INTERFACE

President's Message

By Mark Poler, MD, Geisinger Health System

In 2013, then President Dr. John Pawlowski set 4 "M" goals for STA: (1) [Annual] Meeting, (2) Meaning, (3) Membership, and (4) Money. Subsequently, Drs. Spiegel, Orr, and Rothman have presided over terrific meetings, continuation of old programs and initiation of new, increasing membership, and a much better financial situation. Altogether, a rich legacy for a tiny society with outsized impact. I will survey some of the many developments that are keeping the society vigorous and vibrant. I am indeed fortunate to inherit this legacy and hoping to build on the foundation.

The name of this newsletter, *Interface*, captures in a word the nature and function of the Society for Technology in Anesthesia. Throughout the seasons of STA's existence, this society has been a nexus where development of new technologies relating to practice of anesthesiology have been discussed and fostered. The small size of the organization favors interaction and lasting friendships of experts from dissimilar disciplines with common cause in the fields of anesthesia innovation, investigation and practice. Members include clinicians, scientists, engineers, business management, educators, students and trainees, nurse anesthetists, academics, and private practitioners. The list is incomplete, yet illustrates breadth, depth, and novelty of the organization.

Recently, your Board of Directors faced a defining decision. The American Society of Anesthesiologists (ASA) invited STA to become a component society. Some enticements were offered. However, acceptance of that proposition would have required a substantial change to the bylaws, only allowing anesthesiologists to be officers of the society, thereby relegating all others to an associate member status. After careful consideration of the implications, the Board voted to decline the invitation, recognizing that the unique character of STA requires that non-anesthesiologist professionals are on an equal footing in this organization, that the very character of STA requires the collegial peer relationships here fostered across medical, engineering, entrepreneurial, management and other corporate professions. Corporate members often express a special affinity for STA, where they enjoy uniquely collegial and informative interactions not available

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In This Issue!

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elsewhere. I have been a member almost from the very beginning, and fortunate to be able to recall conversations with founders Ty Smith and Nik Gravenstein. They intended the organization to have this unique cross-disciplinary culture. Having set this course from inception, it will continue uninterrupted as an equal opportunity professional home for those with interests in any technologies related to anesthesia.

History

The interdisciplinary character of STA has expressed itself in many ways. In the early days, emphasis was on developing monitoring technologies, their applications and refinement, and computer programming in the still young world of personal computing. Human factors and simulation were frequent topics. The Society for Simulation in Healthcare (SSIH.org) that now dwarfs STA, was spawned in this society. Those topics continue to have a place, though less prominent. Some topics wane, others increase.

Many of the same individuals who played pivotal roles in founding of STA were also instrumental in founding of the Anesthesia Patient Safety Foundation (APSF), and its seminal role in the rising patient safety movement. The mutual interests and participation of individuals in both organizations continues to this day. Improving patient safety has always been an essential guiding principle.

Now older technologies continue to be refined and new innovations arrive. Additionally, increasing focus on optimization and efficiency are now essential to control escalating healthcare costs, with concurrent need to improve patient safety. These are challenging objectives, especially for those minutes spent in surgical settings which are the most expensive in healthcare. STA members have often been at the forefront of these enabling and necessary, often technological, undertakings. Part of the excitement of STA has been early exposure to cutting edge innovations.

Meetings

We had a wonderful 2017 Annual Meeting in San Diego despite persistently wet weather. Many contributed, but special thanks are due to Dr. Jonathan Wanderer for organizing a stimulating, never-dull meeting program. Drs. Brewer and Tan were abstract reviewers for a record 60 submissions. Dr. Wanderer moved the interaction with speakers one more step into the modern, electronic media era by using PollAnywhere to field audience questions for our speakers, in addition to the usual direct interactions with the floor. Drs. Swift and Chan further encouraged use of social media interactivity, even for those not in attendance, continuing an innovation introduced a year previously.

STA also directly participates in the Annual Meetings of ASA and IARS (International Anesthesia Research Society, iars.org), usually organizing panels, and by contributions of individual members. An annual tradition is the Ty Smith dinner, on Sunday evening of the ASA October meeting for a time of collegial interactions and always interesting speakers.

International Connections

STA has principally been oriented to practice in the United States, yet has always had a substantial number of members from diverse international origins, enriching the society. Diverse experiences and perspectives further increase opportunities for insight and innovation. Growing and strengthening international engagement is actively being pursued. One highlight of the 2017 Annual Meeting was an inaugural presentation of Dr. Grant Forrest, under the cooperative sponsorship with our UK counterpart, SCATA (Society for Computing and Technology in Anaesthesia, scata.org.uk), giving us a broader perspective of our professions elsewhere in the world. Drs. Ori Gottlieb and Brian Rothman will represent STA at the coming May SCATA meeting in Glasgow, Scotland.

