STA Interface NEWSLETTER

SOCIETY FOR TECHNOLOGY IN ANESTHESIA • APRIL 2019

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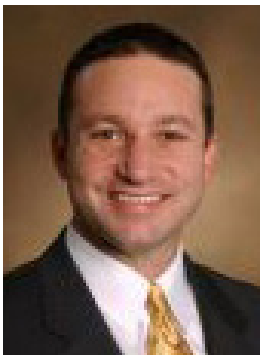

President's Message

BRIAN ROTHMAN, MD, Vanderbilt University

On behalf of the Society for Technology in Anesthesia (STA), I deeply appreciate and want to thank STA's outgoing President, Dr. Kai Kuck, for his leadership of our Society this past year. He and the Board of Directors did a great job leading the Society and, as we heard at our Annual Meeting in Scottsdale, the Society is in great shape. Our membership remains strong thanks to our Membership Committee Chair, Dr. Charlene Blake.

Drs. Matthew Levin and Charlene Blake, the Co-Chairs of this year's Annual Meeting at the Four Seasons in Scottsdale, Arizona, created an outstanding program exploring the theme "Mind and Machine". Panels explored how artificial intelligence and machine learning might impact and augment the quality of our care in the future, and were joined by topics including cyber security, medical education, closed loop systems and monitor design. Abstract Co-Chairs, Drs. Clyde Matava and Robert Freundlich ensured that we preserved and improved on the abstract quality we have enjoyed in previous years, and continued the "Posters in a Minute" sessions where authors are able to present their abstracts in a centralized fashion. I anticipate we will enjoy this format for years to come based on the favorable feedback received. Finally, the meeting again received accreditation for MOC LLSA and Clinical Informatics credits for our physician members.

We all deeply appreciate and thank Jane, Marie, Rachel, and their team who plan every event detail, work tirelessly with hotel staff during the meeting to ensure our Annual Meetings run without a hitch, and works with the STA the rest of the year to keep our Society running smoothly. The success of the 2019 Annual Meeting would not have been possible without our SAMI management team.

STA is sustained by the support and ongoing relationships with our Corporate Members, and our Corporate Members have STA's special thanks for their continued support. We recognize that there are competing priorities and thank all of you for making us your priority. Our Corporate Members are our priority, and

President's Message
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In This Issue

President's Message *continued from previous page*

we are continuously seeking ways to improve the experience and value of membership at the Annual Meeting and throughout the year. To augment Corporate Membership further, a membership roundtable was dedicated this January to gain feedback and insight from all Corporate Members on how STA might deliver more value during the Annual Meeting and importantly, between meetings. There were some practical and popular ideas introduced, and we look forward to trying them out in months and years to come.

STA introduced a new Sustaining Corporate Member category that allows Corporate Members to take advantage of a robust three-year membership benefit package. More information on this can be found on the STA website. STA Sustaining Corporate Members, Edwards Lifesciences (Platinum Plus), Becton Dickinson (Platinum), Draeger Medical (Platinum) and GE Healthcare (Gold), are hopefully the first of many to take advantage of this new Sustaining Corporate Member program.

I want to extend my congratulations to Dr. Jan Ehrenwerth, this year's recipient of the J.S. Gravenstein Award for his lifetime achievements in technology in anesthesia. Dr. Ehrenwerth has been a Professor of Anesthesiology at Yale since 1990. His contributions to equipment and patient safety issues is extensive in the form of countless presentations, article, and book chapters. His book entitled, "Anesthesia Equipment: Principles and Applications" is gearing up for a new edition. He has served and led the STA for many years in several Board of Director positions including President, and in recent years, he continues to be very involved as a member and a mentor to many of us. Most significantly, his leadership guided STA through some particularly difficult years and has allowed our membership to continue to benefit from the relationships and educational content that we enjoy today. His leadership contributions to anesthesia extend beyond the STA as well, including: President of the Connecticut State Society of Anesthesiologists, a Member of the Board of Directors of the Anesthesia Patient Safety Foundation and the American Society of Anesthesiologists, and Senior Examiner for the American Board of Anesthesiology. His career and achievements embody what the STA and J.S. Gravenstein Award are all about, including a strong foundation and outstanding achievements in anesthesiology, science, and engineering.

Another round of congratulations is due to the recipient of this year's Neurowave Research Grant, Dr. Asad Siddiqui at the Hospital for Sick Kids in Toronto, Canada. Looking forward, our relationships with other organizations and opportunities continue to expand. We would like to thank Neurowave for extending their $5,000 grant for the next two years. Consider submitting your proposal through the STA website once the submission portal opens in June.

Our United Kingdom counterparts, Society for Computing and Technology in Anaesthesia (SCATA), continued to have a strong

President's Message *continues on next page*

President's Message *continued from previous page*

showing this year. Drs. Cyrus Razavi and Craig Johnstone delivered outstanding prototype presentations during the entrepreneurial session. We thank them for their time, effort, expertise, and contribution to strengthening the relationship between our two societies. Dr. Jonathan Wanderer will be presenting at the 2019 SCATA Annual Meeting in Manchester, England, and we are all looking forward to building and strengthening our relationship with SCATA in the years to come.

Dr. Maxime Canneson has expertly served as the Executive Section Editor, Technology, Computing and Simulation, of the Society's official scientific journal, Anesthesia & Analgesia (A&A), and has requested that we begin a search for his successor. STA is grateful for his outstanding service and commitment to this important role. His tenure is notable for the further improving the quality and quantity of technology manuscripts in A&A. The STA is accepting applications for Candidates who are leaders in academic anesthesiology, particularly in the many technologies applicable to the field of anesthesiology: perioperative medicine, critical care, and pain management. Candidates should have an international reputation for research excellence in anesthesia technology, computing, and simulation. Candidates should also have a record of manuscript peer review, and proven administrative and organizational skills. Interested candidates should submit their curriculum vitae to the STA office via email at marie@stahq.org.

I am excited for the STA's growth opportunities this year and in the years to come. Let us continue to create even more opportunities for engineers, clinicians, and industry to meet, network, and collaborate on technology innovations in the changing anesthesiology and healthcare environment. The increasing number of younger members in our Society combined with the many members that have deep experience in anesthesia technology innovation provides an excellent opportunity for creating a strong mentoring program in STA.

