STA Interface
NEWSLETTER

SOCIETY FOR TECHNOLOGY IN ANESTHESIA • MARCH 2020

President's Message

JEFF E. MANDEL, MD, MS
Jersey Shore University Medical Center

I want to thank the Society for allowing me to serve as your President for the coming year. My work as President has been made easier by the contributions of many people; Dr. Brian Rothman, Dr. Allan Simpao and Marie Odden to name a few. The active participation of the Board of Directors is another valuable asset. The Program Chairs continue to develop innovative sessions at our Annual Meeting, explore the use of social media, and attract new membership from both the clinical and engineering sides of the specialty. Everyone's efforts demonstrate our value to the anesthesia community.

As I mentioned at the Business Meeting in Austin, this is not the first time I have held the office of President; in 1971 I was elected President of the Bellaire High School Ecology Club. I mention this not only to reassure the membership that I can call upon my previous executive experience, but also to illustrate that I have an enduring interest in environmental issues. Anesthesia makes an outsize contribution to the environmental footprint of healthcare. Technology may be perceived as driving our environmental impact. We wrap everything in plastic, consume electricity, reuse and recycle very little, and complain that we can't do much because of regulatory oversight.

However, STA members have done much to give anesthesiologists options. We developed simulations to show clinicians how to safely reduce fresh gas flows, designed physiologic closed loop control systems to achieve even greater efficiency in drug delivery, and we pioneered monitors that can work without a physical connection to the patient, to name a few areas. Our industry partners help to push these innovations into clinical practice. When we see examples of environmental responsibility, we need to be supportive. When we see ways to improve our environmental stewardship, we need to speak out. We need to make sure the public doesn't develop cynicism about technology and show the rising generation of anesthesiologists and engineers (who see environmental degradation as a personal threat) that they can make an impact through STA. I invite you all to participate in this shared mission.

Jeff E. Mandel, MD, MS
STA President

In This Issue

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Greetings from STA's New Executive Director

MARIE ODDEN
STA Executive Director

The New Year has brought new changes behind the scenes for the Society for Technology in Anesthesia (STA). Jane Svinicki, CAE, STA's Executive Director since 2008, will be retiring this year. As many of you know, Jane has been a constant advocate for the STA and has worked hard to ensure past and future success of the Society.

Though I am excited for my new role as Executive Director, I'm far from a new face to the Society – I've been working with the STA since I began my career at Svinicki Association Management, Inc (SAMI) in 2008, the same year STA sought management services with SAMI. I began by handling membership and administrative meeting work and as a result had the opportunity to get to know many of you personally. In 2014 I moved into the meeting planner role, and in 2016 my position evolved into an executive role alongside Jane.

I attended my first STA meeting in 2010 at the PGA National Resort and Spa in West Palm Beach, Florida. It was the first time I was introduced to this brilliantly techy and wonderfully *self-proclaimed* "nerdy" group of anesthesiologists and engineers, all of which had a strong interest in improving the quality of patient care through the use of technology and its applications. The STA was the best group to begin my career with. *For any potential members reading this, I'm confident you'll feel the same welcome and embrace I did 10 years ago!*

I have a great deal of experience in the world of anesthesiology in my role as Executive Director for the Wisconsin and Minnesota state component societies, a subspecialty in sleep medicine as it relates to anesthesia and finally a state group of Anesthesiologist Assistants. Through my work among these societies, I've made some great friendships, truly enjoy what I do and look forward to seeing everyone at the Annual Meeting and at ASA each year.

Executive Director's Message *continues on next page*

Executive Director's Message *continued from previous page*

None-the-less, Jane leaves big shoes to fill. I sincerely appreciate her guidance since the start of my time at SAMI and wish her the best in retirement. It's the end of a decade-long mentorship. I am excited to help take the STA into the future with all of you.

Looking forward, we have exciting changes happening at SAMI, now Association Resource Center (ARC), with a new President, Jennifer Rzepka, CAE. I say "new" in title because she has been equal partners with Jane since 2015. Though her name may be new to some of you, her role and experience with the company (for 20 years!) is not. Please see below for more on her background and how the company has shifted.

I am excited for the future of the STA and am looking forward, as the new Executive Director to helping the Society advance the field of anesthesiology and patient safety through technology.

Sincerely,

Marie Odden

Marie Odden
Executive Director, STA

Jennifer Rzepka, CAE is excited to announce the ownership change and rebranding of Svinicki Association Management, Inc. (SAMI) to Association Resource Center, Inc. (ARC).

Rzepka has been working with the company for twenty years, for the past five years as 50% owner while purchasing the company from former business partner Jane A. Svinicki, CAE. The two have had a long, successful history that Rzepka looks forward to expanding in the new decade as President of ARC. With a full-time staff of over a dozen employees serving nearly twenty state and national non-profit associations, the company has had a strong and consistent path that made for a smooth transition.

