STA Interface NEWSLETTER

SOCIETY FOR TECHNOLOGY IN ANESTHESIA • MARCH 2018

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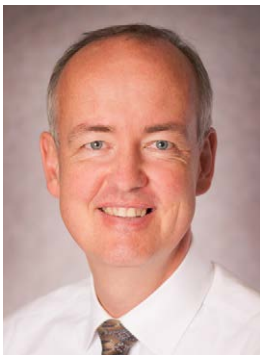

President's Message

KAI KUCK, PHD, UNIVERSITY OF UTAH

I'd like to take this opportunity to express my sincere thanks and STA's deep appreciation for outgoing President Mark Poler's leadership of our society this past year. He and the Board of Directors did a great job steering the society and, as we heard at our Annual Meeting in Miami, the society is in very good shape. Our membership increased to 332 members. Thanks to our Membership Committee Chair Dr. Charlene Blake, many of the new members are anesthesia residents.

Drs. Brewer and Tan, the Meeting Co-Chairs of this year's Annual Meeting created a fabulous program covering a broad spectrum of topics including anesthesia in space, automated drug delivery, big data, and the internet of things. Another recurring theme, both in the general session and during the FAER sponsored program on Saturday, was the translation of innovations from their academic origins to where they have an impact on patient care. Several sessions gave both inspiration and introduction to the entrepreneurial pursuit of bringing our innovations to the bedside.

A big thank you goes to FAER for sponsoring the program and meals on Saturday. And, of course to all our excellent contributors, be it speakers, moderators, poster presenters, and discussants. I would be amiss if I did not give a shout out to our management, Jane, Marie, Rachel, and their team. They are the ones who pay attention to and plan every detail of the logistics and organization of the meeting, making sure it runs as smoothly as we have become used to -- and then bring the same dedication to supporting the society's operation throughout the rest of the year. The combination of excellent content and meticulous planning and organization allowed the Annual Meeting (for the second year now) to achieve accreditation so that attendees are eligible for MOC LLSA or Clinical Informatics credits.

A society as ours and its Annual Meeting are not sustainable without strong support from our corporate sponsors. Companies have many choices these days of how to interact with innovators and users of their solutions and services, of how to spend their outreach resources, and their time. We deeply appreciate our sponsors making it a priority to support

President's Message
continues on next page

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our society, to come to our meeting and to interact with us. We have seen a slight drop in corporate support, which is partially attributable to the many forces that at the same time squeeze corporate budgets and present new opportunities and demands on how to spend them. Your board is taking dedicated steps to explore this trend and how to address this. I have made it one of my priorities during my term as president to listen to our corporate friends and learning how we can make their interaction with STA even more valuable to them.

Personally, what I enjoy most about STA and our events, besides reconnecting with friends, is how they bring together clinicians, engineers and scientists, academia and industry, regulators and innovators, experienced anesthesia technologists, and those that are new to the field. The interactions between great minds from these groups create conditions that result in the innovations that are a hallmark of STA and its members. We cannot hope to completely formalize or pre-plan these interactions. That is why the relatively small size of the STA Annual Meeting and the many opportunities to meet during breaks and social events are so important. I would love to find ways to carry some of the buzz and positive energy from the meeting into the time after the meeting when we are all returning to our clinics, labs, corporate offices, and day jobs.

I want to extend my congratulations to Dr. Matthew Weinger, this year's recipient of the J.S. Gravenstein Award for his lifetime achievements in technology in anesthesia. Dr. Weinger is Professor of Anesthesiology, Biomedical Informatics, and Medical Education at Vanderbilt where he holds the Ty Smith Chair in Patient Safety and Medical Simulation and serves as Vice Chair in the Department of Anesthesiology, Director of the Vanderbilt Center for Research and Innovation in Systems Safety, and Director of Research in the Center for Experiential Learning and Assessment. Dr. Weinger was one of the first members of STA, organized the workshops at the first STA meeting in 1988 and many other annual meetings since and is one of our society's Past Presidents. His career and achievements embody what STA and the 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. Clyde Matava, Assistant Professor at the University of Toronto and Director of Innovation, Informatics and Technology in the Department of Anesthesia and Pain Medicine, The Hospital for Sick Children.

