of 1% lidocaine. More studies are necessary to confirm this finding, including surgical outcomes as well as various concentrations of lidocaine, both with and without epinephrine.

References
109 Automated Reminders and Technology Access in Glaucoma Patients

DEREK MAI¹, Paul Houghtaling¹, Travis Frazier¹
¹ Madigan Army Medical Center

Purpose/Relevance
Adherence to treatment regimens is a commonly encountered problem in medicine. Multiple studies have shown that patient compliance is typically less than 70% in chronic diseases (hypertension, diabetes). As glaucoma is both a chronic disease and medical management is the mainstay of therapy, patient compliance is an important factor in this disease. Many risk factors for low patient compliance have been identified however; the most commonly stated reason is patient forgetfulness. Information technology, especially internet use and cell phones, are increasingly being used by the general population. With this growth, potential means of increasing patient compliance include further patient education as well as automated reminders.

Methods
A questionnaire was given to patients seen at the Madigan Army Medical Center Glaucoma clinic.

Results
182 surveys were completed. In regards to technology, 82% of patients owned a cell phone and 42% owned a smart phone. 73% had access to the internet, and 50% used it daily. 66% of patients used the internet to research medical information and 53% used it to learn about glaucoma. Most patients (79%) found what they were looking for and most (81%) trusted the information. Men were more likely to find what they were looking for (93% vs. 63%) and were more trusting of the information they found (94% vs. 64%). In regards to receiving automated reminders, 41% would find it helpful all the time and 46% would decline the service. Older patients were more likely to decline the service (60% of patients older than 70 vs 21% ages 18-49). The most popular way to receive the reminders was via a call to patient’s home phone with 34% of respondents preferring this option and older patients more likely than younger to prefer this option (45% of patients older than 70 vs 13% ages 18-49). Younger patients were more likely to prefer a text to their cell phone (75% of patients 18-49 vs 2% older than 70).

Discussion
As with other chronic medical diseases, compliance to medical therapy is problematic in the treatment of glaucoma. Among the most common reasons reported by patients for medication non-compliance is forgetfulness. Boland et al reported improved patient compliance from 54 to 73% in patients receiving automated reminders to take once daily glaucoma medications¹. Our data shows that 41% of glaucoma patients completing our survey would be interested in receiving automated reminders to take once daily glaucoma medications¹. Interestingly, younger patients were more likely to indicate interest in such a service. Thus, as the glaucoma patient population ages, the use of information technology has the potential to play a significant role in improving glaucoma medication compliance.

Conclusion
Glaucoma patients are using technology and using it to learn about their disease. Automated reminders are a potential means to increase patient compliance and can be tailored to the patients’ preference.

Reference
Laser Trabeculoplasty Practice Patterns in Relation to Glaucoma Medication Adherence
VEENA RAO¹, Sandra Woolson², Ben Whigham¹, Cynthia Coffman³, Kelly Muir¹,²
¹ Duke Eye Center
² Durham VA Medical Center

Purpose/Relevance
Laser trabeculoplasty (LT) may be a useful treatment option in glaucoma patients with poor medication adherence. Here we investigate adherence in patients receiving LT compared to those receiving medications alone to examine if we are effectively utilizing LT in this setting. As some may have concerns of worsening adherence post-LT, we also studied adherence patterns following LT.

Methods
In this case control study, all patients with glaucoma on medications undergoing LT at Durham VA Medical Center between 1/1/05 and 1/1/11 were identified. Patients were included if they required medication at least 6 months prior to LT and filled medications at the VA pharmacy at least 3 times pre-and post-LT. Controls without LT history were matched on age and glaucoma severity. Medication possession ratio (MPR=days of medication supplied/days of medication needed) for each medication prescribed was calculated as a marker of adherence¹ for each subject at least 6 months pre- and post-LT (for controls, pre- and post-clinic visit closest to their matched subject’s LT). Statistical analyses were performed using SAS 9.2.

Results
A total of 190 patients (95 subjects, 95 controls) were included. Mean age was 65.0±11.1 years for subjects and 64.6±9.5 for controls (p=0.84); 98% of subjects and 96% of controls were male. There was no significant difference in age, glaucoma severity, clinician note of non-adherence, or other demographics between subjects and controls. Mean MPR pre-LT did not differ between subjects and controls [MPR=1.04±0.6 vs 1.03±0.6, p=0.80], including when MPR was capped at 1 (no credit for oversupply) [MPR=0.81±0.27 vs 0.83±0.32, p=0.53]. Subjects were on significantly more medications than controls (2.2±0.8 vs 1.6±0.8, p<0.0001) prior to LT. Following LT, mean MPR was not significantly changed (post-LT MPR=1.14±0.8 vs pre-LT MPR=1.04±0.6, p=0.20).