Membership

Drs. Charlene Swift and Lisa Chan have been remarkably successful in engaging anesthesiology residents using social media and gatherings. About 80 new—mostly young—members have been added to the membership rolls, an auspicious development for the future of STA. STA will need to continue to support the traditional base and engagement among academic, practicing, industry representatives (engineers, product managers). We often hear from our corporate partners that the quality of engagement available in various ways through STA is superior to other venues. This characteristic attracts and retains corporate engagement and support, a foundation for the professional and financial viability of the society.

Other approaches may expand membership among non-clinical professions engaged in technical aspects of the practice of anesthesia. One innovative approach has been the annual Engineering Challenge, consistently organized and sponsored by Dr. Jeff Mandel. This has gained attention from Biomedical Engineering programs that might not have otherwise been aware of STA or participated in the meeting. For another, at Dr. Thomas Hemmerling's urging, Fresenius sponsored competitive research grants for two years. Now Neurowave has agreed to fund the continuation the program for three more years. The innovative achievements arising from these small grants acknowledge and advertise support from STA and the sponsors when presented or published.

Informatics

Actively embracing informatics fits well with the history and character of STA. Custom, single computer programs were once novel; now interfaced and networked systems are the

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norm, grown to corporate scale and governance. While device interfacing, standards, and AIMS have been perennial topics at STA meetings, few imagined the explosive growth of informatics that we have witnessed over 25 years. Improving clinical monitoring, interfaced devices with electronic anesthesia and critical care records produce massive data repositories. We are only beginning to understand how to engage the richness of available data, and the associated opportunity to discern value for outcomes related to such things as monitoring, optimization of fluid management, targeted and closed-loop control of infusions, or management of operating rooms.

A substantial number of our members are already board certified in the new subspecialty of Clinical Informatics, widely applicable even beyond the fields of anesthesia. There is an opportunity to attract others engaged in this new and ascendant subspecialty to a professional home in STA. Dr. Patrick McCormick is especially to be thanked for his ongoing contributions, facilitating applications and preparation for the examination. The opportunity to apply for examination under grandfathering provisions has been extended to 2022, so more of our members already in practice could potentially qualify without needing to satisfy the formal degree or fellowship requirements that will later come into play. If you are interested, please inquire to take advantage of this window of opportunity. Others have blazed the trail and can assist you.

Dr. Wanderer achieved something of a coup with the substantial number of MOCA credits available for maintenance of certification for Clinical Informatics boarded physicians. Hitherto, almost the only available source of such credits required attendance at AMIA meetings. This validates the position of STA as a premier society for leaders in the rapidly developing field of clinical informatics.

Influence and Interactions

FAER (Foundation for Anesthesia Education and Research, faer.org) has increased engagement with STA in common cause on the technology front, planning co-sponsorship of a joint session at the 2018 Annual Meeting, which has been approved by the STA Board. A previous joint venture highlighting entrepreneurship was very successful during the 2014 Annual Meeting. We are pleased with the renewal of this relationship.

STA members continue to exert a significant influence in other organizations, including the ASA, mentioned above. STA members chair and are active participants especially in information technology, equipment, and facilities committees. STA regularly supports a Panel Discussion of technology topics at the ASA Annual meeting. During the ASA Annual Meeting every year the Ty Smith dinner is another opportunity to gather, honoring the memory of one of STA's founding visionaries, and enjoy interesting speakers.

Likewise, STA members are active participants in IARS, and regularly provide a Panel Discussion related to STA interests and activities at the IARS Annual Meeting. Dr. Cannesson is Associate Editor for technology of the IARS journal, Anesthesia and Analgesia, which also publishes the abstracts of our Annual Meetings.

Finally, Thanks

Many thanks are due to Jane Svinicki, Marie Odden, and recently Rachel Dubinski. Their efforts as our very professional managers are distinguished, contributing greatly to the fine quality of our meeting arrangements, financial improvements, and management stability.

Thanks are also due to *Interface* editor Dr. James Szocik, who year in and out regularly prepares excellent content for this newsletter.

We must also thank our steadfast corporate sponsors. Without their assistance and financial support, we could not continue to exist.

The STA website (stahq.org) has been professionally redesigned, to debut about the time that this issue of Interface is published. Please visit stahq.org to enjoy the facelift. We are hopeful that this investment in a very professional appearing website will help to raise the perception of the society, interaction, participation, and membership. Your comments and suggestions for further improvement are welcome, as this is the public face of STA.