Rzepka says, "It's thrilling to see the re-invigorated engagement and buy-in as I continue making changes, empowering the incredibly talented management team and engaging staff members at all levels of the company. I am honored to carry this company into the future and keep our strong legacy alive of exceptional people providing exceptional services to our clients."

Changes have already begun with the modification of workstations to create a more flexible and collaborative environment. A large, open space has been cleared to make way for a community workstation as staff continue to find more comfort and ability to develop by working closer together in non-traditional seating arrangements.

Along with the recently expanded ability for more remote work, the time spent in the office now involves more 'break time' to spark learning, engage the creative side of the brain and balance the intensity of client work with some colorful and fun group games and activities.

As an active member of the Wisconsin Society of Association Executives (WSAE) and the American Society of Association Executives (ASAE), Rzepka earned her Certified Association Executive (CAE) credential in 2010. This credential represents her strong professional and ethical conduct and confirms she holds the wide range of knowledge essential to expertly manage the affairs of an association. She believes strongly in investing in the continued education of her staff, three of which also hold the CAE credential.

Rzepka's commitment to excellence and the continual process of improvement is also shown through the company being one of the few association management companies (AMCs) in the world to hold the esteemed title of being accredited by the AMC Institute. Of more than 500 AMCs, fewer than 20% hold this status, which demonstrates the company's overall commitment and ability to deliver the highest level of professional management services to clients. The AMC Institute accreditation is recognized and supported by the American Society of Association Executives and The Center for Association Leadership and is based on the ANSI Standard of Good Practices for the AMC Industry. The process of be becoming accredited (and re-accredited on a four-year cycle) revolves around an intense evaluation by an independent auditor is performed to review the company's operating policies and procedures.

***

For more information please contact Jennifer Rzepka, 414-276-8788, jennifer@arc-amc.com.

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STA 2020 Annual Meeting Recap

ROBERT E. FREUNDLICH, MD, MS, MSCI
2020 Annual Meeting Program Co-Chair
Vanderbilt University

CLYDE MATAVA, MD, MMED
2020 Annual Meeting Program Co-Chair
Hospital for Sick Children,
University of Toronto

We had the privilege of organizing this year's STA Annual Meeting from January 15th through 18th at the Four Seasons Hotel in Austin, Texas. This year's meeting, STA's 30th anniversary, was extremely well-attended, shattering previous attendance records. Photos from the past 30 years were featured during breaks throughout the meeting.

This year's meeting focused on how perioperative technology and innovation can demonstrate value to key stakeholders. Attendees hailed from a diverse background, representing 27 American states, and 11 countries across 4 continents. Participants were able to earn up to 17 CME credits and an impressive 9.75 LLSA MOC (clinical informatics) credits over the course of the meeting. The program featured a new edition this year, a series of TED-style "Power Talks", giving attendees the opportunity to hear short, high-impact presentations from a diverse group of early career investigators.

Drs. Matthias Görges (University of British Columbia) and Ira Hofer (UCLA) helped to organize the abstract submission process, with more than 65 high-quality and high-impact abstracts presented at the meeting. These abstracts reflected the broad and far-reaching impact of society members in innovative and important perioperative care. Awards were presented for best abstracts, found on the bottom half of this page.

We look forward to next year's Annual Meeting, organized by Drs. Görges and Hofer, at the Naples Beach Resort and Golf Club in Naples, Florida from January 13 – 16, 2021! It promises to be an interesting and informative meeting.

STA 2020 Annual Meeting Abstract Winners

Abstracts Listed on pages 11-19

Best in Show
Epidural Ultrasound Catheter Development and Prototype Testing in Swine: A First Look
Presenting Author: Neil Feinglass, MD, Mayo Clinic

Best Clinical Application
The Application of Immersive Technologies as a Distraction Technique to Improve Office Laryngoscopy Exam Success Rates in Pediatric Patients
Presenting Author: Clinton Fuller, MD, MS, Texas Children's Hospital/Baylor College of Medicine

Excellence in Technology
Transdermal Monitoring of Volatile Anesthetic Concentration During Surgery
Presenting Author: Robert Fiala, MD, University of Miami

Honorable Mentions
Assessing Machine Learning and Deep Learning Models for Suggested Dosing of Anesthetic Induction Medications
Presenting Author: Samir Kendale, MD, NYU Langone Health

Prediction of Postinduction Hypotension with Deep Learning
Presenting Author: Christine Lee, PhD, University of California, Irvine

Immediate Past President, Dr. Brian Rothman, presents plaques to the 2020 Annual Meeting Co-Chairs, Dr. Clyde Matava and Dr. Robert Freundlich.