Discussion
Patients undergoing LT have a greater medication burden than those receiving medications alone; otherwise, they do not appear to differ in clinician-perceived non-adherence or MPR. MPR appeared adequate prior to LT and remained stable following treatment.

Conclusion
LT may be underutilized in patients with poor medication adherence. In the future, we may benefit from better using adherence patterns to guide LT treatment, especially as medication adherence does not appear to decrease following LT.

Reference
Anesthetic Device Reduces Pain Perception for Laser Iridotomy

SHENODA ELMASEH1,2, Julia Song1, Trisa Palmares1, Mike Song2, Alice Song2
1 Southern California Eye Physicians & Surgeons
2 Center for Oculofacial & Orbital Surgery

Purpose/Relevance
Anesthetics and distractors have been utilized, including ethyl chloride, lidocaine gel, ear pulling, coughing during the injection, and massaging to lessen the discomfort or the perception of discomfort. However, there are limitations including potential toxicity, cost, and patient movement. There is a new device, the Vibration Anesthetic Device (VAD, Blaine Labs),1 which works on the Gate theory to reduce the transmission of noxious stimuli by stimulating the large nerve fibers. Inhibitory cells are stimulated simultaneously so that the gates for pain are closed, and the transmission of pain to the thalamus is decreased.

According to the gate control theory of pain, A-β nerve fibers, which transmit information from vibration receptors (Pacinian corpuscles and Meissner corpuscles) and touch receptors in the skin, stimulate inhibitory interneurons in the spinal cord that in turn act to reduce the amount of pain signal transmitted by A-δ and C fibers from the skin to second-order neurons that cross the midline of the spinal cord and then ascend to the brain. The purpose of this study was to determine whether the VAD can help reduce pain associated with laser iridotomy.

Methods
Prospective study with survey of 14 patients undergoing laser iridotomies who received the VAD. 8 patients received VAD in the peri-orbital region. 6 of the patients received VAD on a remote region of their body (arm or shoulder).

Results
Of the 8 patients who received VAD in the peri-orbital region, 7 reported increased discomfort in eye receiving the VAD. 1 patient reported decreased discomfort in the receiving VAD. Of the 6 patients receiving VAD on the extremity, 4 reported decreased pain sensation when receiving VAD, while 2 reported increased pain with VAD application.

Discussion
Pain associated with laser iridotomy has not previously been discussed or addressed. Historically, VAD has not been shown to be efficacious in reducing pain in infants receiving venipuncture.2 However, it was found to be helpful in reducing pain associated with venipuncture in children 4-18 years of age.3 The VAD was not efficacious in reducing pain during corticosteroid injection for trigger finger.4 It has been proven useful in decreasing pain during dermatologic procedures/injection5 and oculoplastic procedures.6 Since our patients reported increased pain awareness while receiving VAD in the peri-orbital region, yet decreased pain while receiving VAD in the extremity, the location of the VAD may be a factor.

Conclusion
The VAD, when applied on the patient’s extremity, is a safe and effective method in reducing discomfort and perceived pain during laser iridotomy. Further studies are needed to determine how useful this device is for future glaucoma procedures.

References
Variation in Number of Doses, Bottle Volume, and Calculated Yearly Cost of Generic and Branded Latanoprost

JOANNA QUEEN1, David Lee1, Robert Feldman1
1 The University of Texas Medical School at Houston, Robert Cizik Eye Clinic

Purpose/Relevance
Discrepancies in doses per bottle and bottle fill volume of topical glaucoma medications has been a frequently debated issue. Such variations impact prescriber habits and cost to patients. The purpose of this study is to evaluate such discrepancies among branded and generic formulations of latanoprost, a popular and commonly prescribed medication with new-to-the-market generic availabilities.

Methods
Four regionally (Southeast US) available latanoprost formulations, branded Xalatan (Pfizer, New York, NY) and three generic latanoprost formulations (Akorn, Lake Forest, IL; Bausch + Lomb, Rochester, NY; and Sandoz, Princeton, NJ) were measured. Number of drops per bottle and actual bottle fill volume were measured from 10 bottles per manufacturer using a standard laboratory graduated cylinder and previously described collection techniques. All bottles were marketed as 2.5 mL volume. The annual cost (based on average wholesale price), days use per bottle, drops per milliliter, and number of bottles used per year were calculated. All calculations were based on the assumption of bilateral, once daily dosing. Data were summarized using mean, standard deviation, minimum, and maximum for each drug as well as compared among drugs using one-way analysis of variance with post hoc Duncan multiple comparisons.