Technology continues to be one of the strongest drivers and enablers of change in anesthesiology. STA is right in the core center of transforming the field of anesthesia through innovation –since its establishment almost three decades ago through today. Just recently I came across my copy of the September 1994 issue of Journal of Clinical Monitoring. The complete issue reports about one of the first STA meetings in 1992. Over three days, all 200 attendees, in 16 groups imagined the future of the anesthesia workstation. That meeting delivered a blueprint of many of the innovations that have become reality since then – and many others that still await implementation. Physical integration of components into an anesthesia delivery "system," advanced displays, less cumbersome user interaction, autopilot, voice-based alarms, heads-up displays, the list goes on and on. Let us consider dedicating part of a future meeting to compare the 1992 vision of the future with today's reality – and then move on and design the anesthesia workplace of 2030!

The growing quality of abstracts submitted to our Annual Meeting (thanks to the many submitters and to our Abstract Co-Chairs Dr. Charlene Blake and Dr. Matthew Levin for organizing this) and the lively interactions during the poster sessions are just a few of the important ways of how STA facilitates innovation in anesthesia. STA and its members have been driving and shaping trends in anesthesia, from patient safety, anesthesia closed loop control, and high-fidelity patient simulation for many decades. We are continuing to bring emerging technologies to applications in anesthesia with themes such as "big data" and "interoperability" that are recurring and strengthening at annual meeting after annual meeting. The Engineering Challenge, directed by Dr. Jeff Mandel, is another example of creating opportunities for looking into the future, be it 3D printing when it was still nascent, artificial intelligence applied to mobile EEG monitoring, or this year, the application of blockchain technology.

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.

I am excited and humbled about leading STA for this term. I am looking forward to seeing many of you at the Ty Smith Dinner on October 14th in San Francisco (we will share details as they become available) and at the ASA. Until then, please continue to engage with your STA, share ideas, get involved!

Kind regards,

Kai Kuck, PhD
President, Society for Technology in Anesthesia

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Report from the Executive Director

JANE SVINICKI, CAE

Lessons Learned from the NCAA 2018

"Plan, Practice, and Prepare for the Improbable"

One of my guilty pleasures is 'March Madness.' Yes, I mean the NCAA basketball tournament held each March where the 64 (or 66 if you count 'first four' teams) complete to become the national champion.

College teams compete with a heart and passion you rarely see in the pros. If you don't believe me, when was the last time you saw a pro-athlete cry when they lost a game? Some Arizona players this year shed tears when beaten in round one.

The exuberance of UMBC in the locker room after beating #1 seed Virginia when they brought out the bracket board and wrote the team name in the second-round line was magnetic.

The fans are a different breed too. Students cheering on the school team, parents and other relatives in the stands, and alumni reliving a time when the world was just beginning for them.

Here are my lessons learned from NCAA:

1. **Anything Can Happen:** When the competing teams are announced, they are ranked #1 (best) - #16 (well, not the worst or they wouldn't be in the tournament, but the least likely to advance). These rankings are based on statistics on the teams and players. But many of us are rooting for the 'Cinderella Story', the lowly ranked team that beats the best. Why do we do this? Because we want to believe in magic, the ability of a team to reach beyond it's obvious talents and excel.

   Strive for the Cinderella Story moments in your own life.

2. **It's All About the Team:** Some of these student athletes maybe looking forward to professional careers, but most will peak their athletic career with their college team. For the majority of these athletes, being a contributor on a winning team is what they want to, and will, remember.

   Strive to have your team win, and you will be a winner too.

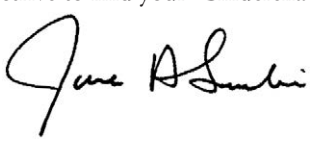
3. **Playing Through the Pain:** Injuries are a part of sports, and student athletes are no exception. Coming back to the court with a sprained elbow, sore muscles, or bruises for a last chance to help the team is important to these players.

   Strive to contribute every day, whether at your worst or your best.

4. **A Generous Spirit:** Commitment to years and years of practice and development is all part of the game for student athletes. Some have natural talent, some develop talent, but hard work is required. But talent alone does not a winning team. Among the members of the team, there must be generosity, evidenced by mentoring and leadership from the players. Even outside the court, development of future talent, is nurtured by the senior players.