Hopefully these reflections have been informative, and evoke further suggestions from you to engage new opportunities and expand our society's horizons. The officers and Board of Directors solicit your suggestions. Thank you, in anticipation of your continuing contributions and ideas.

Sincerely,
Mark Poler
STA President

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Report from the Executive Director

By Jane Svinicki, CAE

If it Was Easy, Everyone Would See It!

It had been on my 'bucket list' for a while – the Aurora Borealis or Northern Lights. But like many things that are wondrous to see, they take some effort to find and observe.

The Aurora Borealis occurs in a circular pattern over the arctic and sub-arctic. Sure, they occasional occur far south, including in Wisconsin, but very rarely. In order to (almost) guarantee that I would see the Aurora Borealis, it was necessary to travel to a place it regularly occurs.

I traveled there in the winter, when night is long (about 18 hours). North from a place few have heard of, Yellowknife, Northwest Territories, Canada, to a place few have visited, Blachford Lake Lodge. It is a remote place perfect for the solitary contemplation of nature's beauty.

I arrived at the lodge by ski plane as the only other option is a ten-hour snowmobile ride. Nature has top priority at the lodge, and its kind treatment through composting, recycling and outhouses leaves the area natural and pristine.

After two nights of cloud cover and frost, a beautiful Aurora Borealis occurred, lasting for hours and lighting up the night sky. It was as glorious as I had anticipated. Camera batteries quickly lost their charge in the -25 degree temperatures while I stood outside to photograph essentially what could not be photographed – dancing ribbons of light.

The journey, including people met along the way, long hours of travel, and bonding with my traveling companions, my brother and sister, was just as large a part of the experience as seeing the Aurora Borealis.

Staring up at the northern sky, without the benefit of cellphone or internet, was an opportunity to focus on the joy of the moment. To contemplate how small we are in comparison to the power and complexity of nature.

The Aurora Borealis occurred several nights in a row. It was an unforgettable light show. My advice is not to hesitate to attempt the difficult things in life. They are often most rewarding.

Enjoy the photos of Aurora Borealis and may you find your brilliant night sky.

Jane A. Svinicki, CAE
Executive Director

2017 Engineering Challenge Recap

By Jeff Mandel, MD, MS, Assistant Professor of Anesthesiology & Critical Care, Perelman School of Medicine at the University of Pennsylvania, Philidelphia, PA

The 2017 STA Engineering Challenge was held at the Annual Meeting in San Diego, CA on January 14. The challenge was to devise a pulse oximeter that can emit MIDI. The intent was to stimulate thought on how to control the cacophony of sounds in the OR caused by multiple devices. Five entries were received:

1. Rami Saab, Hospital for Sick Children, Toronto
2. Nirav Bhasar, MD, University of Miami
3. Elie Sarraf, MDCM, B.Eng, University of Vermont
4. Ryan Durk, MD, Washington University, Saint Louis
5. Krithika Anand, MD, Children's Hospital of Philadelphia

A common element of the entries was an examination of aspects of music perception. Current pulse oximeters encode saturation tone as a linear function of saturation; musical scales are based on a geometric progression. Our perception of loudness is influenced by pitch; lower frequency tones are perceived as softer than higher frequency tones. Novelty can be produced by changes in tempo and introduction of minor tones. We learned that MIDI does not encode absolute volume, but rather note velocity. The entries in some cases made use of commericial pulse oximeters, but Ryan Durk demonstrated a system that included its own pulse oximeter circuitry. Many of the systems produced a rhythmic output at the heart rate, but Elie Sarraf demonstrated a system that could reduce the frequency of output when hear rate and saturation were stable. The devices were typically based on single board computers such as the Raspberry Pi, and could easily be adapted to use in the OR. The session was well attended, and we hope that our industry representatives take note of the lessons our entrants learned in finding ways to solve this problem.

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2017 J.S. Gravenstein Award Presentation by James Philip, MD

By James Szocik, MD, STA Communication Committee Chair

Dr. James Philip, MD received the J.S. Gravenstein Award and delivered the eponymous lecture at the 2017 STA Annual Meeting in San Diego, CA. He appropriately titled his talk "Engineer for Life", beginning with escaping from a crib at an early age using a screwdriver and his later exploits helping devise engineering solutions for health care. As a child, Jim hacked an analog multiline phone for his construction engineer father. In high school, he used an IBM 1620, programming in Fortran II, 1962. He attended Cornell for his undergraduate degree, trained as electrical engineer, and did well enough to get into a co-op program with Hewlett-Packard.