Please be sure to join us for these important, upcoming events – STA's panel at the International Anesthesia Research Society (IARS) Annual Meeting in Montreal on Sunday, May 19 from 2-3:30pm (STA members enjoy a discount on IARS' full membership), STA's panel at the American Society of Anesthesiologists (ASA) Annual Meeting in Orlando on Saturday, October 19 from 2:45-4:45pm, and of course, the Ty Smith Dinner on Sunday, October 20 in Orlando (location TBD).

Drs. Matava and Freundlich have the honor of Co-Chairing STA's 30th Annual Meeting in 2020 at the Four Seasons in Austin, Texas. It promises to be one that should not be missed. In the time between these important invents, please continue to engage with STA, share ideas, and stay involved!

Report from the Executive Director

JANE SVINICKI, CAE

Welcome to 2019!

The beginning of the year is always hectic as STA holds its Annual Meeting in January. The Four Seasons Scottsdale was a beautiful venue for the meeting, and many attendees are asking to return to the hotel in the future.

STA members are certainly a group of lifelong learners, highly engaged in their field and in the organization. Continuous learning is part of my personal mission statement. I believe that if you do what you love, you can never know everything about it.

Another part of the personal mission statement is to keep traveling, which I believe is also part of my continuous learning.

In November, I had the opportunity to visit the country of Nepal and hike in the high mountains. It was an incredible experience, and it pushed me both mentally and physically. We spent a week hiking from village to village on the Annapurna Circuit. This 128-mile route circles Nepal's Annapurna range and first opened to foreigners in the early 1980s. I only hiked a small portion of the trail during my one-week guided tour.

It was a humbling experience as we walked along trails that have been the transportation highway in this part of the world for hundreds of years. Our Sherpas walked uneven stone paths for

hours carrying up to 50 pounds of our personal items in handmade baskets.

Sometimes they would hold our hands and guide us over the 'difficult' parts of the trail. Walking through the villages, we were so close to the homes of these high-country residents that we were looking into living rooms and kitchens as they cooked meals. Each night, as we arrived at a lodge, we settled in with our Everest beer, hearty food, and music and dancing from the Sherpas.

The Nepalese people are generous and friendly, living close to nature in some of the most remote places in the world. Every day is a quiet life of work and meditation, eating and connecting with others – all bound together for survival.

For all of you, I wish you a year of learning and new experiences. Since my return from Nepal, I have been asked where I am going next and I don't have a destination yet. But when I find a place I could love, I will go there!

Jane A. Svinicki, CAE,
Executive Director

Highlights from the 2019 STA Annual Meeting

MATTHEW LEVIN, MD
2019 Annual Meeting Program Co-Chair
Icahn School of Medicine at Mount Sinai

CHARLENE BLAKE, MD, PHD
2019 Annual Meeting Program Co-Chair
University of California, San Francisco

Clinicians and industry members came together to enjoy the beautiful vistas and fine hospitality of the Four Seasons Resort in Scottsdale, Arizona at the 2019 STA Annual Meeting in January. The theme of the meeting was "Mind and Machine" and each session highlighted ways in which our specialty is being driven forward by the deep and growing role of machine learning, computer-based simulation, and integrated electronic health records (EHRs) in our specialty.

The meeting opened with a fascinating keynote by Ben Ransford, PhD, of Virta Labs, who talked about "The Hidden Cyber security Risks of Hyperconnected Healthcare". With a serious but jolly tone, Dr. Ransford gave a broad overview of the security threats facing the modern healthcare system, from replay and side-channel attacks on pacemakers to the threat of ransomware and hardware/software obsolescence for healthcare organizations.

The keynote was followed by the "Innovations in Technology in Medical Education" session, which highlighted the recent advances in screen-based, augmented, and virtual reality simulation. The presentations were complemented by a hands-on session the following day that allowed attendees to try out both the simulations that were presented, as well as the developer toolkit used to build the simulations.

"Posters in a Minute", the popular abstract presentation format pioneered at the 2018 STA Annual Meeting, returned again this year. Presenting authors had one minute to summarize the purpose and key points from their work on the main stage. Other sessions highlighted emerging device technologies, challenges and opportunities with next generation EHRs, deep dives into machine learning algorithms, and the annual Young Researchers Workshop and Engineering Challenge. Finally, the meeting wrapped up with "Anesthesiologist Idol", an entrepreneurial pitch competition inspired by "American Idol" style TV shows.

Many thanks to all the STA members whose attendance and enthusiasm made the meeting such a success. On pages 9-12 is a brief photographic summary of the meeting. More details and material from the meeting can be found on the STA website: www.stahq.org/resources/annual-meeting-archive/2019

Please save the date – January 15-18 for the 2020 STA Annual Meeting, where STA will be celebrating its 30th anniversary! More details to come on the STA website.

2019 STA Annual Meeting Abstract Winners

Abstracts Listed on pages 15-20

Best in Show
Endotracheal Tube Intracuff Pressure is Not Equal to Tracheal Wall Pressure on a Simulated Trachea
Presenting Author: B. Randall Brenn, MD, Vanderbilt University

Best Clinical Application
A Visual Analytics Dashboard to Summarize Serial Anesthesia Records in Pediatric Radiation Therapy
Presenting Author: Olivia Nelson, MD, Children's Hospital of Philadelphia

Excellence in Technology
Rating the Severity of Opioid-Induced Ataxic Breathing in Healthy Humans
Presenting Author: Sean Ermer, BS, University of Utah

Honorable Mention
Assessing Pain Under General Anesthesia with Functional Near Infrared Spectroscopy
Author: Andrea Gomez-Morad, MD, Boston Children's Hospital

2019 J.S. Gravenstein Award Winner

JAMES SZOCIK, MD
STA Communications Committee Chair
University of Michigan

Preceding his lecture, Dr. Jan Ehrenwerth, the 2019 recipient of the J.S. Gravenstein Award, was introduced by Dr. Brian Rothman, President of the Society for Technology in Anesthesia (STA). Jan began by paying tribute to J.S. Gravenstein, then introduced his talk regarding his path through a career in anesthesia. He stated that he was not an engineer, but during an organic chemistry lab experiment, Jan had a foreshadowing of his upcoming career. He was attempting to dissolve a substance in the laboratory, and decided to heat the container to speed-up the rate of dissolving, thereby starting a fire across the entire lab bench. The solvent was ether; foreshadowing Dr. Ehrenwerth's future interest in anesthesia and operating room fires.