   Strive to provide mentoring and leadership to those around you.

There are many lessons to be learned by the competition of student athletes at all levels. The NCAA tournament provides a national platform in which we can all engage. We can watch the skill of premiere athletes, but we can also see the emotion and learning that is beyond the game. Even if you are not interested in basketball, strive to find your 'Cinderella Story.'



Jane A. Svinicki, CAE,
Executive Director

Highlights from the 2018 STA Annual Meeting

JONATHAN M. TAN, MD MPH
(2018 STA Annual Meeting Co-Chair)
Assistant Professor of Anesthesiology and Critical Care
The Children's Hospital of Philadelphia
Perelman School of Medicine at the University of Pennsylvania

LARA BREWER, PHD (2018 STA Annual Meeting Co-Chair)
Research Assistant Professor
Departments of Anesthesiology and Bioengineering
University of Utah

While much of the United States was experiencing temperatures below freezing, the 2018 STA Annual Meeting was attended by a diverse and international group in the warmth and beauty of Florida at the Turnberry Isle Miami. This year's program highlighted the theme of Data Driven Innovation and Technology in Anesthesia. The central role of data was evident in many of the most important developments in anesthesia and perioperative medicine including medical device development, cybersecurity, automated drug delivery and successful entrepreneurship.

The meeting kicked off with an inspiring and outside-the-box thinking keynote by Dr. Mattieu Komorowski, who traveled from the UK, on the Challenges of Anesthesia during Future Interplanatery Space Missions. Dr. Komorowski shared his experiences and work in developing resuscitation protocols and medical emergency planning in space where resources are scarce, communication is delayed and the complexity that zero gravity environments bring.

In addition to the wide range of accomplished and inspiring experts who comprised the panels of the conference, this year's STA Annual Meeting brought about its own innovation by including scientific "Abstracts in a Minute." Presenting authors had one minute to summarize the purpose and key points from their work on the main stage. These sessions were well received, as they allowed for the larger audience to gain an overview of the work people are involved in while promoting conversations about exciting state of the art research developments. Returning meeting events included an interesting Engineering Challenge based on Bitcoin and a popular FAER-supported concurrent session for young researchers.

This year's meeting was also unique in that STA partnered with FAER for the second time in a few years to hold a one-day Foundation for Anesthesia Education and Research Session Workshop that highlighted the successful steps in entrepreneurship. The FAER session was conducted in honor of Dr. Ted Stanley and included stories from entrepreneurs in different phases of their careers who had commercialized clinically-driven ideas. FAER also held a fun and educational "Swimming with the Sharks" pitch competition for entrepreneurs. The contestants pitched their ideas to panel of innovation experts, while the audience learned about the steps involved in the process of developing an idea to bring it to market.

On page 7 is a brief photographic summary of the meeting. More details and material from the meeting can be found on the STA Website: http://www.stahq.org/events/annual-meeting

2018 STA Annual Meeting Abstract Winners

Abstracts Listed on pages 11-18

Best in Show
The Feasibility of Anesthetic Drug Delivery by a Valve-Less Micro-Pump
Matthias Görges, PhD, University of British Columbia

Best Clinical Application
Feasibility of Panda, a Pediatric Post-Discharge Pain Management Smartphone Application for Use by Parents
Dustin Dunsmuir, MSc, University of British Columbia

Excellence in Technology
Development of an Anesthetic Reflection System
Patrick Kolbay, BS, University of Utah

Honorable Mention
3D Printed Thermal Powered Laryngoscope
Michael Dinsmore, MD, FRCPC, Toronto Western Hospital

2018 STA Annual Meeting Photos

Drs. Jeff Mandel and Tom Engel in the exhibit hall.

Dr. Poler presenting awards to Drs. Jonathan Tan and Lara Brewer for their work as 2018 Annual Meeting Program Chairs.

Dr. Matthew Weinger, 2018 J.S. Gravenstein Award Recipient, with Dr. James Philip, 2017 J.S. Gravenstein Award Recipient.