At Hewlett-Packard, he accomplished the following: 1966 developed auto brightness control, 1968 measurement of defibrillator discharge energy, 1969 ICU computer keyboard using Hall effect keys, 1970 multiplexed ECG, and most importantly, since HP allowed and encouraged after-hours use of their lab, he created a disco light show (for rent). During his time at HP, he discovered a disconnect between marketing and what physicians thought they needed, and what they actually needed. To fully investigate this, he went to medical school to discover what physicians truly needed from engineers and their companies.

Jim's summary of the disconnect between marketing, physicians, and engineers:

"Marketing surveys discovered what physicians wanted.

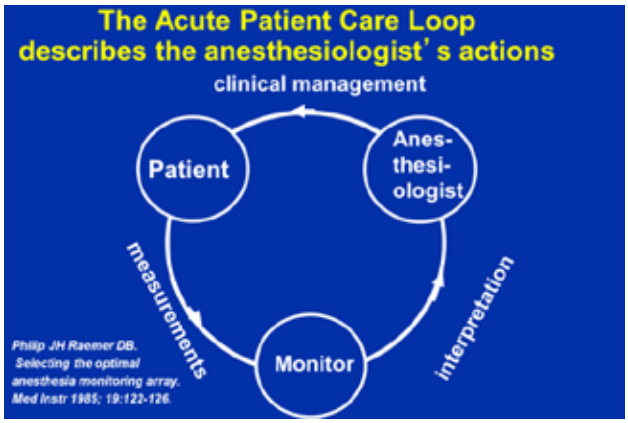
Engineers designed the products physicians wanted.

The products built often didn't sell well.

The products were not what physicians needed.

I decided to go to Medical School and discover the needs, suggest the needed products, and educate physicians to understand what they needed. That is what I have tried to do throughout my career: Identify the needs, create the products, educate clinicians to want what they really need.

Much of anesthesia can be viewed as an acute care loop:



The monitor measures the dimensions of life under anesthesia: Circulation, metabolism, respiration, anesthesia. In engineering terms, the dimensions are the eigenvectors and if we monitor them correctly we are monitoring the eigenvalues of life. Historically, the only dimension we monitored well was circulation. We later learned that its ventilation that count's a lot."

Jim saw these issues and created a new display mode: the Ohmeda polygon, wherein multiple dimensions could be visually compared at a glance.

He also related the story of development of continuous cardiac output monitoring.

"We got it funded: Baxter Edwards Lifesciences.

We published it: Philip JH, Long MC, Quinn MD, Newbower RS. Continuous thermal measurement of cardiac output. IEEE Trans Biomed Eng. l984;3l:393-400.

We Patented it: Philip JH, Newbower RS. Cardiac Output Detection by Multiple Frequency Thermodilution. Number 4,236,527 assigned to Massachusetts General Hospital, issued l980. Licensed to Baxter Edwards.

Interflow Corporation stole it: Multiple frequency thermodilution using pseudo-random noise thermal signal.

Baxter Edwards bought Interflow: Vigilance CCO monitor

MGH and Inventors received royalties from Baxter Edwards

1/4 Inventors, 1/4 Laboratory, 1/4 Department, 1/4 Hospital Ventures Office

Multi-frequency Thermal CCO Continues to be used worldwide"

Jim has also had a role in engineering pressure infusions to deal with exsanguinating bleeding; gas analysis, from mass spec to infrared; to aid in measuring the respiratory eigenvalues; and Gas man, to teach uptake and distribution to anesthesiologists. Prior to concluding, he thanked a long list of mentors and colleagues.

Gravenstein Award *continued on next page*

Gravenstein Award *continued from previous page*

To conclude, Jim's summary slide expresses it best:

"I began my education as an Engineer

I learned it well

I entered a field of medicine

Anesthesiology where life is carefully maintained

Each problem I encountered led me to an Engineering Solution

I have had the the opportunity to

Engineer for Life"

Direct links to 3 publications with Dr. Gravenstein:

- Philip JH. Discussion on "How the University Handles Inventions." In: Gravenstein JS, Newbower RS, Ream AK, Smith NT, Barden J, eds. Monitoring Surgical Patients in the Operating Room. Springfield: Charles C. Thomas, l979;244-245
- Philip JH. Oxygen Monitoring. In: Gravenstein, Moderator. Minimal Non-invasive Monitoring, NYSSA Post Graduate Assembly in Anesthesia. St. Petersburg, FL: The Hour Company #C16-83-85, 1985.
- Philip JH. Thoughtful Alarms. In: Gravenstein JS, Newbower RS, Ream AK, Smith NT, eds. The Automated Anesthesia Record and Alarms. Butterworths, 1987.