Dr. Brian Rothman presenting Dr. Jan Ehrenwerth with the J.S. Gravenstein Award

Between Jan's M2 and M3 year, the American Society of Anesthesiologists (ASA)-sponsored summer preceptorships. Citing fate, chance and serendipity, Dr. Ehrenwerth wound up working at Mercy Hospital in Pittsburg, Pennsylvania, with Dr. Rick Siker, the chair of the department at that time. The chief resident was Dr. Jim Cottrell, later ASA President, and chair at SUNY. His interest in both anesthesia and technology equipment was solidified with a trip to Cardiff, Wales, where he met Professor Mapleson.

At the time of his residency, every machine and ventilator were dangerous. There were only two operating rooms with invasive monitoring, many had Ohio Vernitrol machines (www.woodlibrarymuseum.org/museum/item/949/ohio-verni-trol-machine) and McKesson 1653 (www.woodlibrarymuseum.org/museum/item/1115/mckesson-1653) with Air Shields Ventilators. Central venous pressure measurements were done with 12-gauge needles, using the catheter threaded through the needle technique. Jan introduced the Seldinger technique to his practice. He spoke of succinylcholine drips, dangerous in multiple ways, and used on multiple patients in contradiction to modern standards. To improve safety, Jan added methylene blue to the drip to aid identification and stop the administration of a paralyzing agent to an awake patient.

Dr. Ehrenwerth worked with Dr. Phil Larson at Stanford for six years. While at Stanford, Jan also worked with Dr. Al Hackel on neonatal transport, Dr. Mike Rosenthal on adult transport [CCM Mar 1981, CCVM Jul 1986], and he met Drs. Chuck Whitaker and Bill New at Stanford, who together created the Nellcor pulse ox. (www.researchgate.net/publication/3155896_Air-To-Ground_Communications_A_Valuable_Aid_in_the_Transport_of_Critically_Ill_Patients)

Jan was then introduced to Dr. Paul Barash and moved to Yale. At Yale, he had two roles - Director of Equipment and Education and Section Chief. In his position as head of education, he managed the visiting professors and started teaching a resident anesthesia machine workshop that became the ASA machine workshop. At the ASA, Jan was eventually the chair of the ASA refresher courses. Additionally, Jan wrote an electrical safety chapter in Dr. Paul Barash's anesthesia textbook, and he was introduced by Dr. Barash to Dr. James Eisenkraft, yielding an anesthesia equipment textbook authored by all three.

At Yale, much of the equipment was old and outdated. Dr. Ehrenwerth brought with him agent analysis and CO_2 monitoring using mass spectroscopy and upgraded from Dr. Boyle's anesthesia machines to modern machines. (www.youtube.com/watch?v=1m-9BUZ6OQY)

Jan also chaired the ASA committee on equipment and was appointed to the ASTM Standards Organization and National Fire Prevention Association (NFPA). While participating in the standards organizations, he fought a ten-year battle over isolated power. American Society Heath Systems and Kaiser opposed to isolated power, which became optional in 1984, but was reinstated as a wet location in operating rooms in 2012 (www.apsf.org/article/line-isolation-still-important). Jan served on the APSF Board of Directors for 25 years.

Gravenstein Award Winner *continues on next page*

Gravenstein Award Winner *continued from previous page*

Jan has a long history with the STA. He participated in the founding of STA (1990-1992) and served as its President in 1997. Prior to that, Jan served as Treasurer where he discovered STA fell victim to embezzlement by the Phenix Corporation, leaving the Society with $15,000 in debt and only $9,000 in cash. He negotiated resolutions in 1994 and helped the STA regain financial stability. Jan proceeded to give a humorous anecdote relating how he bluffed his way onto the USS Salt Lake City nuclear submarine in San Diego at an STA Annual Meeting.

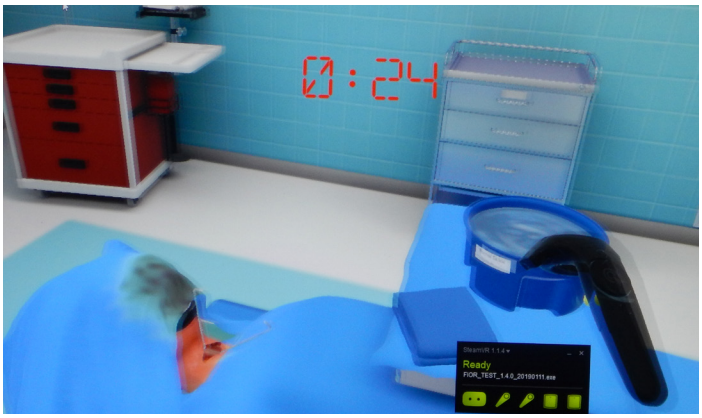
Finally, Dr. Ehrenwerth left us with these take away points:

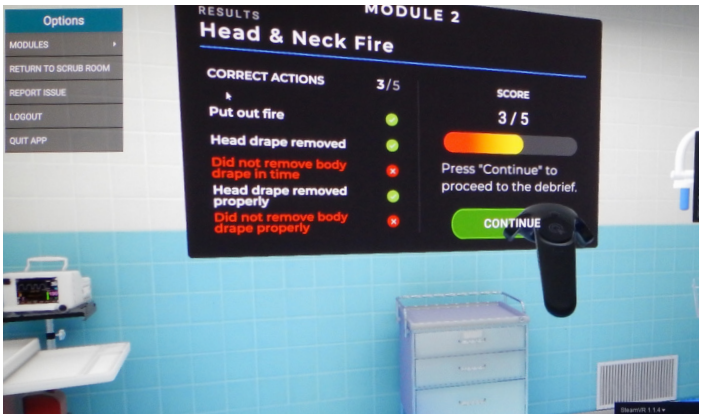
1. **Understand technology, minimize black box concepts**
2. **Teach technology**
3. **Promote technology**
4. **Leadership roles in ASA, standards organizations, and APSF**
5. **Never stop asking questions…**

2019 STA Annual Meeting Photos

Dr. Charlene Blake in Virtual Reality (What we see)

Dr. Charlene Blake in Virtual Reality (What she sees)