Results
Please refer to Table 1. AWP=average wholesale price. Within data sets (columns), values denoted by the same number of asterisks are not significantly different from each other using Duncan multiple comparisons, and values denoted by different numbers of asterisks (i.e. * vs. ** vs. ***) are significantly different from each other using Duncan multiple comparisons.

Discussion
Significant differences exist among branded and generic formulations of latanoprost in all variables tested, including total volume, drops/doses per bottle and annual cost.

Conclusion
Annual cost and time to refill, factors important to patients in regards to medication use, vary significantly depending on manufacturer of latanoprost. Practitioners can better advise patients being aware of these differences.

References

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Name/Generic</th>
<th>Trade Average Fill Volume (ml)</th>
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Effect of Switching from Latanoprost to Bimatoprost in Primary Open-Angle Glaucoma Patients Who Experienced a Hypotensive Effect Reduction During Treatment

**C. Gustavo de Moraes**, Remo Susanna Jr, Renato Germano, Carolina Susanna, Milena Chibana

1. Columbia University Medical Center
2. University of Sao Paulo

**Purpose/Relevance**
To investigate intraocular pressure (IOP) variations after switching from 0.005% latanoprost to 0.01% bimatoprost in open-angle glaucoma patients who experienced a reduction of the hypotensive effect during treatment.

**Methods**
Single center, retrospective, interventional cohort study. We included 41 patients on latanoprost who showed a peak IOP increase of at least 15% (assessed during the Water Drinking Test, WDT2) relative to the peak IOP measured during the previous WDT (WDT1). In these patients, treatment was switched to 0.01% bimatoprost. A third WDT (WDT3) was performed two to four weeks thereafter. Main outcome measures: Baseline, peak, and IOP measurements at each time point (15, 30, and 45 minutes) during all three WDT sessions (WDT1, WDT2 and WDT3).

**Results**
Mean peak IOP was 15.6 mmHg (standard error (SE), 0.73) during WDT1; 21.1 mmHg (0.73) during WDT2; and 16.1 mmHg (0.73) during WDT3 (p <0.0001, repeated-measures ANOVA). Comparing WDT1 vs. WDT2, the mean peak IOP difference was 5.5 mmHg (p<0.0001); for WDT1 vs. WDT3, the difference was 0.5 mmHg (p=0.3127); for WDT2 vs. WDT3, the mean difference was -5.0 mmHg (p<0.0001). The mean IOP at each time point during the WDT sessions was significantly different between WDT1 and WDT2 and between WDT2 and WDT3.

**Discussion**
Many authors consider peak IOP the most important pressure parameter predictive of glaucoma progression. Our study shows that glaucoma patients on latanoprost who experienced loss of the IOP lowering effect may benefit from switching to bimatoprost. The peak IOP reduction was on average 5.0 mmHg, corresponding to a mean 23% reduction.

**Conclusion**
This alternative can potentially postpone more costly or invasive treatment options.

**References**
114 Do Males Have More Severe Glaucoma?

DAVID SEAMONT¹, David Eng¹, Andrew Plummer¹, Xilong Li¹, Beverley Adams-Huet¹, Karanjit Kooner¹
¹ University of Texas Southwestern Medical

Purpose/Relevance
To understand the role of gender in the development and progression of primary open angle glaucoma (POAG) by contrasting the severity of glaucoma, health differences and risk factors in male and female patients with POAG.

Methods
In an IRB approved cross-sectional study, 304 patients with POAG were interviewed across 3 hospitals (a county hospital, university based clinic, and VA hospital). Detailed family and medical histories were recorded from patients through a review of systems interview and verification from patient charts. Markers of the severity of glaucoma, such as family history of glaucoma, myopia, visual field (VF) defects, nerve fiber layer thickness, central corneal thickness (NFLA), C/D ratio, IOP, number of medications, and glaucoma surgeries were recorded. These markers, as well as patient comorbidities, were stratified by gender and compared using Fisher Exact test for categorical variables, analysis of variance for Gaussian distributions, and Kruskal-Wallis test for non-Gaussian continuous variables.

Results
There were 148 females and 156 males. Men had more VF damage of 1.99 vs 1.68 (p=0.0168) based on a 0-3 severity scale, higher C/D ratio of 0.77 vs 0.73 (p=0.0373) and needed more glaucoma medications (2.72 vs 2.11, p=<0.0001) than women respectively. No significant difference was found for CCT or IOP. 55.41% of women and only 39.1% of men had a first degree relative with POAG (p=.0057). Women were more likely to have immunological disease (51.35% vs 28.21%; p= <0.001) and disease of the GI system (36.49% compared to 23.08%; p= 0.012).