Success at the STA Annual Meeting

By Jonathan Wanderer, MD, MPhil, Vanderbilt University School of Medicine, 2017 Annual Meeting Chair

For the 2017 STA Annual Meeting, we met at the Hilton San Diego Bayfront, and enjoyed beautiful views while learning about Technology Advancing Perioperative Outcomes. For the program this year, I wanted to draw attention to our Society's increasing focus on informatics, while keeping the membership up-to-date on important developments in medical device innovation. Our keynote speaker, Dr. Mark Rice, shared his life story, which has taken him from academic anesthesiologist through several business ventures, and finally back to academic anesthesia. Panel discussions ranged from key statistical concerns in working with large datasets to practical aspects of implementing quality improvement programs. Below is a brief photographic overview of the meeting. More details and material from the meeting can be found on the STA Website: http://www.stahq.org/events/annual-meeting/

Dr. Ori Gottlieb and STA Treasurer Dr. John Sudkamp visit the Draeger display.

A representative from Codan With Dr. James Philip and STA Secretary Norma Sandrock.

2017 Annual Meeting Photos *continued on next page*

2017 Annual Meeting Photos *continued from previous page*

Annual meeting attendees anticipate the next session.

Dr. John Eisenach with incoming STA President Dr. Mark Poler.

Dr. Thomas Hemmerling with Fresnius Research recipeint Dr. Christian Peterson.

2017 STA Annual Meeting Chair Dr. Jonathan Wanderer receives recognition for his work by outgoing STA President Dr. Brian Rothmann.

Drs. James Philip, Derek Sakata and Joan Spiegel enjoy an evening reception.

The 2017 STA Annual Meeting Awards for Best Abstracts

By Jonathan M. Tan, MD, MPH and Lara Brewer, PhD, 2017 STA Annual Meeting Abstract Co-Chairs

The 2017 STA Annual Meeting, held in San Diego, California was a successful conference where 60 abstracts were presented over the course of several days. In a testament to the multi-disciplinary nature of the STA, abstracts represented collaborations from clinicians, data scientists, engineers and industry. In addition, the abstracts also represented a variety of institutions including large academic centers and community hospitals. The abstracts were presented in poster formats throughout the entire conference allowing for presenters and attendees to discuss current and future work.

For the conference this year, Lara Brewer, PhD and I had the privilege of being the Co-Chairs to review the submitted abstracts. Each abstract was assessed based on multiple factors including originality, scientific impact, quality of writing, technical innovation and clinical application. These scores were then used to determine which abstracts won awards for Best in Show, Excellence in Technology and for Best Clinical Application. In addition, an Honorable Mention was also awarded this year.

The best abstracts were highlighted during this year's conference with oral presentations from each award winner. The presentations stimulated thoughtful discussion and questions. The following were the presenters of the best abstract winners of the 2017 STA Annual Meeting:

Christine Lee accepts the award for Best in Show abstract from Dr. Thomas Hemmerling.

BEST OF SHOW

Title: Deep Learning for Predicting in Hospital Mortality
Presenting Author: *Christine Lee, MS, University of California, Irvine*

EXCELLENCE IN TECHNOLOGY

Title: Concurrent Piezo- and Photo-Plethysmography for Enhanced Signal Context
Presenting Author: *Christian Petersen, PhD, University of British Columbia*

BEST CLINICAL APPLICATION

Title: Patient Monitoring Quality Improvement Program: Impact on Respiratory Compromise
Presenting Author: *Michael Mestek, PhD, Medtronic*

HONORABLE MENTION

Title: The Contribution of the Induction Period to Overall Gas and Vapor Consumption
Presenting Author: *Ross Kennedy, MD, PhD, Christchurch Hospital*

Abstracts on pages 14-17

Deep Learning for Predicting in Hospital Mortality

Presenting Author: *Christine Lee, MS, UC Irvine Department of Biomedical Engineering*
Co-Authors: *Ira Hofer, MD, UCLA Department of Anesthesiology ; Maxime Cannesson, MD PhD, UCLA Department of Anesthesiology; Pierre Baldi, PhD, UC Irvine Department of Computer Science*

Introduction: Patients undergoing surgery are often at higher risk of instability during surgery as well as poor postoperative outcomes. Being able to identify patients at higher risk for poor outcomes would allow for more effective care and allocation of hospital resources, and ideally avoid complication altogether. Current risk scores such as the ASA, POSPOM, and RQI have shown success in identifying patients at risk of mortality, however, they are limited to preoperative information. The Surgical Apgar score utilizes intraoperative data, however, has been shown to have limited accuracy. We hypothesize that deep neural network models (DNNs) can leverage the complexity of intraoperative data to improve the classification of in hospital mortality in surgical patients.