2019 Annual Meeting Photos *continues on next page*

2019 Annual Meeting Photos *continued from previous page*

Drs. John Feiner, Norma Sandrock and Joan Spiegel at the Opening Reception

Mindray North America - Gold Annual Corporate Members

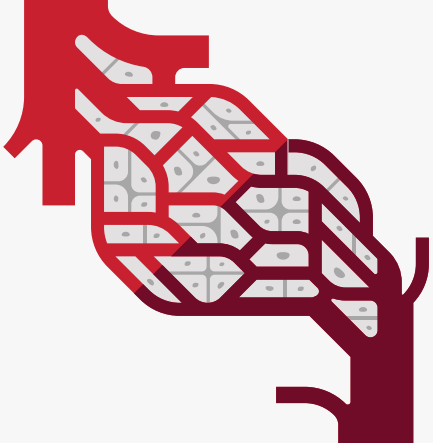
Masimo – Gold Annual Corporate Members

Drs. Joseph Orr and Jeff Mandel at the Opening Reception

Mr. Sean Ermer, Excellence in Technology Abstract Award Recipient with Dr. Thomas Hemmerling

Dr. Olivia Nelson, Best Clinical Application Abstract Award Recipient and Dr. Thomas Hemmerling

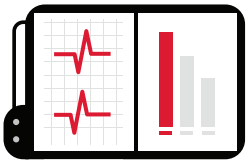
2019 Annual Meeting Photos *continues on page 11*



Intraoperative hypotension matters

Recent studies show associations between intraoperative hypotension and increased risk of myocardial injury (MI) and acute kidney injury (AKI) in non-cardiac surgical patients.[1,3]

Myocardial injury is the leading cause of people dying within a month after surgery.[2]



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1. Sun, L.Y., et al. (2015). Association of Intraoperative Hypotension with Acute Kidney Injury after Elective Noncardiac Surgery. Anesthesiology, 123(3), 515-523.

2. Salmasi, V., et al. (2017). Relationship between intraoperative hypotension, defined by either reduction from baseline or absolute thresholds, and acute kidney injury and myocardial injury. Anesthesiology, 126(1), 47-65.

3. Walsh, M., et al. (2013). Relationship between Intraoperative Mean Arterial Pressure and Clinical Outcomes after Noncardiac Surgery. Anesthesiology, 119(3), 507-515.

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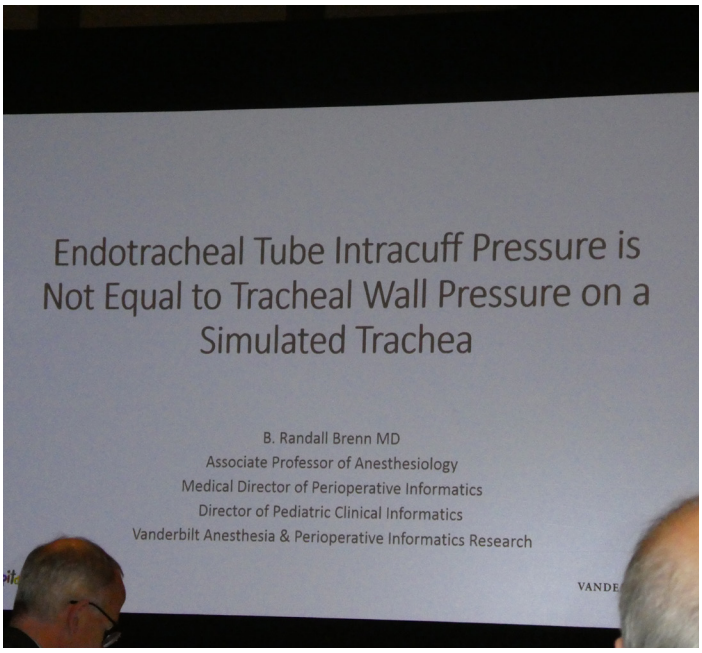
2019 Annual Meeting Photos *continued from page 9*

Dr. B. Randall Brenn, Best of Show Abstract Award Recipient and Dr. Thomas Hemmerling

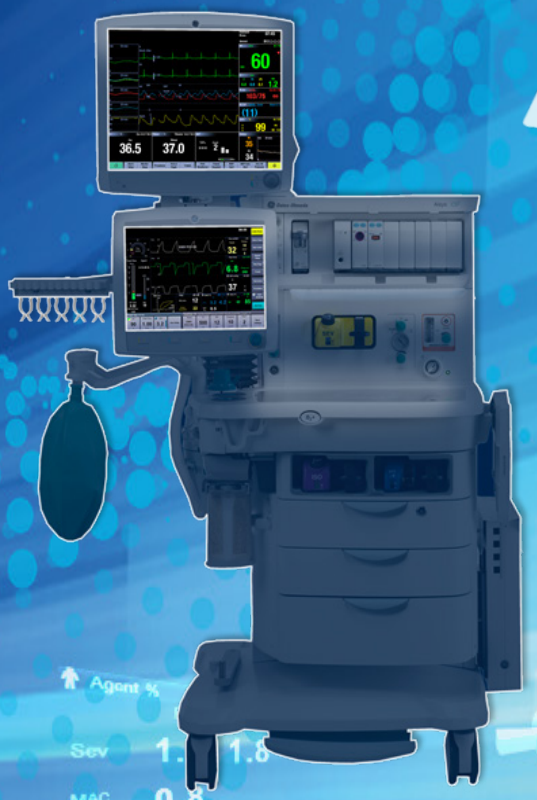
Dr. Andrea Gomez Morad, Honorarble Mention Abstract Award Recipient, and Dr. Thomas Hemmerling



Dr. B. Randall Brenn, Best of Show Abstract Award Recipient Presentation

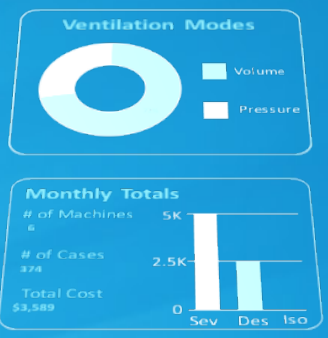
Carestation Insights

...unleashing the power of connected data



APPLY

ANALYZE



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2019 Engineering Challenge

JEFFREY MANDEL, MD, MS
Perelman School of Medicine at the University of Pennsylvania

The STA Engineering Challenge for 2019 was to demonstrate how quantum computing could be applied to the problem of end-of-day relief for anesthesiologists. The challenge to the entrants is to educate the membership on the technology through the assigned problem. Most anesthesiologists have, at some point in their career, been subject to the need to make assignments of staff in order to transition from daytime to evening coverage. While it may seem like a simple problem, there are many possible solutions, and evaluating all of them becomes extremely time consuming as the number of anesthesiologists grows, often as the factorial of the number of assignments. Quantum computing may offer a solution to this problem.