President, Dr. Jeff E. Mandel, presents outgoing President, Dr. Brian Rothman, with a plaque in appreciation of his service as President (2019-20).

STA Corporate Members meet with STA leadership to wrap-up the Annual Meeting.

Corporate Members gather in the exhibit room during the Annual Meeting.

2020 J.S. Gravenstein Award Winner

JONATHAN M. TAN, MD MPH MBI
STA Communications Committee Chair
The Children's Hospital of Philadelphia
Perelman School of Medicine at the University of Pennsylvania

The Society for Technology in Anesthesia (STA) had the opportunity to celebrate Dr. Kirk Shelley as the 2020 recipient of the J.S. Gravenstein Award. The J.S. Gravenstein Award is named for J.S. "Nik" Gravenstein, a founding member and former President of the STA who committed his career to advancing anesthesia technology, patient simulation, and patient safety. The Award is bestowed upon an individual each year for their lifetime achievement in the area of technology in anesthesia. This year's awardee, Kirk Shelley, MD, PhD, Professor Emeritus of Anesthesiology at Yale University and previous President of the STA (2011-2012), had his career's work celebrated among previous winners and the rest of the Society.

One of the best aspects of the award for the STA is that Dr. Shelley, like previous recipients, was given the stage at the STA Annual Meeting to share his views and reflections on his career. For those in the room in different stages of their careers, it was a wonderful opportunity to learn about the history of anesthesiology, how far it's come, and reflection on what successful individuals have learned throughout their career and on passion for their work. This year's message from Dr. Shelley was no different as we had an opportunity to hear his reflections on his career and some of his thoughts on the future.

Dr. Shelley's message was titled "Looking forward…and a bit backwards," and it focused on where we are going as a field and what the great opportunities are for the future. He emphasized with encouragement that we tend to underestimate the future of anesthesia and gave several examples. In particular, he shared a brief story about how his research on waveforms was rejected as an ASA abstract submission in 1996, and shortly thereafter, it won 1st place at the STA Annual Meeting in 1997. He celebrated the community and expertise in the STA to recognize emerging research and support a wide vision of the future of anesthesiology.

Dr. Shelley's message also focused on the importance of respecting data, and he encouraged all of us to love artifacts and outliers. While reflecting on his own discoveries and development of tools for noninvasive measurement of physiologic parameters, he gave examples of how artifacts are often our discoveries and how outliers in data can be the way forward. In a testament to his scientific leadership, he shared how he tells his lab that if the data doesn't fit a particular story, that could very well be a discovery. In an era of enormous data generation in modern day healthcare, Dr. Shelley

Dr. Jeff Mandel presenting Dr. Kirk Shelley with the J.S. Gravenstein Award

reminded us, through his lifetime contributions and wisdom, that data has always been key to the future of discovery.

As he turned to look to the future, Dr. Shelley provided the meeting attendees with what he believes are areas of opportunity for anesthesiologists. He highlighted automation with artificial intelligence and machine learning for patient monitoring and drug administration as one area of large growth. In addition, Dr. Shelley also emphasized the future of ultra-non-invasive monitoring for vital signs as an example of opportunity. Large applications of non-invasive monitoring at scale included the use of vital sign monitoring at airports, ER's, and other public spaces. These are areas of healthcare that anesthesiologists and the STA can impact based on historical successes and the future potential of the group. In closing, Dr. Shelley thanked the STA, many friends and colleagues he has had, as well as his wife Stacey.

Upon a reflection of his lifetime achievements, it was wonderful to see Dr. Shelley reflect most importantly on the relationships and people in his life, from his professional world to his most personal. Congratulations to Dr. Shelley, and thank you for sharing your experiences and reflections with us. Our practice and field are better because of the advancements and contributions you have made to science.

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2020 Engineering Challenge

JEFFREY MANDEL, MD, MS
Jersey Shore University Medical Center

The Engineering Challenge is a regular feature of the Annual Meeting, and this year marked the 10th anniversary of the event. The purpose of the Challenge is to provide trainees with the opportunity to showcase their talents and to educate the membership on an emerging area of technology. Past topics have included 3-D printing, the blockchain, quantum computing, and use of MIDI for pulse oximeters, to name a few examples. The Challenge is open to teams that include a trainee – graduate students, anesthesia residents, and medical students.

The 2020 Challenge was to demonstrate the use of millimeter wave radar for a practical problem in the OR. Millimeter wave radar makes use of high frequency radiofrequency waves, typically 40 – 60 GHz, to locate and track objects relatively close to the antenna. Millimeter wave radar can penetrate obstacles to vision such as fog and has become common in automobile collision avoidance systems. Because of this, the price of these systems has decreased to the point where tinkerers can afford to use them. All entrants were given a budget of $400 to use to purchase a system. There were four teams; University of Minnesota (Kevin Wang), Penn State (Elie Sarraf and Austin Culp), Cleveland Clinic (Nirav Bhavsar and Eileen Petros), and Brigham & Women's Hospital (Chris Connor and Gwen Owens).