Discussion
The severity of VF defects in male patients points to a more severe disease course while the increased medications point to an increased difficulty in management of the disease. Family history of POAG was more associated with female patients than males. Women also seemed to carry higher burden of immunological and GI diseases, a finding that requires further exploration. With larger sample sizes and a control group, specific diseases can potentially be isolated as gender-specific co-morbidities in POAG.

Conclusion
Our study suggests that men develop a more severe form of glaucoma. In addition, it stresses that we need to consider both ocular and systemic associations in developing the picture of an “at-risk” patient, with implications both in gender-specific treatment plans and patient screening.

References
115 Diplopia Associated with Glaucoma Drainage Devices

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Purpose/Relevance
Although diplopia has been reported following Glaucoma Drainage Device (GDD) surgery1, there are minimal data on the specific causes, severity, and effect on health-related quality of life (HRQoL).

Methods
In this pilot study, we prospectively evaluated diplopia in 20 patients undergoing GDD surgery (twelve Baerveldt 350mm², two Baerveldt 250mm², and seven Ahmed FP7), compared with 17 patients who underwent trabeculectomy. Patients completed three established questionnaires – NEI VFQ-25, Adult Strabismus-20 (AS-20), and Diplopia Questionnaire (DQ), at least one month following surgery. We defined diplopia as “Sometimes”, “Often”, or “Always” in distance straight ahead and/or reading positions on DQ and determined underlying reasons for diplopia. We also compared HRQoL concerns based on AS-20 and VFQ-25 subscale scores between diplopic and non-diplopic patients.

Results
5 of 20 (25%) post-GDD patients reported diplopia, compared with 2 of 17 (11.8%) in the trabeculectomy group. All cases of post-GDD diplopia were associated with strabismus; two patients with exotropia, one with hypertropia, and one with excyclotropia. In all cases of post-GDD diplopia, strabismus and/or diplopia were noted pre-GDD placement except possibly for one case of sensory exotropia. All post-trabeculectomy diplopia cases were strabismus-related (esotropia and uncharacterized). AS-20 reading function scores were lower in diplopic patients (52.7 ± 31.8 vs. 68.2 ± 26.1). AS-20 general function scores were also worse in diplopic patients (55.7 ± 26.3 vs. 78.2 ± 20.4). In contrast, VFQ-25 reading & general function subscale scores were similar.

Discussion
DQ allows standardized collection of diplopia symptom data and reveals that about 1/4 of patients experience diplopia following GDD surgery. Nevertheless, all patients with diplopia post GDD had strabismus and/or diplopia prior to GDD placement. Diplopia following GDD or trabeculectomy surgery negatively affects HRQoL, particularly reading function and general function, and the AS-20 appears more sensitive than the VFQ-25 in detecting poor HRQoL.

Conclusion
Diplopia following GDD surgery may be more common than previously appreciated and affects HRQoL. Diplopia is primarily associated with strabismus, but strabismus and/or diplopia are often pre-existing and may not be related to GDD placement. Patients undergoing GDD surgery should have a standardized assessment of diplopia and strabismus both before and after surgery.

Reference
Comparison of Microbial Contamination Rates Between 2.5ml and 5.0ml Dispensers of Travoprost 0.004% with Sofzia

RENEE PETRIE¹, Pierre Blondeau¹, Mohammad Hamid², Olivier Lasnier³
¹ Université de Sherbrooke
² Université de Montréal
³ Hôpital Trois-Rivières

Purpose/Relevance
Repeated use of multi-dose containers of topical ophthalmic products are subject to contamination by a variety of microorganisms and may carry a risk of ocular infectious complications. We aimed to determine the rate of bacterial and fungal contamination of bottles of Travoprost Z 0.0004% with Sofzia based on duration of use of the medication.

Methods
Fifty-six asymptomatic glaucoma patients participated in this prospective single-blinded in-use pharmacological safety trial. After a new diagnosis of glaucoma, patients were randomly given a 2.5ml or 5.0ml dispenser of Travoprost 0.0004% with Sofzia. Patients assigned to the 2.5ml or 5.0ml group were asked to submit their topical drops after 3 or 6 weeks of use, respectively. Preparations were sent to the microbiology laboratory of Université de Sherbrooke for culture of remaining drops using blood agar, chocolate agar, Brucella agar, Sabouraud agar and Thioglycolate broth.

Results
Fifty-four dispensers of glaucoma medication were collected; 28/28 (100%) from the 2.5ml group and 26/28 (92.9%) from the 5.0 ml group. Bacteria were recovered from seven (13.0%) preparations. Four bottles (57.1%) were contaminated by Gram positive microorganisms and three bottles (42.9%) by Gram negative bacteria. Contamination rate was highest in the 5.0ml group (4/24, 16.7%) compared with the 2.5ml group (3/28, 10.7%). However, this difference was not statistically significant (p=0.447). No infectious complications were detected in either group.