A number of companies have developed quantum computers. These devices operate at temperatures near 0° Kelvin and are accessed through a network interface using libraries that can be called from languages such as Python. Small amounts of time on a quantum computer can be obtained free of charge, and quantum programs can run in computer simulation, albeit very slowly. Quantum programs exploit interesting effects to find the solution to minimization problems - a conventional solution might get stuck in a local minimum; a quantum program can use quantum tunneling to traverse directly between minima. Quantum computers are capable of state superposition, meaning many solutions can be expressed simultaneously. Quantum computers may be general purpose, containing a relatively small number of quantum bits (qubits), such as Rigetti or IBM Q, or may contain a larger number of qubits that are restricted to the single task of quantum annealing, such as D-Wave Systems.

Three groups presented their solutions to the challenge; Dr. Michael Burns from the University of Michigan, Ms. Angad Kalra from University of Toronto, and Dr. Chris Connor from Brigham and Women's Hospital. Dr. Burns presented a branch and bound solution using the D-Wave system. The essence of the solution is an Adiabatic quantum computation, which represents each possible set of assignments as an energy state and seeks to minimize the energy by satisfying soft constraints. The system explores the possible solutions in parallel, trimming branches that are unlikely solutions, until a likely solution is found.

Ms. Kalra presented a directed graph solution using the Rigetti Python library. The system considers each move of one anesthesiologist to replace another as a path on a graph that has a weight; the weights are evaluated in parallel using quantum superposition.

Dr. Connor led with a discussion of the use of quantum annealing using the D-Wave to explore the entire solution space, but concluded that this was an inefficient approach, and presented a simpler approach known as the Hungarian algorithm. This approach constructs a matrix of all available workers and all available jobs, with a cost for each cell in the matrix. It then uses linear transformations on the matrix to find the lowest cost for each assignment. The advantage of this approach is that its computational demands are polynomial, not factorial, and thus may be soluble with conventional computers.

While quantum computing is clearly an evolving field, and it is unlikely that real world anesthesia schedules will be run on quantum computers in the next few years, as the field develops, this may be the way of the future. Which department wouldn't want to be so chill that it ran the schedule at 0° K?

2019 STA Annual Meeting Abstract Winners

Best in Show

Endotracheal Tube Intracuff Pressure is Not Equal to Tracheal Wall Pressure on a Simulated Trachea

Presenting Author: B. Randall Brenn MD, Vanderbilt University Medical Center, Nashville TN; **Co-Authors:** Dinesh K. Choudhry MD, FRCA, Alfred I. duPont Hospital for Children, Wilmington DE; Nicholas A. Brenn BSEE, MSEE, Nespresso: Industrial Engineering, Lausanne CH

Introduction: It has been known for decades that pressure exerted by the inflated endotracheal tube cuff on the tracheal wall (TWP), if excessive, can cause tracheal mucosal ischemia leading to necrosis, scarring and tracheal stenosis.(1) It is generally accepted that if the TWP does not exceed 30 mm Hg that there will be little chance of mucosal damage in long term intubation. (2) Also, it is accepted that high-volume low-pressure cuffs if not stretched, the intra-cuff pressure, as measured by the attached pilot balloon, should closely correlate with TWP. (3) The objective of this study was to test the correlation between intra-cuff pressures and TWP using 3 different cuffed tubes in a simulated trachea.

Methods: A 4mm force sensitive resistor (SEN-09673, Sparkfun.com) was transposed between the outside of ETT cuff positioned inside an 8 mm ID ETT serving as an in-vitro trachea (faux trachea). Three different sizes of ETT (3.0, 3.5, and 4.0 mm ID) were placed in the faux trachea for the study purpose. A voltage divider circuit was created with the sensor and a current limiting resistor. The pressure applied to the sensor generates a variable voltage output which is read by the Analog-to-Digital Converter (ADC) on an Arduino (Arduino Uno-R3) microcontroller (Software version: Arduino 1.8.5). The ETTs pilot balloon was attached to a three-way stopcock attached to tubing to a manometer in an airtight closed system. Each ETTs pilot balloon was inflated in 0.5cc increments. The pressures inside the cuff were measured with the connected manometer and force exerted by the inflated pilot balloon on the inside of the faux trachea were measured by the transposed sensor. Recordings of the serial pressures were transferred to a spreadsheet for graphical interpretation.

Results: The intracuff pressures and the transmural forces exerted between the ETT cuff and the faux trachea are recorded with an interposed sensor for each ETT are shown in figure 1. As the volume and pressure in the pilot balloon is increased, there are clear differences in the resultant recorded tracheal force exerted by the cuffs of different sized ETT tubes.

Conclusions: This apparatus revealed that the same intracuff pressure exerts different tracheal wall pressures depending on the size of the endotracheal tubes. The concept that the pilot balloon measured cuff pressure is a good measure of tracheal wall pressure exerted by the ETT cuff is not true.