What can millimeter waves detect in the operating room? One example, presented by the University of Minnesota group, was to detect the response to a neuromuscular nerve stimulator. As Kevin Wang demonstrated, the detector requires no contact with the patient, and it can even work through a sterile drape. The ability to monitor twitch without patient contact eliminates one more sterile consumable from the OR, and the ability to apply the monitor when the patient's arms are tucked under the drapes would be useful in a number of settings.

The Penn State group presented another monitoring application, demonstrating a monitor that could gauge respiration and heart rate in a clothed individual, again, eliminating a sterile consumable and allowing monitoring of untethered patients.

The Cleveland Clinic group demonstrated a system that could recognize simple gestures.

The group from Brigham & Women's Hospital interfaced a Seeed Studio gesture shield to a GE Solar 8000 monitor and were able to issue simple commands using hands.

All of these projects were accomplished with consumer off the shelf development systems such as the Texas Instruments IWR1443; the core sensors are available in large quantities for under $20, making it quite possible that we will see these systems in the OR at some point, and when you do, remember that you saw it at STA first!

Save the Date

2020 Ty Smith Dinner

Sunday, October 4, 2020

The Hamilton • Washington, DC

Guest Speaker: *Leslie G. Biesecker, MD, National Human Genome Research Institute*

Save the Date

2021 Annual Meeting

January 13-16, 2021

The Naples Beach Resort • Naples, FL

Registration, Abstract Submission and Engineering Challenge Submission Opens June 2020.

2020 STA Annual Meeting Abstract Winners
Best in Show

Epidural Ultrasound Catheter Development and Prototype Testing in Swine: A First Look!

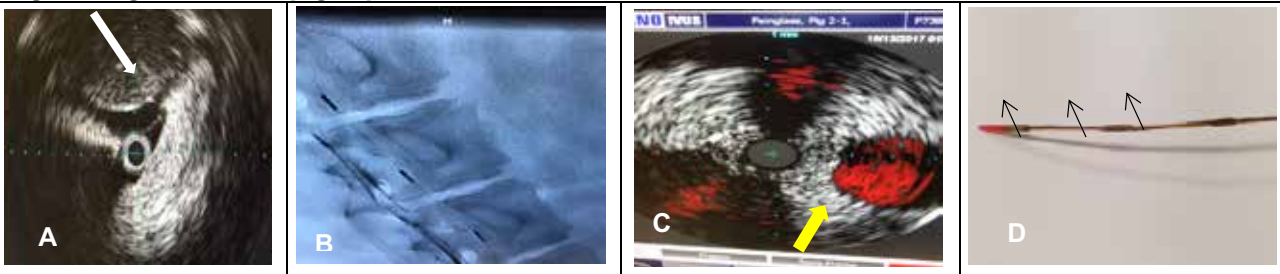
Presenting Author: Neil G. Feinglass MD, FASE, FCCP
Co-Author: Christopher B. Robards, MD

Introduction: Spinal Ultrasound and Surface Ultrasound Neuraxial Imaging has been limited by the boney skeleton which is challenging for the sonographer and current technologies[1] The miniaturization of ultrasound catheters has now advanced producing images that guide the clinician through difficult invasive procedures[2]. This study demonstrates the first known successful ultrasound images from within neuraxis in a live swine model using a multi-array engineered ultrasound catheter prototype proof of concept design.

Methods: After approval by Mayo IRB and IACUC review (2) 60kg adult pigs were anesthetized and placed in lateral position. Biplane fluoroscopy confirmation with the addition of epidural contrast Iohexol 3 cc (Omnipaque-140 GE Healthcare Marlborough, MA) administration confirmed Epidural placement of the Touhy needle and catheters. The catheters were engineered from intracoronary ICE catheters (Volcano Eagle Eye Platinum Catheter San Diego, Ca.) such that the catheter had a plurality of mechanical transverse arrays (three) able to produce images at multiple spinal levels and display onto the ultrasound console (Volcano Corporation). Each catheter (20MHz, 0.056", 5F) offers transverse imaging planes at 3 independent levels.

Results: Epidural imaging was achieved in the swine model from lumbar region to the thoracic regions without incident. A significant amount of epidural fat was identified in the epidural space and the Intrathecal placement was not achieved. All images obtained are viewed from the epidural space (Fig 1).