Dr. Poler presenting an award to Dr. Clyde Matava, 2018 Neurowave Research Grant recipient.

Dr. J. Mark Ansermino presenting in general session.

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2018 J.S. Gravenstein Award Winner

JAMES SZOCIK, MD
University of Michigan

The 2018 Gravenstein Award was presented to Matt Weinger, who delivered his talk entitled "Bringing Human Factors Engineering to Healthcare on Friday, January 12, 2018.

Matt began with a tribute to Nik Gravenstein and all of Dr. Gravenstein's publications (138 publications with over 3000 citations). Dr. Weinger's first anesthesia publication, co-authored with Dr. Gravenstein, was entitled "Why Investigate Vigilance" and published in 1986 (Journal of Clinical Monitoring and Computing 2 (3), 145-147. Matt has a long history of involvement with the STA, from early planning discussions and organizing the workshops at the 1988 STA meeting, as well as giving a plenary talk on displays in 1992. He was the Meeting Chair in 1993 and 1994, a member of the board for many years and President of the society from 2000-2001.

A self-described high school computer nerd, he participated in a neurobiology National Science Foundation summer program at University of Southern California, and an IBM 360 assembler GE summer internship in DC. During his electrical engineering program at Stanford (1974-78), he spent 2 summers at Woods Hole Oceanographic Institute involved in more neurobiology. After his undergrad, he continued at University of California San Diego for medicine (1978-82) and anesthesia at University of California San Francisco (1983-85). With an interest in simulation, he went back to UCSD for a post-doctoral fellowship (1986-87). Under the tutelage of George F. Koob at the Scripps Research Institute, Matt had excellent training resulting in 10 years of NIH & VA funding and 18 papers from 1987-1996. During his fellowship he discovered Human Factors Engineering (HFE), and received some extramural support from both the Anesthesia Patient Safety Foundation (APSF) and the National Patient Safety Foundation. In his first HFE publication in Anesthesiology 1994, he "quantified the obvious"; experienced clinicians have lower workload.

Being in the right place at the right time with the Institute of Medicine report on "To Err is Human", Matt was awarded RO1 on Unexpected clinical events: Impact on patient safety, 2001-2005, establishing his linkage between STA and APSF.

From the 1992 STA, Matt recalled some of his early illustrations on various aspects of anesthesia displays concluding with an article in Anesthesiology (Anes 83: 1184-1193, 1995). He went on to highlight his collaborations with the University of Utah including past STA President Dwayne Westenkow.

Matt concluded by stating he gracefully stumbled into his career focus with everything he did and everyone he met shaping and contributing later activities. He thanked his great mentors, colleagues, and collaborators, his current team, sponsors, and his family.

Dr. Weinger's slides can be found at:

http://www.stahq.org/userfiles/ckfiles/files/STA_18AM_Handout_Weinger(1).pdf

https://www.stahq.org/resources/annual-meeting-archive/2018

2018 Engineering Challenge

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

Anesthesiologists have a relatively unique need for access to one specific aspect of the medical history – previous difficulty with intubation. While individual healthcare entities may have a standardized approach to labeling a patient as a "difficult airway", what happens when I move to another city, or my insurance carrier tells me I can no longer get care at my previous hospital? While we all hope for the ubiquitous EMR that can follow us from cradle to grave, the technical barriers to this are immense. The Engineering Challenge for 2018 was to demonstrate a method to enter an Intubation Difficulty Score[1] into a blockchain to permit an interaction between a patient and an anesthesiologist that permits the anesthesiologist to be able to access the previous entries and add a new entry in a secure fashion.