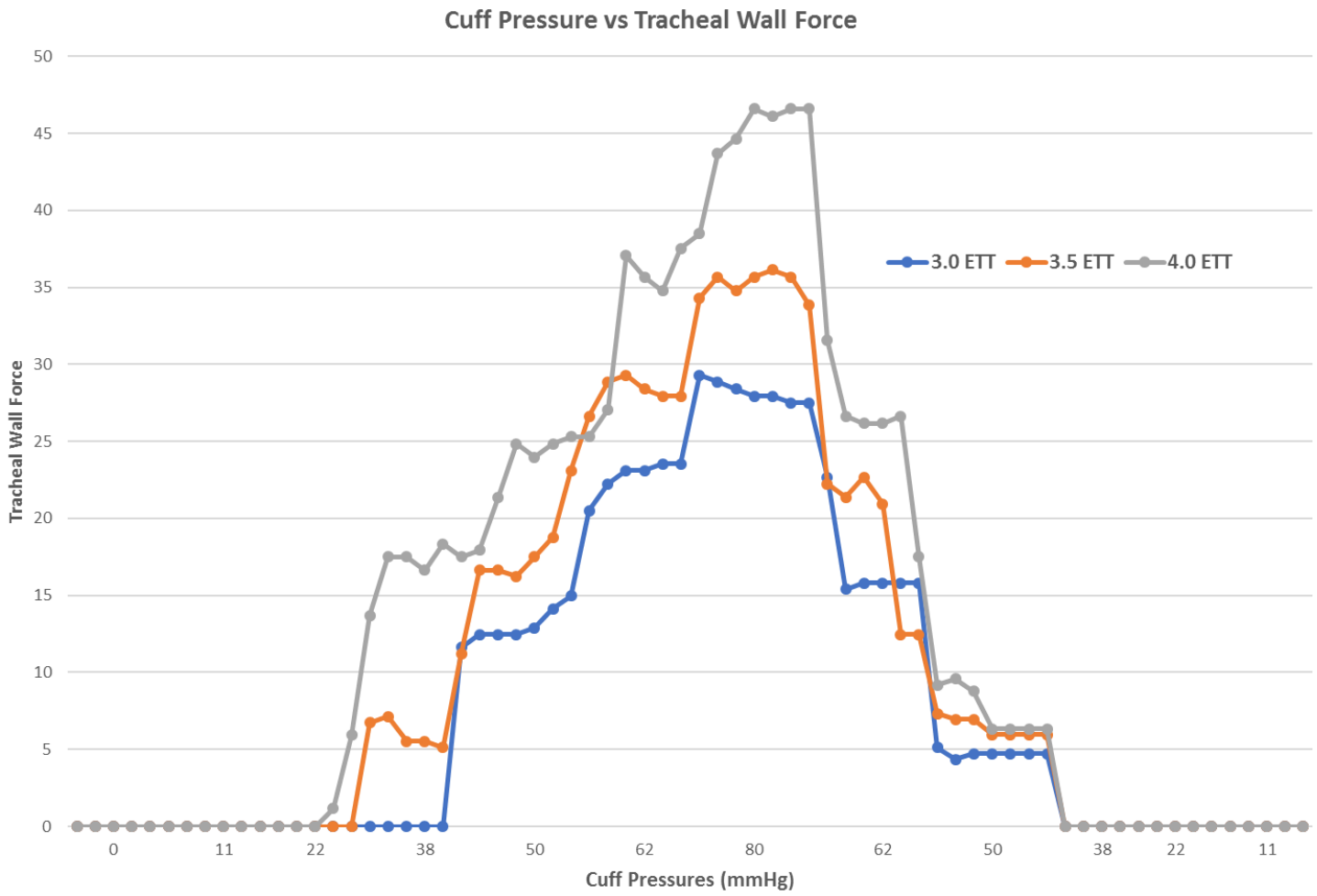
References: 1.Knowlson GT, Bassett HF**.** Br J Anaesth. 1970;42(10):834-7. 2. Seegobin RD, van Hasselt GL**.** Br Med J. 1984;288(6422):965-8. 3.Talekar CR, Udy AA, Boots RJ, Lipman J, Cook D**.** Anaes Int Care2014;42(6):761-70.

Figure 1.

2019 STA Annual Meeting Abstract Winners

Best in Show

page 2



2019 STA Annual Meeting Abstract Winners

Best Clinical Application

A Visual Analytics Dashboard to Summarize Serial Anesthesia Records in Pediatric Radiation Therapy

Presenting Author: Olivia Nelson MD, Department of Anesthesiology and Critical Care, Children's Hospital of Philadelphia

Co-Authors: Brian Sturgis, Enterprise Reporting & Analytics, The Children's Hospital of Philadelphia.
Keri Gilbert, MSN, CRNA, CCRN, Department of Anesthesiology and Critical Care Medicine, Children's Hospital of Philadelphia
Elizabeth Henry, RN, BSN. Pediatric Proton Therapy Center, Perelman Center for Advanced Medicine. The Children's Hospital of Philadelphia
Kelly Clegg, RN, BSN, CPHON. Clinical Supervisor, Pediatric Proton Therapy Center, Perelman Center for Advanced Medicine. The Children's Hospital of Philadelphia
Jonathan Tan, MD, MPH, MBI, Department of Anesthesiology and Critical Care, University of Pennsylvania Perelman School of Medicine; Department of Anesthesiology and Critical Care Medicine, Children's Hospital of Philadelphia
Jack Wasey, MD, Department of Anesthesiology and Critical Care Medicine, Children's Hospital of Philadelphia
Allan Simpao, MD, MBI, Department of Anesthesiology and Critical Care, University of Pennsylvania Perelman School of Medicine; Department of Anesthesiology and Critical Care Medicine, Children's Hospital of Philadelphia
Jorge Galvez, MD, MBI, Department of Anesthesiology and Critical Care, University of Pennsylvania Perelman School of Medicine; Department of Anesthesiology and Critical Care Medicine, Children's Hospital of Philadelphia

Introduction: Children undergoing radiation therapy require daily sedation or general anesthesia for the duration of their treatments.[1] Patient position is paramount to allow precise targeting of the radiation beam which is then replicated during subsequent treatments. The user interface of the electronic health record can hinder reviewing serial anesthesia records. We designed a visual analytics interface that simultaneously displays data from multiple anesthesia encounters.

Methods Documentation in the electronic health record (EHR, Epic Systems, Verona, WI) is backed up in a clinical data warehouse on a daily basis. A visual analytics interface (Qlikview, QlikTech, Radnor, Pennsylvania) was built to aggregate data from all anesthesia encounters in pediatric radiation oncology at The Children's Hospital of Philadelphia. The display includes the patient schedule, medications administered, airway device used, radiation procedure completed, recovery room time and agitation scale. The application was embedded in the EHR's anesthesia module and automatically updated daily.

Results: The dashboard was divided into four sections with icon legends: medications, airways, procedures, and recovery score and time. Each anesthesia encounter is represented by a vertical line with the date at the bottom of the screen. The medication icons display dosing information when the mouse cursor hovers over an icon. The airway section shows icons for endotracheal tube (ETT) or laryngeal mask airway (LMA) and a number to denote the size of the

2019 STA Annual Meeting Abstract Winners

Best Clinical Application

device (e.g. a green circle with 1.5 represents a size 1.5 LMA). The procedures section shows the various procedure types including CT simulation (CT-SIM), conventional radiation therapy (XRT) and proton radiation therapy (PROTON). The "days between" represents the number of days between the current and previous anesthetic.

The patient displayed underwent one course of radiation therapy finishing in 2017, and then began another course of radiation therapy 352 days later. The recovery score and time section includes "Time to Phase 2" representing the duration of the initial recovery phase from anesthesia in minutes. The delirium scale shows the patient's maximum recovery score based on the Watcha scale (1- calm, asleep, 2- calm, can be consoled, 3- crying, cannot be consoled, 4- thrashing and inconsolable).[2] The dashboard was incorporated into the pediatric radiation therapy team's daily morning huddle.