Fig.1. Images from the pig experiment



A. *2-dimensional image with spinal cord viewed in short axis.* ***B.*** *Fluoroscopy with catheter inserted with 3 US-arrays visible.* ***C.*** *Epidural space with epidural veins and flow identified (arrow).* ***D. Prototype catheter V1.*** *3 ultrasound arrays indicated (arrows).*

The epidural ultrasound catheter identified the spinal cord and Dura Mater of the pig throughout the neuraxis. 2 out of 3 arrays produced images due to presumed soldering issues. Other anatomic structures including large epidural venous vascular collections were identified. A proprietary doppler color flow mode (Volcano Corp) distinguished the flow pattern of red blood cells to be continuous further confirming the identification of these structures as venous.

Pulsatile smaller tortuous structures that moved in and out of the ultrasound plane were viewed in close proximity to the spinal cord. The application of color flow doppler did not enhance our characterization of possible arterial vessels). Fluid and fat containing spaces were seen near the cord with no discernable

2020 STA Annual Meeting Abstract Winners

Best in Show

intrathecal space. Further attempt to identify the rudimentary intrathecal space by passing the Touhy needle and catheter through the dura mater was not successful. This finding was consistent with other studies that have reported anatomic differences between man and swine.[3]

Final examination of the relationship of the ultrasound catheter to the Intraspinal anatomic structures was validated by surgical laminectomy after euthanasia of the animal. The dissection revealed the ultrasound catheter epidural placement adjacent to the spinal cord.No traumatic injury could be recognized to the spinal cord, dura, or vasculature or exiting nerve roots.

Discussion/Conclusion:

1. Percutaneous epidural ultrasound is feasible with miniaturization of the ultrasound catheter transducers.
2. Spinal cord, dura mater, epidural veins, epidural fat and arterial vascular structures could be identified.
3. The neuraxis (Lumbar to Thoracic) regions were effectively imaged in continuity.
4. No traumatic injury to the spinal cord post study could be identified.
5. Future refinement could lead to potential low-cost diagnostic devices for assessing spinal cord therapies and viability which heretofore have been difficult to achieve.

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3. Eur Spine J (2010) 19:1104–1114

2020 STA Annual Meeting Abstract Winners

Excellence in Technology

Transdermal Monitoring of Volatile Anesthetic Concentration During Surgery

Presenting Author: Robert Fiala, MD, Assistant Professor, Department of Anesthesiology, University of Miami, Department of Anesthesiology, Perioperative Medicine and Pain Management, Miller School of Medicine, University of Miami/Jackson Health System
Co-Authors: Ahmed Hasnain Jalal, Ph.D., Adjunct Faculty, Department of Electrical and Computer Engineering, Postdoctoral Associate, BioMEMS and Microsystems Research Laboratory, Florida International University; Carla R. Cordova, MD
Assistant Professor, Department of Anesthesiology, Perioperative Medicine and Pain Management, Miller School of Medicine, University of Miami/Jackson Health System; Shekhar Bhansali, PhD, FAAAS, FNAI, Alcatel Lucent Professor and Chair, Department of Electrical and Computer Engineering, Florida International University; Ernesto A. Pretto, MD, MPH, Professor, Department of Anesthesiology, Perioperative Medicine and Pain Management, Miller School of Medicine, University of Miami/Jackson Health System

Background/Introduction:
Monitoring the therapeutic dose of any anesthetic agent is critical for patient safety during surgery. Modern anesthesia machines are equipped with infrared spectroscopy monitors to detect inhaled volatile anesthetic (VA) dose. However, the latter are not readily portable, impractical for use in austere conditions and unaffordable in low resource environments. In this work, a low cost miniaturized, wearable fuel cell sensor was tested in patients undergoing surgery to determine the clinical utility of a totally non-invasive transdermal sensor to reliably monitor Isoflurane dose.

Methods: A wearable device integrated with a micro-fuel cell and built-in miniaturized potentiostat was developed as a practical and portable solution for transdermal VA gas detection during surgery. The device can be modified to detect any VA. The method used in this system is amperometric and its functionality described previously (1). A customized printed circuit board (PCB) was designed to accommodate the potentiostat (LMP91000) with a low power data processing microcontroller (nRF51822) with Bluetooth (RN-42). The device begins operation when it detects a voltage less than -0.05 V across the fuel cell electrodes (reference and anode). The current corresponds to the concentration of the VA, which can be determined through calibration. The current from LMP91000 is converted to a potential and fed to the internal analog-to-digital converter (ADC) of the wireless microcontroller. Data is transmitted wirelessly to the end device (e.g. smartphone). After IRB approval we conducted an observational pilot clinical trial of the device on 11 randomly selected patients to validate its ability to sense the start, steady-state and end of Isoflurane administration during elective surgery. The platform was attached to the wrist of patients in the holding area. Baseline readings for calibration of the device were obtained before the start of Isoflurane inhalation in the OR. The reaction mechanism of the fuel cell involves oxidation at the anode and reduction at the cathode. The anodic reaction is expressed in equations (1– 3), where oxidative addition of Isoflurane occurs instead of direct oxidation reaction.