Discussion
Clinical studies have demonstrated that although glaucoma drops frequently become contaminated, their typical chronic use does not represent a significant infectious risk. Our results support this finding because no infectious complication was detected even if 7 bottles were contaminated. We did not find that the contamination was related to the duration of use or format of dispenser.

Conclusion
Our data suggest that both formulations of Travaprost 0.004% with Sofzia had similar contamination and are found safe to use in terms of infectious complications. With proper use, patients can utilize the same dispenser at least 6 weeks before replacing it, which constitute a financial advantage over the one month recommended use.

References
The Best Glaucoma Quiz? A Qualitative and Quantitative Evaluation of Glaucoma Knowledge Assessments

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¹ Duke Eye Center

Purpose/Relevance
To determine which glaucoma quiz provides the best information about a glaucoma patient’s knowledge, to the clinician in a clinical practice setting.

Methods
Glaucoma knowledge quizzes were identified from the literature (Gray¹ and Hoevenaars²) and national eye education programs (National Eye Health Education Program, NEHEP, and Prevent Blindness America, PBA). The qualitative analysis included categorization of questions by topic. For the quantitative analysis, the quizzes were reviewed, rated, and ranked by members of the American Glaucoma Society, using an on-line survey. Descriptive statistics were done: percentages and means with standard deviations. Provider comments from the survey were analyzed qualitatively using themes and representative quotations.

Results
Qualitative analysis: All four quizzes covered content important for the diagnosis and management of glaucoma, with some differences between the quizzes. The NEHEP and PBA quizzes covered primarily diagnosis, screening, and risk factors; the quizzes from the literature covered primarily causes of glaucoma, vision loss, eye drops (Gray) and systemic disease (Hoevenaars). Provider survey: Overall, the NEHEP quiz was ranked best for use in clinical practice, ranked first by 38% of the respondents. Ranked second overall, the Gray quiz was ranked first by 34% and last by 34% of respondents.

Discussion
Glaucoma specialists ranked the NEHEP quiz as most useful, due to it being clear, easy-to-understand, and covering “the basics”, although a deficiency of this quiz was that knowledge about treatment was not covered. The short-answer-format of the Gray quiz garnered both strong positive and negative opinion, with a third of respondents ranking it first and another third ranking it last. It covered important content, and the open-ended short-answer-format could better identify gaps in knowledge; however, those same attributes may make this test less appealing to patients and more time-consuming in a busy clinical setting.

Conclusion
The NEHEP quiz appears to be most useful for assessing baseline general glaucoma knowledge in the setting of a busy clinical practice. The Gray quiz appears to be more useful as part of a comprehensive education program, perhaps in combination with an ophthalmic educator.

References
Resident Perspectives on Microinvasive Glaucoma Surgeries (MIGS)

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2 University of Alabama at Birmingham

Purpose/Relevance
Microinvasive glaucoma surgeries (MIGS) are a category of glaucoma surgeries intended to provide surgical treatment of open-angle glaucoma while minimizing the risk of surgical complications inherent to traditional glaucoma surgeries1. MIGS have been shown to reduce intraocular pressure while decreasing dependence on glaucoma medications, thus increasing interest in their use amongst ophthalmologists2. The purpose of our survey was to understand more about MIGS usage by ophthalmology residents in training as well as residents’ opinions about MIGS.

Methods
A brief, internet-based survey was sent to United States (US) ophthalmology residency program directors to be distributed to current residents in October 2014. The survey responses are reported here.

Results
Sixty-four responses were collected, of which 77% are postgraduate year three or four residents. Half of the residents rated their exposure to glaucoma surgery as “adequate,” and most residents had performed less than fifteen trabeculectomies or glaucoma drainage implant procedures thus far in their training. Opinions on MIGS were mixed with 75% finding them to have some value, but nearly a quarter of respondents were unsure. A majority reported that MIGS were offered at the hospitals or surgery centers at which they operate, with the iStent being most commonly available. Less than half of the residents reported the opportunity to participate in MIGS as an assistant or primary surgeon. Of those that will include glaucoma surgery in their future practice, over 75% plan to offer MIGS. Overall, nearly three quarters of residents surveyed felt that it was important to learn MIGS while in residency in order to be competitive/marketable upon the completion of residency.

Discussion
MIGS are a growing category of surgery in ophthalmology with interest amongst current US ophthalmology residents. Despite this interest, MIGS use in residency programs is low.

Conclusion
Efforts to expand the role of MIGS in resident education are needed to better prepare residents for their future practices.