Methods: Data used in these experiments came from UCLA Medical Center with IRB approval. The data consists of 59,985 patients with 87 features calculated at the end of surgery. These variables include intraoperative vital signs, interventions, and anesthesia events. The data included all surgical procedures performed since March 1, 2013. Cases not done with general anesthesia, and patients > 89 or < 18 years of age were excluded. Missing values were filled with the means for that feature. Values that were greater than a clinically normal maximum were set to that maximum possible. Finally, all variables were rescaled to have mean 0 and standard deviation 1. The % occurrence of in hospital mortality was 0.81%. Thus, training data was augmented 100x for a mortality occurrence of ~45% by adding Gaussian noise with a standard deviation of 0.0001 to mortality patients only. All DNNs were trained on 80% of the data (n=47,988) with five-fold cross validation. 20% of the data was held out as a future test set. All DNNs were feedforward networks with a sigmoid output, and were trained using stochastic gradient descent with momentum. Dropout, L2 weight decay and early stopping were used to prevent overfitting. We also assessed improvement of the DNN with adding ASA as a feature, and robustness of the DNN to a reduced feature set of 46. A logistic regression model with the 87 features was also trained for comparison. Performance was assessed using mean and standard deviation of AUROC from cross validation. For comparison, the AUROC of ASA, Surgical Apgar, RQI, and POSPOM were also calculated on the training data. It should be noted that RQI could not be calculated for 25,621 training patients due to lack of RQI score weights for their CPT codes.

Results: The final DNN architecture consisted of 4 hidden layers with 300 neurons in each layer. RQI outperformed Surgical Apgar, POSPOM, ASA, logistic regression, and the DNN with all 87 features (Table 1). DNN with ASA added as a feature and DNN with the reduced feature set performed comparably to RQI. However, RQI could not be calculated on approximately half of the data, while the DNNs do not have this limitation. In addition, we see that there is improved performance with the addition of the preoperative feature ASA and DNNs are robust to a reduced feature set.

Risk Score	AUC
Surgical Apgar	0.58
POSPOM	0.74
ASA	0.85
RQI Score*	0.92
Model	**5 Fold Cross Validated AUC**
Logistic Regression	0.87 ± 0.02
DNN w/ 87 Intraop Features	0.90 ± 0.01
DNN w/ 87 Intraop + ASA Features	0.92 ± 0.01
DNN w/ 46 Intraop + ASA Features	0.92 ± 0.01

Table 1. Risk score AUC results and model 5 fold cross validated AUC results (mean ± std) on training data (n=47,988). *RQI could not be calculated for 25,621 patients.

Conclusion: In conclusion, DNNs exhibit potential for being able to not only classify patients at risk for inhospital mortality, but also for improving upon and leveraging preoperative risk.

Concurrent Piezo- and Photo-Plethysmography for Enhanced Signal Context

Presenting Author: *Christian L Petersen, Departments of Anesthesiology, Pharmacology & Therapeutic, The University of British Columbia, Vancouver, Canada*
Co-Authors: *Nancy Luo and J Mark Ansermino, Departments of Anesthesiology, Pharmacology & Therapeutic, The University of British Columbia, Vancouver, Canada*
Guy A Dumont, Electrical and Computer Engineering, The University of British Columbia, Vancouver, Canada

Introduction: The plethysmogram (PG), in old times measured by mechanical displacement, is now typically captured in a finger photoplethysmogram (PPG). The PPG is sensitive to motion artifacts, and an accelerometer on the sensor can be employed to estimate signal quality [1]. In this work we consider an alternative: Having a piezoelectric transducer mounted inside the sensor finger boot generate a concurrent mechanical PG that can be used to detect motion through correlation with the PPG.

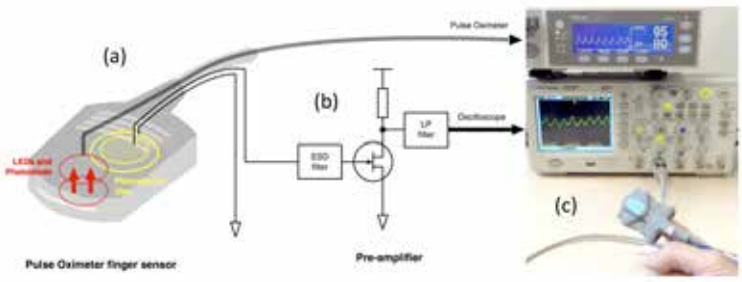


Fig. 1: Dual piezo- and photo-plethysmogram sensor (a), pre-amplifier (b), and picture of operation (c).

Method: A brass disk with a ceramic piezoelectric coating, commonly used as a "buzzer" in consumer electronics, was mounted inside a regular PPG finger boot (Fig. 1a). The voltage generated from finger pulsatile blood engorgement was sent to an oscilloscope through a high input-impedance pre-amplifier and filter (Fig. 1b). The PPG sensor was connected to a standard pulse oximeter, and the timing of the oscilloscope scan was chosen to be comparable to the PPG waveform readout on the pulse oximeter.