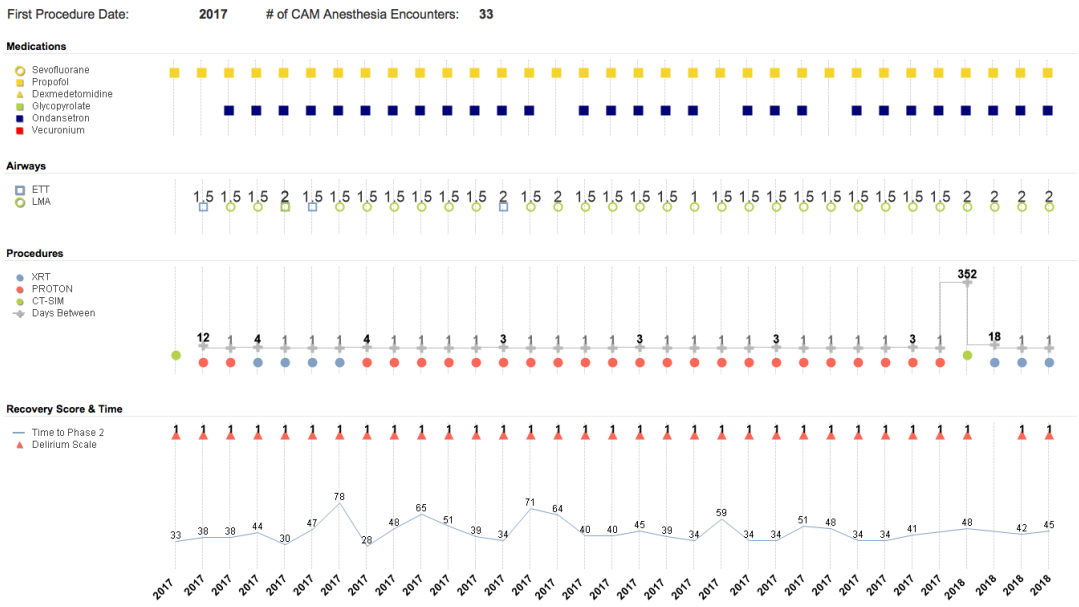
Users can identify patterns and changes more readily in a summary view. For example, in the case displayed, both ETTs and LMAs were used. The ETT sizes correspond to LMA sizes (LMA 2 instead of size 2.0 ETT) representing user data-entry error. This type of error led us to re-design the user interface for airway device documentation in order to minimize user data-entry errors.

Discussion: The dashboard provides a high-level summary of all radiation therapy anesthesia records for children receiving recurrent treatments. In this clinical scenario, it is desirable to replicate an optimal anesthetic approach each day or to adjust the anesthetic based on observed patterns. In the future, we will continue to develop this dashboard to summarize multiple anesthesia records for other patient populations.

References

1. McFadyen, J. G., et al. (2011). "Sedation and anesthesia for the pediatric patient undergoing radiation therapy." Current Opinion in Anaesthesiology 24: 433-438.
2. Watcha, M. F., et al. (1992). "Perioperative effects of oral ketorolac and acetaminophen in children undergoing bilateral myringotomy." Can J Anaesth 39(7): 649-654.

Figure 1



2019 STA Annual Meeting Abstract Winners

Excellence in Technology

Rating the Severity of Opioid-Induced Ataxic Breathing in Healthy Humans

Co-Authors: Sean Ermer[1], Robert Farney[2], Lara Brewer[1]
[1]University of Utah, Department of Anesthesia, Salt Lake City, Utah
[2]University of Utah, Clinical Professor of Medicine, Pulmonary Division, Salt Lake City, Utah

Abstract: Opioid induced respiratory depression is traditionally recognized by assessment of respiratory rate, arterial oxygen saturation, end-tidal CO_2, and mental status. Although an irregular or ataxic breathing pattern is widely recognized as a manifestation of opioid effects, the presence of ataxic breathing is not routinely monitored. A major obstacle to widespread monitoring for ataxic breathing is the lack of a reproducible metric for it and the necessity for manual offline analysis. We explored the feasibility of using an automated machine learning algorithm to quantify the severity in ataxic breathing pattern for healthy volunteers experiencing opioid induced respiratory depression. The primary aim was to assess the agreement among all raters, including the machine learning algorithm and the domain experts. The secondary aim was to compare the scores from the machine learning algorithm to those from the domain experts.

After IRB approval, informed written consent was obtained from 26 volunteers (13 male, 13 female) who were given target controlled infusions of propofol and remifentanil with the goal of modeling light sleep together with opioid induced ventilatory depression. Respiration data were collected from chest and abdomen Respiratory Inductance Plethysmography (RIP) bands and a nasal pressure transducer sampled from a nasal cannula during steady state periods. Three domain experts scored the severity of ataxic breathing in accordance with predefined scoring guidelines. Krippendorff's alpha and Vanbelle's Kappa were used to assess the level of agreement in ataxic breathing severity scores from the machine learning algorithm and the domain experts.

Krippendorff's alpha was 0.912 (CI 0.852- 0.949) for the RIP-based algorithm and 0.899 (CI 0.819- 0.941) for the intranasal pressure-based algorithm. Vanbelle's Kappa was 0.976 (0.951-0.983) for RIP and 0.893 (0.813-0.936) for intranasal pressure.

We concluded it may be feasible for a machine learning algorithm to quantify ataxic breathing severity in a manner consistent with a panel of domain experts. This measure may be helpful in conjunction with measures of respiratory rate and SpO_2 to identify patients at risk for opioid induced respiratory depression.

2019 STA Annual Meeting Abstract Winners
Honorable Mention

Assessing Pain Under General Anesthesia with Functional Near Infrared Spectroscopy

Presenting Author: Andrea Gomez-Morad[1] MD
Co-Authors: Ke Peng[1,2] PhD, Arielle Lee[1,2] BS, Arielle Mizrahi-Arnaud[1] MD, Barry Kussman[1] MD, Joseph Cravero[1] MD, Lyle Micheli[3,4] MD, Lino Becerra[1,2] PhD, David Borsook[1,2] MD PhD
1 Department of Anesthesiology, Critical Care and Pain Medicine, Boston Children's Hospital and Harvard Medical School
2 Center for Pain and the Brain, Harvard Medical School
3 Division of Sports Medicine, Boston Children's Hospital
4 Department of Orthopedic Surgery, Harvard Medical School

Abstract content: Establishing an objective evaluation of pain perception with a low-cost, portable device will dramatically improve current medical care for pain patients, including those undergoing surgical procedures. Functional near infrared spectroscopy (fNIRS) is a robust neuroimaging technique that is able to provide non-invasive, long-term measure of cortical hemodynamic changes. In this study, we applied fNIRS in both healthy, awake volunteers and anesthetized surgical patients to monitor the brain activities during induced ongoing pain (awake case) and during surgical procedures (anesthetized case).