References
119 Timeline of Glaucoma

DAVID ENG¹, Karanjit Kooner¹, Andrew Plummer¹, David Seamont¹, Xilong Li¹, Beverley Huet¹

¹UT Southwestern Medical Center

Purpose/Relevance
To establish a timeline of risk factors and comorbidities in patients with primary open angle glaucoma (POAG).

Methods
In an IRB-approved cross-sectional study, patients with POAG in at least one eye were interviewed. Patients with secondary or congenital glaucoma were excluded. Patients were selected from a university-based clinic, a county hospital, and a VA hospital. Data were collected for the following variables: sex, age, race, family history, date of POAG diagnosis, comorbidities, severity of comorbidities, and date of comorbidity diagnosis. A descriptive analysis was done to determine the mean age at diagnosis and percent of patients with each comorbidity.

Results
Of the 304 patients interviewed, 51.4% had a family history of POAG, 32.7% had myopia, 81.2% had cardiovascular disease (CVD), 39.6% had rheumatoid or immune disease (RID), 43.2% had endocrine or metabolic disease (EMD), 23% had a history of cancer (ONC), and 3.3% had a history of breast cancer (BC). The average age at diagnosis for each disease were as follows: CVD, 52.78±15.2; RID, 52.92±18.4; EMD, 55.49±13.32; POAG, 56.51±14.26; ONC, 62.50±12.36; BC, 63.60±9.65.

Discussion
In this study, CVD, EMD, and RID were diagnosed before POAG, and ONC and BC were diagnosed after POAG. Although the standard deviations for age at diagnosis were high, the general sequence of disease presentation appeared as listed previously. Because this was a descriptive study, no controls were recruited. Bias based on patient population cannot be ruled out.

Conclusion
This timeline provides a snapshot of the global associations of POAG and encourages us to be aware of the potential role of comorbidities in the progression of POAG. A longitudinal study may help further elucidate the sequence of events before and after a diagnosis of POAG.

References
120 Sutureless 360 Degree Cyclodialysis Cleft Repair

ANNA JUNK1,2, Sara Grace2
1 University of Miami
2 Miami Veterans Affairs Hospital

Purpose/Relevance
The treatment of cyclodialysis cleft and associated hypotony can be challenging. Even the cyclodialysis may be occult. Small clefts may be treated medically with laser cyclopegry. Clefts encompassing more than 4 clock hours require surgical intervention to achieve apposition of the sclera and the ciliary body to close the cleft. Surgical techniques include direct or indirect cyclopegry, anterior scleral buckling, vitrectomy with endotamponade and more recently, suture fixated Cionni ring placement.

Methods
A 54 year old male presented 9 days after blunt trauma left eye with decreased vision (VA cc 20/50, IOP 10 mm Hg) and was started on medical treatment with Prednisolone and Atropine. The patient was lost to follow up and returned 3 months later (VA counting fingers, IOP 2 mm Hg) with worsening hypotony maculopathy due to 360 degree cyclodialysis cleft. The deep cleft was not amenable to laser cyclopegry. Given the extent of the cleft over 360 degrees placement of capsular tension ring to the ciliary sulcus was considered. As preoperative lens calculations revealed 0.9 mm asymmetry in axial length and 0.3 mm asymmetry in anterior chamber depth phacoemulsification and suture fixation of the rings were avoided. To achieve complete closure of the cleft two overlapping 13 mm capsular tension rings were placed into the ciliary sulcus.

Results
Postoperatively the patient experienced gradual improvement of visual acuity, resolution of hypotony maculopathy and slow rise in IOP. Four months postoperatively best corrected visual acuity was 20/40, IOP 21. Axial length is 23.02 mm compared to 22.44 preoperatively, anterior chamber depth asymmetry is 0.4 mm compared to 0.3 mm preoperatively. On gonioscopy there is 360 degree angle recession.

Discussion
Cyclodialysis clefts are often difficult to visualize and challenging to repair. Multiple procedures are often required to achieve good visual acuity and resolution of hypotony. The placement of a capsular tension ring in the ciliary sulcus offers a new, more predictable and less traumatic approach. Typically, phakic patients will have concomitant cataract surgery and subsequent McCannel suture fixation of the capsular tension ring. The IOL selection for a hypotonus eye with traumatic deepened anterior chamber can be challenging especially as successful cleft repair will result in reversion of hypotony and postoperative increase in axial length.

Conclusion
This case demonstrates that capsular tension rings may be safely placed to the ciliary sulcus in phakic patients to achieve successful cyclodialysis cleft repair.