Results: Simultaneous measurements were performed with the pulse oximeter and the oscilloscope. The readings from the mechanical sensor were more sensitive to vibrations than the optical readings, as expected. Under static conditions the output from the two sensors correlated well (Fig. 1c). It was feasible to obtain a strong signal from both sensor elements simultaneously. However, the positioning of the mechanical sensor is important, with the strongest signal appearing from the fingertip.

Conclusion: Our findings show that a piezoelectric transducer can register mechanical blood pulsations inside a typical PPG finger boot sensor, concurrently with the optical PPG measurements. This opens for a new regiment of measurements in which the coherence of the PG readouts carry signal quality information, and possibly even new physiological information. For example, the relative timing of the two waveforms could potentially be used to detect changes in peripheral blood pressure.

References

1. Tamura T, Maeda Y, Sekine M, Yoshida M. Wearable Photoplethysmographic Sensors - Past and Present. Electronics 2014, 3, 282-302 (2014).

Patient Monitoring Quality Improvement Program: Impact on Respiratory Compromise

Presenting Author: *Christine O'Farrell, BSN, CPHQ, CPHRM, Barton Healthcare, South Lake Tahoe, CA*
Co-Authors: *Mary Kay Sennings, RRT, Barton Healthcare, South Lake Tahoe, CA; Dawn Evans MSN, RN, PHN, CPPS, Patient Safety Officer, Barton Healthcare, South Lake Tahoe, CA; Michael Mestek, PhD, Patient Monitoring & Recovery, Medtronic, Boulder, CO*

Background/Introduction: Acute respiratory compromise events are common on inpatient hospital wards[1]. Analyses of closed claims related to postoperative opioid-induced respiratory depression specifically have demonstrated that 97% were deemed preventable with improved patient monitoring and intervention[2]. Continuous patient monitoring of oxygenation and ventilation has been recommended for such patients[3]; however, there are currently limited data evaluating how this change in practice affects patient outcomes. Therefore, the purpose of this study was to assess the impact of a quality improvement program (QIP) that established continuous capnography and pulse oximetry monitoring in recovery settings for high-risk patients.

Methods: A hospital Patient Safety Committee instituted a QIP with continuous capnography and oximetry monitoring in October 2013 on the Orthopedic, Medical/Surgical, Intensive Care and Post-Anesthesia Care Units for patients with STOP-BANG scores ≥ 3. Subsequently, 38 months of data on 2,258 postoperative discharges were analyzed using UB04 billing data. Respiratory adverse events (RAE) were evaluated as: 1) all respiratory events including any secondary respiratory diagnosis of hypoxemia, asphyxia, respiratory arrest and failure, 2) PSI-11 (secondary diagnosis of respiratory failure and/or re-intubation/mechanical ventilation), 3) postoperative respiratory failure, and 4) cardiac arrest/resuscitation. Changes in length of stay for RAE, ICU transfers and mortality were also determined. Comparisons were made between all metrics at the start (2013-2014) and at the end of the QIP monitoring period (2015-2016).

Results: Following QIP initiation, the total number of RAE changed from 90 (6.84% of hospital events) to 87 (9.22% of hospital events) ($p < 0.05$). Postoperative respiratory failure and cardiac arrest/resuscitation events decreased from 6 (0.45% of hospital events) to 0 and 7 (0.52% of hospital events) to 0 ($p < 0.05$), respectively. PSI-11 related events did not significantly change (1 to 0; $p = 0.38$). Length of stay for all respiratory event with from 9.2 to 6.5 d ($p<0.05$), while ICU transfers and mortality did not significantly change ($p > 0.05$). Documented compliance with continuous monitoring went from 22% at the start of the program to 97% at the end.

Conclusions: The implementation of a hospital-based QIP that established continuous monitoring with capnography and pulse oximetry was associated with a decrease in postoperative respiratory failure, cardiac arrest/resuscitation events and length of stay from a respiratory event. This program did not result in changes in PS-11, ICU transfers or mortality. These data suggest that continuous monitoring with a both capnography and pulse oximetry may play a role in quality improvement by helping to reduce severe respiratory adverse events and length of stay for high risk patients.

References:

1. Andersen, Lars W., et al. "Acute respiratory compromise on inpatient wards in the United States: Incidence, outcomes, and factors associated with in-hospital mortality." *Resuscitation* (2016).
2. Lee, Lorri A., et al. "Postoperative Opioid-induced Respiratory Depression: A Closed Claims Analysis." *The Journal of the American Society of Anesthesiologists* 122.3 (2015): 659-665.
3. Joint Commission, and Joint Commission. "Sentinel Event Alert. Safe use of opioids in hospitals. Issue 49; August 8, 2012." (2013).