There were 5 presentations – Univeristy of South Florida, University of Michigan, Beth Israel Deaconess, Hospital for Sick Children, and Cleveland Clinic. The utility of the blockchain was discussed. The blockchain is a distributed ledger. Entries can be placed on the chain, but can never be removed. A group of entries form a block, whose integrity is assured by a cryptographic hash – an irreversible mathematical operation. As we learned, you can make hash from a cow, but you can't make a cow from hash. Entries can be placed on the blockchain as clear text available to everyone, or they can be encrypted so only an authorized user can read the entry. While it is possible to write your own blockchain solution, this wheel has been invented, and the entrants focused on established efforts such as Ethereum. While everyone was commended for their efforts, by acclamation of the nearly full room, Priya Ramaswamy of Beth Israel Deaconess was chosen as the winner. We all eagerly await further developments in this area, and note that last year's challenge has resulted in at least one published paper.[2]

References

1. Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P, Lapandry C. The intubation difficulty scale (IDS): proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology. 1997 Dec;87(6):1290-7. PubMed PMID: 9416711.
2. MacLean LJ, Saab R, Gordon A, Matava CT. The Design of a Pulse Oximeter to MIDI Output Conversion Unit--a Technical Report. Journal of Medical Systems. 2018;42:41.

2018 STA Annual Meeting Abstract Winners
Best in Show

The Feasibility of Anesthetic Drug Delivery by a Valve-Less Micro-Pump

Co-Authors: Kirsten Allen, Christian L Petersen, J Mark Ansermino, Matthias Görges, Digital Health Innovation Lab, The University of British Columbia, Vancouver, Canada

Introduction: Globally, one of the biggest health inequalities is the lack of access to essential surgical services in low resource settings [1]. Safe delivery of anesthesia is crucial to address the need for increased surgical services. Intravenous administration of agents such as ketamine requires less complicated equipment (i.e. syringe pumps) than the administration of volatile agents that need gas delivering anesthesia machines fitted with vaporizers. Even so, conventional syringe pumps remain large, complex and costly. In this study, an alternative method of drug delivery by disposable valve-less diffuser micro-pumps [2] is explored.

Method: A valve-less diffuser pump is realized by the 3D printing of the pump body in resin with 25 µm resolution stereolithography (Fig. 1a). The body is a 6.4 mm thick disc, 25.4 mm in diameter. The driving element is a 20 mm brass disc with piezoelectric coating (a widely available piezo “buzzer”). The disc is driven by an off-the-shelf audio power amplifier causing large oscillations at ~300Hz (Fig. 1b). The difference in flow resistance at ingress and egress of the pump chamber below the disc results in liquid being forced through the pump. The pumped liquid (water was used during testing) is measured by a precision scale as a function of time.

Results: The prototype demonstrated the ability to pump at a rate of 0.85 ml/min (51 ml/h) in the absence of back-pressure, and displayed a linear infusion profile over time (Fig. 1c). This rate is adequate for maintenance of anesthesia but insufficient for induction and bolus action. In addition, the prototype is currently not able to overcome the back-pressure observed in drug delivery when connected to a patient. More optimization is needed to determine whether these shortcomings are fundamental to the valve-less design, or if a more accurate pump body design and a dedicated high-voltage piezo driver can increase rates and overcome the back-pressure.

Conclusion: With further development, it may be possible to realize a coin-sized, disposable anesthetic delivery system, which can be manufactured for a few cents and provide safe drug delivery in resource constrained environments around the world. Such a system might also prove useful for delivering other medications, such as oxytocin.