References
Patients' Attitudes Towards Generic Versus Brand-name Glaucoma Eye Drops

目的/関連性

グルコースの持続性の問題とうつ伏せに患者の対応をに関してのパラメタが急速に増している。この研究は対応の観点とこの対応の第一の研究である。この情報は医師が患者の対応の障害をビジュアライズするための有用な手段を提供し、この問題を解決するのに役立つ。

方法

アンケートは、2014年4月から6月までの間、少なくとも1個用いるグルコースの目薬が使用されている私的診療所の患者に配布されました。アンケートは16個の問題から成り立ち、グルコースの目薬、および患者の知識とこれらの目薬に対する態度を含んでいました。

結果

57％の被験者はブランド名のグルコースの目薬を使用し、9％の被験者はジェネリックのグルコースの目薬を使用し、22％の被験者はどちらも使用し、12％の被験者はどちらも知りませんでした。58％の被験者はそのグルコースの目薬を絶対に失ったことがない、40％の被験者はそのグルコースの目薬を時々失った、2％の被験者はそのグルコースの目薬を頻繁に失った。χ²=0.34, df=1, N=67, p=0.56）。Generic drops, 67% said cost, 23% said effectiveness, 10% said packaging, 15% said no difference, and 28% did not know (multiple answers allowed). 51% of respondents said they were willing to pay more for brand-name glucocorticoid drops. Only 35% of respondents correctly identified the FDA’s definition of a generic medication.

考察

患者はジェネリックとブランド名のグルコースの目薬の間で差を認識している。患者はブランド名の目薬を好むと好むが、ジェネリックの目薬とブランド名の目薬の使用の対応の統計的な影響がある。最後に、患者はジェネリック薬物の理解が不十分である。

結論

この研究は初めに、ジェネリックとブランド名のグルコースの目薬の対応の患者の態度を観察する。

引用

122 Do Bottle Cap Colors Adequately Communicate the Identity of Topical Ophthalmic Medications?

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2 Johns Hopkins
3 University of Colorado

Purpose/Relevance
Bottle color is a primary cue to help patients and physicians communicate about topical ophthalmic medications. However, it is unclear if cap color facilitates proper patient-physician communication, particularly amongst individuals with glaucoma who might have color vision deficiency.

Methods
Glaucoma patients provided descriptions of 11 distinct medication bottle caps. Patient-produced color descriptors were then presented to three physicians, and each was asked to match the color descriptor to the medication they thought the color descriptor was describing. The frequency of patient-physician agreement, occurring when all three physicians correctly matched the color descriptor to the correct medication, was calculated across the 11 medication bottles evaluated. Multivariate regression models evaluated whether patient-physician agreement decreased with the extent of better-eye visual field (VF) damage and/or the extent of color vision deficiency as determined by Hardy-Rand-Rittler (HRR) score and the Lanthony D15 testing index.

Results
The 100 glaucoma patients studied had a mean age of 69 (11) years, with a mean VF mean deviation of -4.7 (6.0) and -10.9 dB in the better and worse-seeing eyes, respectively. A total of 102 unique color descriptors were used to describe the colors of the 11 tested medication bottle caps. Among individual patients, the mean number of medications demonstrating patient-physician agreement was 6.1/11 (55%), and agreement rates across patients were noted to be less than 15% for 4 medications (prednisolone acetate, betaxolol, brinzolamide/brimonidine, and latanoprost). Lower HRR scores and higher D15 CCI (both indicating worse color vision) were associated with greater VF damage (p<0.001). Severity of better-eye VF damage and extent of color vision deficiency were both associated with a lower likelihood of patient-physician agreement in univariate analyses (p<0.05 for all), while greater color vision loss was the only significant predictor of patient-physician agreement in multivariate models (Odds of agreement = 0.90 per 1 point decrement in HRR score; p<0.001).

Discussion/Conclusion
Physician understanding of patient medication usage based solely on bottle cap color is frequently incorrect. Healthcare providers should be aware of potential errors based on communication using bottle cap color alone to protect patients from both confusion and harm.
123 Video Screen Capture of Flicker Chronoscopy and Other Ophthalmic Imaging

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¹ Weill Cornell Medical College

Purpose/Relevance
Flicker chronoscopy superimposes two optic nerve photographs allowing the observer to “flicker” between two images and observe change.¹ The technique is highly sensitive for detecting glaucomatous optic nerve changes.²,³ Sharing ophthalmic imaging, such as fundus photographs, has traditionally been accomplished by exporting images and then printing, transmitting by facsimile, or emailing the images. These methods work only for static imaging, and in some cases, may result in a significant loss of image quality. Inability to share high fidelity dynamic imaging with ease may lead to diagnostic delays and unnecessary retesting. We describe a simple technique for sharing high fidelity HIPAA compliant videos of flicker chronoscopy.