$$\mathrm{Ni} + \mathrm{R} - \mathrm{Cl} \rightarrow \mathrm{RNi(II)}^{-} + \mathrm{Cl}^{-} \quad (1)$$

$$\mathrm{Cl_2} + \mathrm{H_2O} \rightarrow \mathrm{HCl} + \mathrm{HClO} \quad (2)$$

$$4\mathrm{HCl} + 2\mathrm{Ni} + 12\mathrm{H_2O} \rightarrow 2\mathrm{NiCl_2}.6\mathrm{H_2O} + 4\mathrm{H^+} + 4\mathrm{e^-} \quad (3)$$

where, R-Cl is the Isoflurane. As given in equation (2), the byproduct HCl gets oxidized on the anode and the electrons are produced in this process. On the cathode, the oxygen gets reduced as given in equation (4).

$$\mathrm{O_2} + 4\mathrm{H^+} + 4\mathrm{e^-} \rightarrow 2\mathrm{H_2O} \quad (4)$$

2020 STA Annual Meeting Abstract Winners
Excellence in Technology

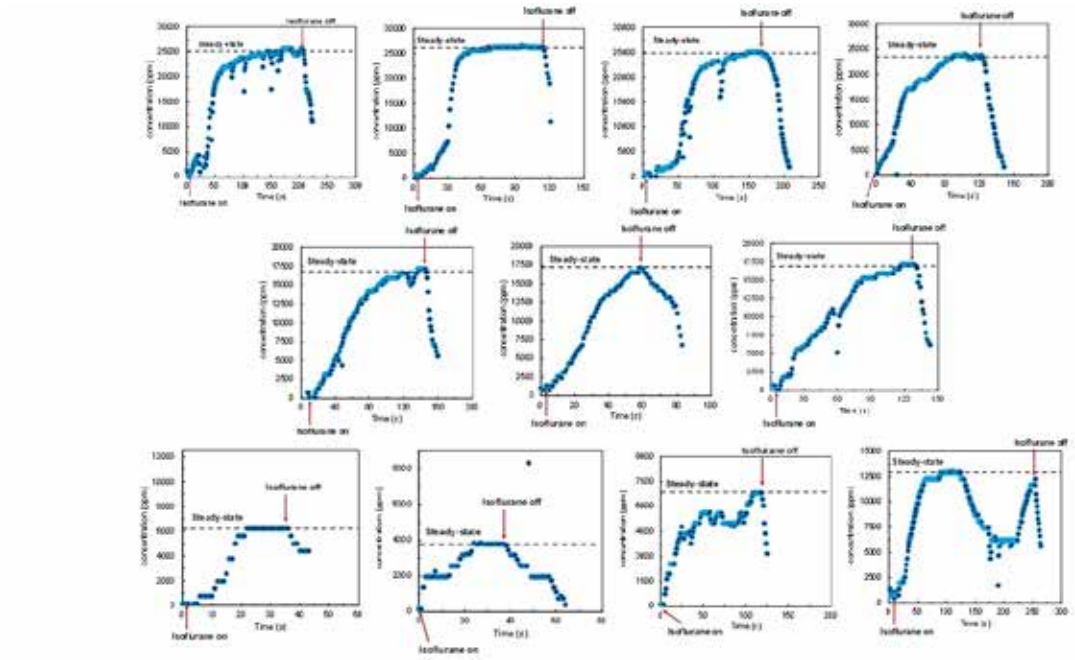
During this reaction, the electrons and H^+ ions flow from anode to cathode generating Faradic current proportional to the concentration of Isoflurane. This current is detected amperometrically. The biasing voltage across working and reference electrodes was -0.3V. The platform includes nRF5 series supported BLE for wireless data transmission and smart phone readout. Electro-chemical signals from the sensor were then recorded and later converted to parts per million (ppm) using equation (5):

$$\text{Concentration (ppm)} = \frac{\{389.29-(I_{conc.}-I_{baseline})\}}{0.0152} \quad (5)$$

Results: The raw sensor data plots in the Figure show real-time trends in readings for the onset, steady-state, and intraoperative variations of Isoflurane concentration, and discontinuation of Isoflurane inhalation in patients. Although the duration of anesthesia varied in all cases, the signal was sensitive and specific to changes in concentration within a therapeutic range Isoflurane (0-2.5%).

Conclusions: We developed a wearable platform to measure VA gas vapors transdermally. The device was tested on 11 patients undergoing general anesthesia with Isoflurane. The resultant current was calibrated to parts per million (ppm). Our preliminary results showed that the sensor tracked anesthesia dose with good reliability within a therapeutic range for general anesthesia with Isoflurane. Further testing will require fine tuning of the signal, optimum anatomic placement, influence of external factors and validation in a larger clinical trial.