2018 STA Annual Meeting Abstract Winners

Best in Show

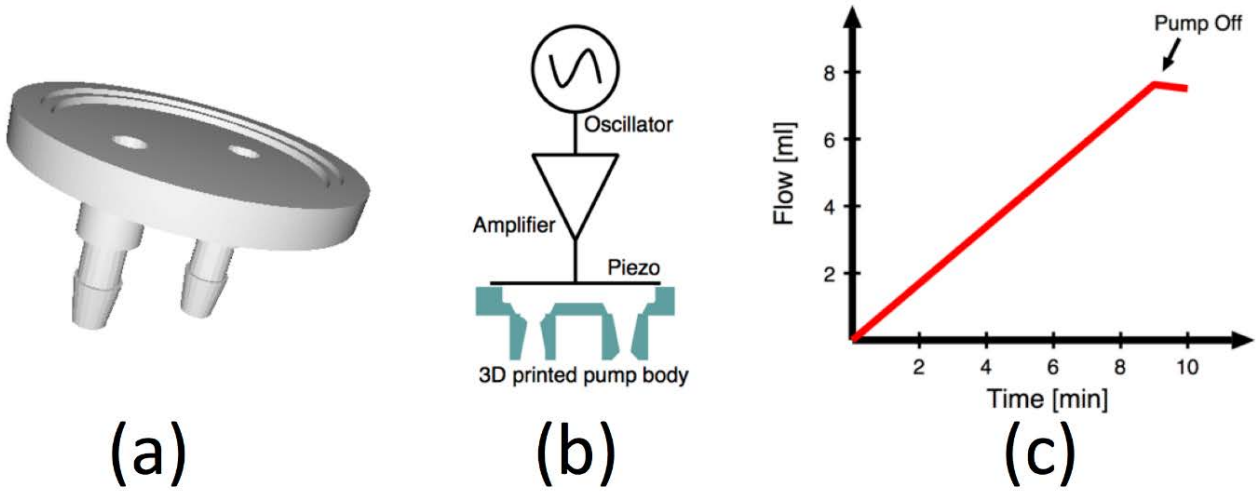

Fig.1: 3D printed micro-pump body (a), system diagram (b) and infusion profile using initial measurements (c).

References: [1] Anesthesiology 2016 Mar;124(3):561-9. [2] Sensors and Actuators 84 (2000) p. 165

2018 STA Annual Meeting Abstract Winners
Best Clinical Application

Feasibility of Panda, a Pediatric Post-Discharge Pain Management Smartphone Application for use by Parents

Presenting Author: Dustin Dunsmuir[1,2] MSc

Co-Authors: Helen Wu[1,2], Terri Sun[1] MD, Nicholas West[1,2] MSc, Matthias Görges[1,2] PhD, Gillian R Lauder[1,3] FRCA, J Mark Ansermino[1,2,3] FRCPC.
[1]Department of Anesthesiology, Pharmacology & Therapeutics, University of British Columbia
[2] Research Institute, British Columbia Children's Hospital
[3]Department of Anesthesia, British Columbia Children's Hospital

Introduction: As the number of pediatric outpatient surgeries increases [1], it is important to empower families to adequately manage their children's pain in the days following surgery. Some families poorly manage their child's postoperative pain at home [2], and this can cause significant behavioural issues such as eating problems and anxiety [3]. The reasons for poor post-operative pain management include inadequate discharge instructions, failure to appropriately assess pain [2], inability to recall medication instructions [2], and underestimation of a child's pain [3]. To address these problems, we have developed Panda, a smartphone application (app) that alerts parents when to give medication and provides a standardized and validated tool for parents to assess their child's pain (Figure 1). This study evaluated the feasibility of providing the Panda app to parents for use at home, based on their compliance and satisfaction with the app.

Methods: Following ethical approval and informed consent, families used Panda for 1-7 days at home after their child's surgery. With assistance from a research assistant, parents set up user preferences and a medication schedule on either a research device or their own personal Apple or Android phone. At each scheduled notification, the parents used validated pain assessment tools and safety checks before completing the administration of medications. Data collection consisted of an audit function recording all actions within the app, responses to app alerts (pain scores and medication given), feedback through a post-study structured telephone interview, and the completion of the Computer Systems Usability Questionnaire (CSUQ) [4].

Results: Twenty-nine families were recruited to use the app and completed a post-study interview. Recruitment was done in 3 rounds with small improvements, such as graphics and alert noises, made between rounds. Families received an average of 13 alerts during the study period, 46% were responded to within an hour and 74% were responded to before the next alert occurred. The CSUQ was completed by 22/29 (76%) families. The median (interquartile range [IQR]) CSUQ approval rating was 2 (1-3) "agree". The most highly rated statement "It was easy to learn using this interface" had a median (IQR) rating of 1.5 (1-2) "strongly agree to agree". In interviews, participants reported the app as easy to use and useful for those who are forgetful, but suggested many ways to expand its functionality and improve its usability. Parents wanted more flexibility and control within the app, including more dynamic medication schedules, custom alerts, and the addition of numeric (adult) pain scales.

2018 STA Annual Meeting Abstract Winners
Best Clinical Application

Conclusion: We have shown that with minimal help from a research assistant, it is feasible for parents to use this app at home in a real world setting. There are several suggestions to improve the app, which we are currently reviewing. We hope to incorporate the app into standard discharge instruction for outpatient surgeries and to add a healthcare provider communication component in the near future, which will include a hospital-based patient recovery information dashboard receiving pain and medication details from Panda.