The Contribution of the Induction Period to Overall Gas and Vapour Consumption

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Background / Introduction: Reducing fresh gas flow (FGF) during volatile anesthesia reduces agent consumption, cost and environmental footprint without reducing drug delivery to the patient. RK and RF have a long interest in this area[1] and are collaborating with GE-Healthcare exploring data collected routinely by anaesthesia delivery systems.

While our work includes all phases of anesthesia some studies exclude induction or the pre-surgical phase from analysis[2,3]. This project allows us to explore the influence of this early phase on total gas flows by investigating and understanding FGF data from a large number of cases; by a simple modelling; and by observing the effect of a simple intervention directed at the early phase on overall gas consumption.

Methods: Data is logged from 4 GE-Aisys CS2 Carestations. The high flow period starts when vapour delivery begins and ends when FGF < 5l/min.

Early data suggested that both the flow rate and the duration of the "high flow" phase have a significant influence on overall mean FGF. A simple spreadsheet was constructed to explore this. Over a 2 week period we provided all anesthesiologists with repeated information on the importance of FGF in the high-flow phase. We compared the pattern of flow rates in the 3 months before this information and the 2 months following. Mean FGF is a marker of vapour consumption.

Results: We have data on 2089 vapour based anesthetics from 4 OR. Mean FGF decreased from 920ml/min to 860ml/min associated with a decrease in the mean duration of the high flow period from 3.3min to 2.3min.

For a single OR with a consistent, case mix, mean FGF decreased from 1.102 l/min to 0.871 l/min ($p<0.0001$). The median [IQR] for FGF during the high flow phase were 6 [6,6] l/min before and 6 [0,6] l/min after and the median durations of the high flow period were 2 [0, 4]min and 0 [0, 3]min ($p<0.0001$).

Simulation shows that for a 90 min case with a maintenance FGF 2l/min and a high flow period FGF 6l/min, reducing the duration of the high flow period from 10 to 2 min reduces mean FGF from 2.44l/min to 2.09l/min, or 14%. If the maintenance flow is 1 l/min, the overall reduction is 29%.

Conclusions: The primary focus of FGF reduction efforts is on maintenance. We have identified that the duration and gas flows during the early phase can have a significant effect on total consumption with the FGF used for pre-oxygenation frequently maintained after induction. We were able to produce an additional 10% reduction to our already low average flows. Modelling suggests that even in an environment where maintenance flows are moderately high, attention to the early / induction phase can produce additional, useful reductions in gas flows and vapour consumption.

References:

1. Kennedy RR, French RA. Anesth Analg. 2008;106:1487–90
2. Epstein RH, Dexter F, Maguire DP, Agarwalla NK, Gratch DM. Anesth Analg. 2016;122:996–1006.
3. Singaravelu S, Barclay P. Br J Anaesth. 2013;110:561–6.

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1. Conscious sedation for surgical procedures. MedlinePlus. https://medlineplus.gov/ency/article/007409.htm. Updated March 2015. Accessed August 2016.

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Resident's Corner: Resident Outreach in 2016/17

By Lisa Chan, MD, Texas Children's Hospital and Charlene Swift, MD, PhD, University of California, San Francisco

The past year was another successful year of resident outreach and participation in the STA. Highlights of the year were the Western Anesthesia Resident Conference (WARC), American Society of Anesthesiology (ASA) conference, and this year's annual conference for the Society of Technology in Anesthesia.

The WARC happy hour mixer was made possible by resident organization, in particular Jeffery Cashin, Jeff Lewis, Charles Aguila, and Rina Balasubramanian. They were vital in the outreach to over thirty residents at the conference and establishing themselves further within the newly-formed resident component of the STA.

Next, the organization and success of the happy hour mixer at the ASA conference must be given to Shoeb Mohiuddin. He selected a creative venue in which to attract residents, which included a very popular ping pong table at the happy hour.

Lastly, this past year's STA annual conference would not have been the same without resident component participation. They showed themselves to be active participants in the conference by the volumes of tweeting they provided throughout the week. Cornerstones to the tweeting movement at the conference must be given to Jeffery Cashin, James Xie, and newly-joined Anthony Kaveh. They provided thorough coverage of all the speakers with their insightful, witty tweets. While the resident pool party was rained out at the conference, the camaraderie could not. It continued at the make-shift happy hour at the hotel bar led by Allan Simpao, and through the rest of the conference. And may it continue to grow in 2017 as well!

FAER: Shark Tank Panel at ASA 2017

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