Reference: Anal. Methods, 2019,11, 2007-2012



2020 STA Annual Meeting Abstract Winners

Best Clinical Application

The Application of Immersive Technologies as a Distraction Technique to Improve Office Laryngoscopy Exam Success Rates in Pediatric Patients

Presenting Author: Clint Fuller, MD, Texas Children's Hospital/Baylor College of Medicine
Co-Authors: Julina Ongkasuwan, MD, FAAP, FACS, Texas Children's Hospital/Baylor College of Medicine; Julie Colbert, MS, CCLS, Texas Children's Hospital; Kim-Phuong T. Nguyen, MD, Texas Children's Hospital/Baylor College of Medicine; Kathleen Chen, MD, MS, Texas Children's Hospital/Baylor College of Medicine

Background/Introduction: Awake indirect laryngoscopy is an integral part of the assessment of voice and swallowing disorders. Traditional flexible nasolaryngoscopy can be uncomfortable, anxiety provoking, and require physical restraint in children. Transoral 70-degree rigid laryngoscopy is a non-painful, alternate, approach to visualization of the larynx which can be achieved in cooperative children as young as 3 years of age[1]. Inconclusive in office exam may escalate patients to a perioperative setting involving tremendous financial consequence for the patients and increasing operating room resources.

Distraction methods have been shown to decrease patient anxiety and discomfort during invasive procedures[2,3,4]. Recent technologies have elevated the level of immersion, enhancing distraction intensity with the use of a video projectors and immersive virtual reality (VR) headsets equipped with age-appropriate games and media. We aim to apply these immersive technologies as a novel distraction technique during in-office transoral 70-degree rigid laryngoscopy exams in order to improve success rates in a pediatric voice clinic.

Methods: Patients were identified as requiring an awake office laryngoscopy exam. If an exam was indicated, they were approached to use the distraction devices, either video projector or VR headset. If consented, patients were oriented to the games on the device, and then coached with laryngoscopy exam prompts for a "practice session". The patient continued to receive supplementary distraction coaching during the laryngoscopy exam.

Results: Eleven out of fifteen patients (73%) successfully completed transoral rigid laryngoscopy with the aid of distraction using immersive technologies. In particular, of those who were ages 3 to 5 years, 83% of the patients completed the exam successfully with this distraction technique, versus a 65% previously published without its use[1]. The use of immersive technologies during rigid laryngoscopy exams showed equal efficacy across our patient cohort, with an increased benefit to our 3 to 5 years age group. The application of this distraction technique allowed for more exam attempts, despite some that were diagnostically insufficient. Families who chose to use immersive technologies as a distraction technique during their child's exam, expressed satisfaction with its application.

Conclusions: Using immersive technologies as a distraction technique enhances office laryngoscopy exam success rates in pediatric patients, particularly in those aged 3-5 years. Achieving increased office exam success rates decreases the concern for escalation to a perioperative setting.

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Best Clinical Application

page 2

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2020 STA Annual Meeting Abstract Winners
Honorable Mentions

Assessing Machine Learning and Deep Learning Models for Suggested Dosing of Anesthetic Induction Medications

Presenting Author: Samir Kendale, MD; NYU Langone Health Department of Anesthesiology, Perioperative Care, and Pain Medicine

Introduction: As we continue to learn to apply machine learning techniques to the perioperative space, we can begin to envision automation of more complex aspects of anesthesiology. Prediction of hypotension combined with closed-loop vasopressor administration, and processed EEG-targeted medication infusions are examples of how processing large amounts of well labeled data can potentially be used for intraoperative management. Induction of general anesthesia requires careful and deliberate decision-making regarding medication choice and dosage. The training of the anesthesiologist in the complex interactions between physiology and pharmacology allows for selection of appropriate induction medications. We hypothesized that we would be able to train a suite of machine learning models to predict induction doses of commonly used medications for induction of general anesthesia, in this pilot study focusing only on propofol and fentanyl.

Methods: For this pilot study, we used 6 months of data (January to June 2019) extracted from the electronic health record (Epic Systems, Veronia, WI) and initially investigated two drugs commonly used during induction of general anesthesia: propofol and fentanyl. Split-set validation was used in which 70% of data were used for training and 30% for testing. Models included age, sex, weight, body mass index, preoperative comorbidities, preoperative medications, and natural language processed procedure text as features. Three algorithms were trained on each target, using 5-fold cross validation: extreme gradient boosting model, deep learning, and elastic net, using mean absolute error as the primary performance metric. The best performer was further tuned and applied to the test set for validation.