References: [1] Pain Res Manage. 2012; 17(5): 328–34. [2] Paediatr Anaesth. 2013; 24(3): 239–48. [3] Arch Dis Child. 2012; 97(10): 879–84. [4] Int J Hum Comput Interact. 1995; 7: 57-78.

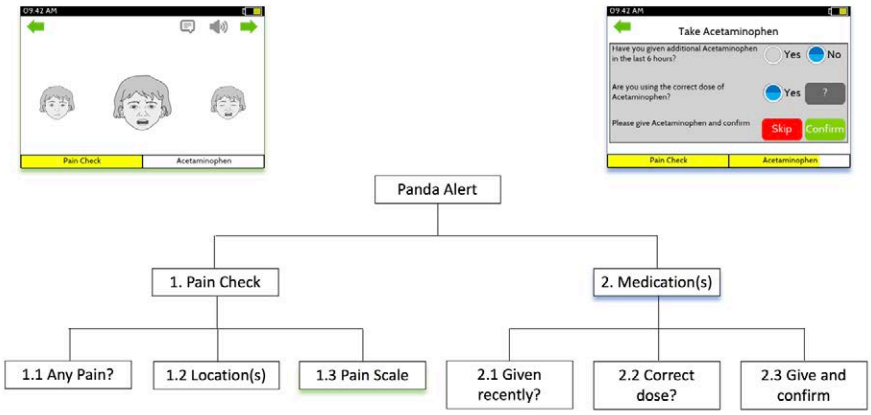

Figure 1: The two-step process of responding to a Panda alert is performing a pain check and then safety checks for medication(s).

2018 STA Annual Meeting Abstract Winners
Excellence in Technology

Development of an Anesthetic Reflection System

Presenting Author: Patrick Kolbay, B.S., University of Utah

Co-Authors: Joseph Orr, Ph.D., University of Utah; Kai Kück, Ph.D. University of Utah

Introduction: The World Health Organization declared climate change the defining issue for health systems in the modern century. Ironically, the health care industry itself is a leading emitter and accounts for 8% of the total carbon dioxide emissions alone [1]. In anesthesia, publications have brought growing concern about the global warming potential of emitted inhalational anesthetics. Previously we have demonstrated that activated charcoal has suitable sorption isotherm characteristics to absorb and desorb isoflurane, suggesting feasibility to reflect exhaled anesthetic gases back to a patient during sedation [2]. Building off this research, we have developed an anesthesia machine add-on that allows for traditional anesthesia delivery in tandem with a charcoal filter for gas reflection.

Methods: An initial proof-of-concept prototype was created to be fitted within the rebreathing circuit of a current anesthesia machine. This system consisted of a housing of two chambers printed with biocompatible acrylic (MED610, Stratasys, Eden Prairie, MN). One chamber was fitted with a charcoal cartridge (Oxpure 1220C-75, Oxbow Activated Carbon, West Palm Beach, FL), and the other remained open. A gear with a semicircular opening was actuated externally to direct gas flow between chambers. In addition, differential pressure sensors were attached at both chamber ends to determine direction of gas flow (simulated inhalation and exhalation). Anesthetic gas concentration measurements from a standard infrared gas bench (Datex-Ohmeda, Helsinki, Finland) was used for basic feedback control. A microcontroller controlled the gear valve to titrate a user give anesthetic concentration based on flow detection and anesthetic gas concentration using a rudimentary hysteresis controller. This device was tested between the breathing circuit of an anesthesia machine and a test lung.

Results and Discussion: Our proof-of-concept device was successful in meeting the basic criteria. During a mock induction, the device oscillated between the open chamber (inhalation) and the charcoal filter (exhalation) to initially saturate the activated charcoal (Figure 1). During this time, it took approximately 6 minutes for the charcoal filter to saturate. Fresh gas flow then primarily flowed bidirectionally through the charcoal filter, with the controller able to maintain average isoflurane concentrations within 0.2% by volume of the user set point (1 MAC). Given a cartridge with 40 grams of activated charcoal, the Anesthetic Reflection System would can reflect 1 MAC/hour of anesthetic gas at a fresh gas flow rating of 1 liter/minute.