Methods: Eleven healthy, male volunteers and ten pediatric patients undergoing knee surgery participated in this study. We recorded fNIRS signals mainly from the medial prefrontal cortex (mPFC), an area that has recently been highlighted to play an important role in the processing of pain. Each healthy volunteer had two scanning sessions: an ongoing heat pain session in which the subject received a continuous heat pain for 5 minutes and a warm session in which the subject received a 5-min nonpainful warm stimulus. For surgical patients, their mPFC signals were recorded during the entire surgery. The timings of major invasive surgical events, such as incisions, injections, soft tissue removal and suture were marked in the data. Support for this work was provided by NIH R01GM122405.

Results: With fNIRS, we observed significant alterations in the low frequency component of the mPFC signal during induced pain (in healthy volunteers) and major surgical procedures (in anesthetized surgical patient, see **Fig.1**).

Conclusion: These results suggest that nociceptive/pain pathways may not be fully blocked by general anesthesia. This work also reveals the potential of using fNIRS as a useful tool to evaluate pain in surgical conditions.

2019 STA Annual Meeting Abstract Winners

Honorable Mention

page 2

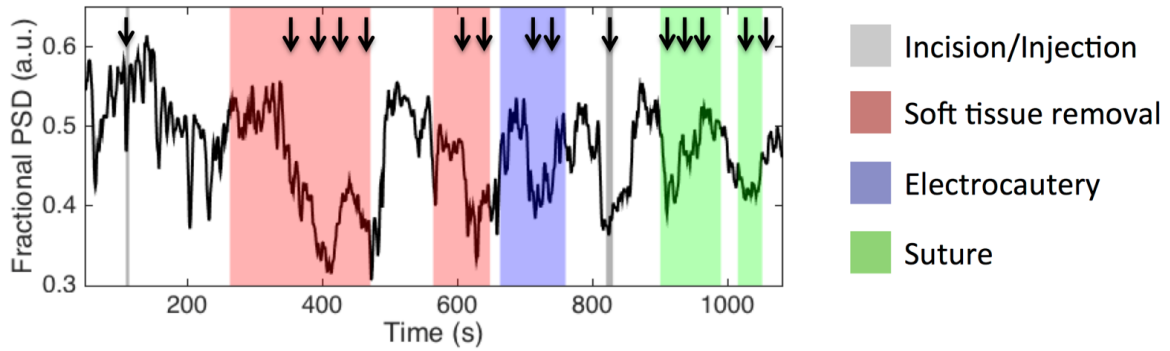
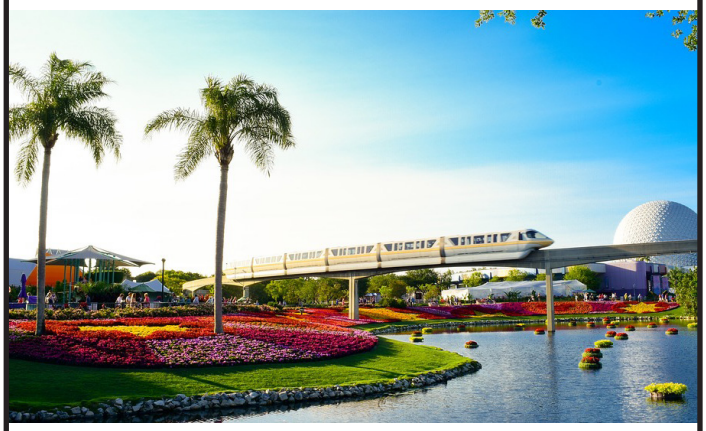


Figure 1. Case study: fractional power spectral density timecourse of mPFC low frequency (0.02-0.08Hz) hemodynamic signals during a knee arthroscopic surgery of a 14-year old female under general anesthesia. Significant power shifts were observed during or shortly after major surgical events, which potentially indicate ongoing pain processing in the brain.

Save the Date

2019 Ty Smith Dinner

Sunday, October 20, 2019
Orlando, Florida



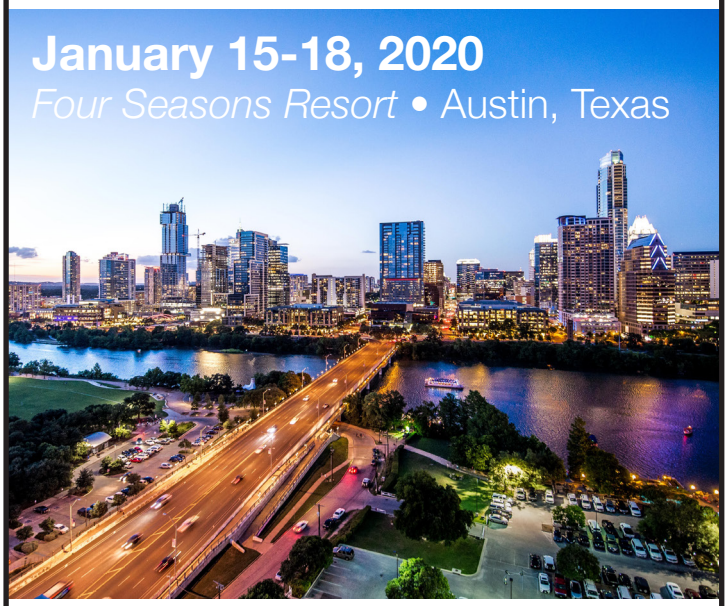
Guest Speaker: *Andrew Pitkin, MBBS, MRCP, FRCA*
Under Pressure: Confessions of a Cave Diving Anesthesiologist

More information available on the STA website: www.stahq.org

Save the Date

2020 Annual Meeting

January 15-18, 2020
Four Seasons Resort • Austin, Texas



Registration, Abstract Submission and Engineering Challenge Submission Opens June 2019.