Results: After tuning, the extreme gradient boosting model for prediction of propofol dosing performed best, with a mean absolute error of 37 mg and a root mean squared error of 54 mg on the training set, and a mean absolute error of 37 mg and root mean squared error of 53 mg on the test set. The extreme gradient boosting model for prediction of fentanyl dosing performed best, with a mean absolute error of 44 mcg and a root mean squared error of 63 mcg on the training set, and a mean absolute error of 44 mcg and root mean squared error of 66 mcg on the test set. Plotting of the errors suggested a normal distribution of error for both models.

Conclusions: We were able to develop two models for prediction of induction doses of propofol and fentanyl. These models could be deployed preoperatively for aid in tailoring an anesthetic plan by providing suggested induction doses, and may ultimately be daisy-chained to other models that can predict postinduction hypotension, resulting in a feedback loop for more precise induction medication selection. Performance of these models would likely improve with the addition of more data, as well as with the addition of more potentially relevant features, and should then be validated externally. Just as with any machine learning model, accurate representation is highly dependent on trusting of the labeled data. Future development of these models may include training of a multi target regression neural network model to incorporate the interaction between induction medications, though this will require significantly more data than used in this pilot study. Long-term possibilities include automated induction of general anesthesia.

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Prediction of Postinduction Hypotension with Deep Learning

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Introduction: Surgical patients with hypotension 0 to 10 minutes postinduction have been shown to have higher prevalence poor outcomes.[1] However, there are few tools available to help predict who is at risk for such hypotension. Recently, Kendale et al. compared machine learning methods to predict hypotension utilizing 56 EMR features and demonstrated an AUC of 0.74 for a stochastic gradient boosting machine.[2] This model utilized only static EMR features, and so we hypothesized that the use of more dynamic arterial blood pressure (ABP) waveform features and deep neural networks (DNN) could improve prediction.

Methods: Data used in these experiments came from UCI Medical Center with IRB approval. The data includes all surgical procedures performed from November 2015 to August 2017 (n=19,545). Patients with no induction time, no MAP 10 minutes after induction, negative time difference between surgical start and induction, < 18 years of age, or no arterial blood pressure (ABP) waveform prior to induction were excluded resulting in 224 patients. Postinduction hypotension was defined as 1) postinduction MAP decrease of > 40% from preinduction and postinduction MAP < 70 mmHg or 2) postinductioin MAP < 60 mmHg. Induction time was defined as first recorded induction event in the EMR, etomidate or propofol administration time. For comparison, we extracted the same EMR features as described in Kendale et al., except for those related to medical comorbidities and preoperative medications due to data availability, to develop a logistic regression and deep neural network model (DNN). This resulted in 15 EMR features. We added an additional 9 EMR features of our own related to HR, MAP, and SpO2 pre-induction. Values for medications greater than a clinically normal maximum (M.C) were assumed as annotation error and set to the maximum. Missing values for other features were filled with the mean, and all features were rescaled to mean 0 and standard deviation 1. For ABP waveform features, we extracted all available ABP waveforms (100 Hz) 5 minutes prior to induction. All waveforms were processed for signal quality and 8 beat-to-beat features such as MAP using the algorithms provided by Physionet[4] and the mean of the features were taken as input. These EMR and waveform features were utilized in a logistic regression and deep neural network model (DNN). Models were trained to classify hypotension 0 to 5 minutes and 5 to 10 minutes postinduction. Due to the small size of the data set, we utilized leave-one-out cross validation (LOO).

Results and Conclusion: The occurrence of hypotension 0 to 5 minutes postinduction is 8.9% (n=20); for 5 to 10 minutes postinduction occurrence is 9.8% (n=22). The best performing model overall was the waveform only DNN model for the prediction of 0 to 5 minutes postinduction hypotension (AUC 0.88 (0.812-0.934)) (Table 1). This model had 2 hidden layers and 60 neurons, and was trained with dropout probability of 0.25, L2 regularization with a lambda 0.0001, batch size 128, and a learning rate 0.001. Overall, all DNN models had higher AUCs than logistic regression (LR) for each feature set, and waveform only features performed best overall (Table 1). EMR only features performed the worst, except in predicting 5 to 10 minutes postinduction hypotension with LR.

Table 1. Leave-one-out validation AUC results

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0 to 5 Minutes Post Induction		
Feature Set	**DNN Model**	**LR Model**
Waveform Only	0.88 (0.812-0.934)	0.875 (0.81-0.929)
EMR Only	0.51 (0.402-0.623)	0.505 (0.363-0.637)
Waveform + EMR	0.804 (0.703-0.888)	0.792 (0.695-0.873)

5 to 10 Minutes Post Induction		
Feature Set	**DNN Model**	**LR Model**
Waveform Only	0.703 (0.557-0.823)	0.613 (0.452-0.752)
EMR Only	0.63 (0.497-0.76)	0.667 (0.555-0.78)
Waveform + EMR	0.653 (0.512-0.779)	0.603 (0.475-0.725)

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