2018 STA Annual Meeting Abstract Winners

Excellence in Technology

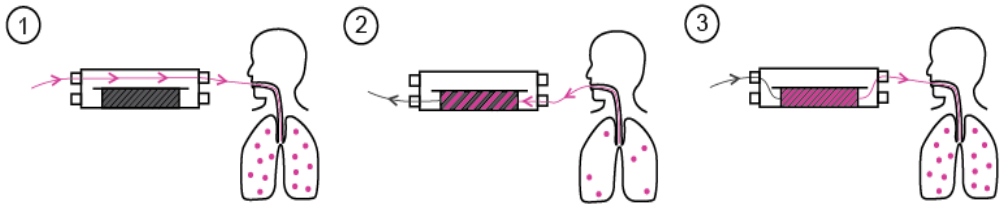

Figure 1 – (1) Patient inhales anesthetic gas directly from anesthesia machine during induction. (2) Patient exhales anesthetic gas into activated charcoal filter. (3) Anesthetic gas is supplied from filter to the patient during anesthetic maintenance.

References:

[1] J. W. Chung and D. O. Meltzer, "Research letter," *J. Am. Medial Assoc.*, vol. 302, no. December 2010, pp. 1970–1972, 2009.

[2] P. Kolbay, J. Orr, and K. Kück, "Reducing Volatile Anesthetic Waste Using Activated Charcoal," in *Proceedings of the 2017 Society for Technology in Anesthesia Annual Meeting*, 2017.

2018 STA Annual Meeting Abstract Winners
Honorable Mention

3D Printed Thermal Powered Laryngoscope

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Introduction: Laryngoscopes are a fundamental and necessary piece of equipment used by every anesthetist on a regular basis. They are a mechanically simple piece of medical equipment, but rely heavily on a properly functioning light source. Current models consist of a metal/plastic handle that encases a halogen/LED light powered by a disposable/rechargeable battery. The handle is designed to allow the attachment of multiple different blades for intubating patients of various ages and anatomical differences. Although laryngoscopes are often available in developing countries, antidotal evidence suggests they are often missing a functional light source. Anesthesia in developing countries must take into account local conditions and whether reliable supplies such as batteries or electricity are readily available. Only 34% of hospitals have reliable electricity access in sub-Saharan African countries and therefore Laryngoscopes with rechargeable batteries would not be a reliable option[1]. Alternatively, lower cost LED laryngoscopes are becoming much more widely available, but batteries are expensive, often difficult to attain and deteriorate through use and over time. In addition, used batteries that are not properly recycled lead to toxic effects on the environment and potentially harmful consequences to the surrounding communities. Therefore, the aim of this research is to develop a low cost 3D printed laryngoscope with a completely green, clean and renewable light source that is powered only by thermal energy produced by the user's hand when holding the laryngoscope.

Materials and Methods: The device contains an external 3D printed shell that is designed to contain at least one thermoelectric generator (Peltier Tile) extending through an open portion of the exterior for direct contact with the users hand in order to extract the maximum heat from the users left hand. The inner surface of the thermoelectric generator is attached to an aluminum heat sink with multiple cooling channels in order to optimize the temperature gradient across the thermoelectric generator. Integrated circuitry consisting of a commercially available step-up transformer and transistor oscillator in direct electrical communication with both the thermoelectric generators and the light source are housed within the handle.

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Results: Optimization has included increasing the number of tiles in sequence in order to reach a maximum brightness of 204.1 ± 11.7 Lux using 4 tiles. Time decay was linear with the average initial brightness of 193.8 ± 40.1 Lux decreasing to 142.3 ± 27.3 and 103.4 ± 20.7 at 60 sec and 120 sec respectively. Further optimization includes handle design and heat sink optimization.

Reference:

[1] Adair-Rohani H, Zukor K, Bonjour S, Wilburn S, Kuesel AC, Hebert R, Fletcher ER: Limited electricity access in health facilities of sub-Saharan Africa: a systematic review of data on electricity access, sources, and reliability. Glob Health Sci Pract 2013,1:249–261

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