Methods
Flicker images were created from serial optic nerve head photographs obtained by a digital fundus camera (Topcon TRC50EX Retinal Camera; Topcon Corporation, Tokyo, Japan) and aligned using PerfectView software (Merge Healthcare, Chicago, Illinois) as is customary during our clinical evaluation of glaucoma patients. Software and web-based programs for video screen capture of flicker images were trialed. Windows compatible programs that enabled video export in .mp4 were included. Programs were evaluated on ease of use.

Results
Multiple video screen capture programs met inclusion criteria. Camtasia Studio (TechSmith, Okemos, Michigan) and Screencast-O-Matic (Screencase-O-Matic Agent, Seattle, Washington) enable creation of high fidelity videos of flicker chronoscopy. Camtasia Studio must be purchased, while Screencast-O-Matic is a free program that leaves a small logo watermark on exported videos. Both programs are easy to learn and generate videos cropped of identifying information.

Discussion
Video screen capture is an easy way to create videos of flicker chronoscopy. Videos can be shared by email or text message to seek real time opinions from colleagues that affect disease management. Additionally, the ability to share dynamic imaging may lead to enhanced case and conference presentations and thus valuable learning opportunities for trainees. Future applications include generating multi-slice video animations of neuroimaging and anterior segment optical coherence tomography.

Conclusion
Video screen capture of flicker chronoscopy is an easy and high fidelity way to share dynamic optic nerve head videos that may contribute to glaucoma management.

References
A Randomized Trial of Fixed-Dose Combination Brinzolamide 1% / Brimonidine 0.2% as Adjunctive Therapy to Travoprost 0.004%

ROBERT FELDMAN, GREGORY KATZ¹, Matthew McMenemy², Douglas Hubatsch³, Tony Realini⁴
¹ St. Joseph Mercy Medical Center
² Lone Star Eye Care, P.A.
³ Alcon Laboratories, Inc.
⁴ West Virginia University

Purpose/Relevance
Fixed-combination brinzolamide 1% / brimonidine 0.2% (BBFC) is currently the only fixed-combination glaucoma medication that does not contain a β-blocker.¹ The purpose of this study was to assess the additional IOP-lowering efficacy provided by BBFC when used in combination with travoprost 0.004% (TRAV).

Methods
This multicenter, randomized, double-masked, parallel-group study was conducted at 32 US sites from October 2013 to April 2014 (NCT01937299). Patients with open-angle glaucoma or ocular hypertension discontinued their prior glaucoma medications and received TRAV for 30 days. After washout, eligible patients were randomized to receive BBFC or vehicle 3 times daily in addition to once-daily TRAV for 6 weeks. The primary efficacy endpoint was mean diurnal IOP (8 am, 10 am, 3 pm, and 5 pm average) at week 6; secondary endpoints were mean and percent diurnal IOP change from baseline at week 6. Adverse events (AEs) were assessed throughout the study.

Results
Of 233 randomized patients, 229 were included in the intent-to-treat data set (BBFC+TRAV, n=113; vehicle+TRAV, n=116). Mean ± standard deviation patient age was 66.8±10.5 years; most patients were female (59.4%), white (78.6%), and diagnosed with open-angle glaucoma (72.1%). At week 6, diurnal IOP (least squares mean ± standard error) was 17.6±0.4 mmHg vs 20.7±0.4 mmHg with BBFC+TRAV vs vehicle+TRAV (P<0.0001), respectively. Mean and percent diurnal IOP reduction from baseline at week 6 were significantly greater with BBFC+TRAV vs vehicle+TRAV (–5.0±0.3 mmHg and –21.9±1.2% vs –2.0±0.3 mmHg and –8.8±1.2%; P<0.0001). At week 6, the IOP decrease from baseline during the day ranged from –3.9 to –6.2 mmHg for BBFC+TRAV and from –1.7 to –2.5 mmHg for vehicle+TRAV. The most frequent AE was conjunctival hyperemia (BBFC+TRAV, n=16 [13.7%]; vehicle+TRAV, n=7 [6.0%]). The most common ocular adverse drug reactions in both groups were hyperemia, blurred vision, allergic reactions, and ocular discomfort.

Discussion
Patients receiving BBFC+TRAV experienced significantly lower IOP after 6 weeks compared with patients receiving vehicle+TRAV and achieved significantly greater IOP reductions from baseline. These results demonstrate that BBFC+TRAV is effective and that IOP-lowering efficacy of BBFC is additive to that of TRAV. There were no new or unexpected safety concerns identified with the combined use of these agents.

Conclusion
Adding BBFC adjunctive to prostaglandin monotherapy is effective in IOP reduction and is well tolerated.

Reference
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