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Innovation and Entrepreneurship Activities:

As a practitioner of Emergency Medicine, I have lamented the lack of new technology that can be used to save lives. The near loss of my wife from post-partum hemorrhage coupled with the events surrounding 9/11 and the ensuing war on terror including Operation Enduring Freedom and Operation Iraqi Freedom led me to turn my research towards combat casualty care. This in turn led me to reevaluate my approach to science as the solutions to really impact lives in these conditions seemed to be almost science fiction. Integrative team science drawing from multiple medical, engineering, and information science disciplines coupled with industry partnerships became the new model for my approach leading me to really understand what innovation was and how it should be executed. There is nothing contradictory to integrating such strategies at all levels of problem recognition and solving, be it in the lab, the classroom, or at the bedside as it applies to the traditional tripartite mission of academic medicine. For me, the above strategies are viewed as enabling and transformational which become force multipliers for team science and that may have some of the highest translational return on investment. This includes providing great insight in how to deal and recover from failures to ensure a greater chance of success in next initiatives. This approach has led to my interest and ability to develop platform technologies in the areas of therapeutics, diagnostics, devices, and digital medicine that scale from critically ill neonates to wounded warriors and from the ICU to the home.

My path based on the above philosophies has led to the privilege of helping to develop and lead two multidisciplinary centers focused on critical care including the Virginia Commonwealth University Reanimation Engineering Science Center (VCURES) and now the Michigan Center for Integrative Research in Critical Care (M-CIRCC). Each has a focus on integration that values teaming and innovation including developing strategic industry partnerships and commercialization efforts to more rapidly move ideas to impact.

Innovation Awards:

2008: United States Army Medical Research and Materiel Command Advanced Technologies Applications in Combat Casualty Care Award for Excellence: *For Development of WoundStat Which Will Save Lives on the Battlefield*. August 11, 2008.

2010: Virginia Commonwealth University Billie R. Martin Innovation Award: University wide-award given to VCU Faculty Member for outstanding accomplishments in field of technology transfer.

Patents Issued:

1. Intrathoracic Mechanical Electrical and Temperature Adjunct to Cardiopulmonary Cerebral Resuscitation, Shock, Head Injury, Hypothermia, and Hyperthermia: Ward KR, et al. United States Patent 5,474,533. December 12, 1995
2. Noninvasive Aortic Impingement and Core and Cerebral Manipulation Method: Ward KR, et al: United States Patent 5,531,776. July 2, 1996

3. A Mechanical Adjunct to Cardiopulmonary Resuscitation (CPR) and an Electrical Adjunct to Defibrillation Countershock, Cardiac Pacing, and Cardiac Monitoring: Ward KR, et al: United States Patent 5,626,618. May 6, 1997
4. Noninvasive Aortic Impingement and Core and Cerebral Temperature Manipulation: Ward KR, et al: United States Patent 5,716,386. February 2, 1998
5. Noninvasive Aortic Impingement: Ward KR: United States Patent 6,296,654 October 2, 2001
6. Methods For Monitoring and Optimizing Central Venous Pressure and Intravascular Volume Vascular Volume. Ward KR, et al: United States Patent 7,118,534. October 10, 2006.
7. Tissue Interrogation Spectroscopy: Ward KR, et al: United States Patent 7,113,814. September 9, 2006
8. One Hand Tourniquet with Locking Mechanism: Licata M, Ward KR, Carr ME: United States Patent 7,468,067. December 12, 2008.
9. Prevention of Ventilator Associated Pneumonia: Ward KR, et al: United States Patent 8,042,544. October 25, 2011.
10. Portable Oxygen Generator. Huvard GS, Imbruce R, Ward KR: United States Patent 8,147,760 B1. April 3, 2012.
11. Method and Apparatus for Monitoring Intraocular and Intracranial Pressure: Lenhardt M, Ward KR: United States Patent 8,172,769 B2. May 8, 2012
12. Acoustic Based Tissue Resuscitation: Ward KR, Lenhardt M: United States Patent 8,197,427 B2. July 12, 2012.
13. Treatment for High Pressure Bleeding: Wnek G, Carr M, Bowlin G, Cohen K, Ward KR et al: United States Patent 8,497,408 B. July 30, 2013.
14. Accurate Pelvic Fracture Detection for X-Ray and CT Images: Najarian K, Vasilache S, Smith R, Ward KR: United States Patent 8,538,117 B2 September 17, 2013.
15. Combining Predictive Capabilities of Transcranial Doppler (TCD) with Electrocardiogram (ECG) to Predict Hemorrhagic Shock. Najarian K, Ward KR, Ji SY, Hakimzadeh R: United States Patent 8,762,308 B2 June 24, 2014
16. Image Processing and Machine Learning for Diagnostic Analysis of Microcirculation. Najarian K, Hobson RS, Ward KR, Demir SU, Mirshahi N. United States Patent 8,805,051 B2. August 12, 2014.

Patents Pending:

1. Mineral Technologies (MT) for Acute Hemostasis and for Treatment of Acute and Chronic Ulcers: Diegelmann R, Ward KR, et al: WIPO/2006/088912
2. Methods and Compositions for Controlled and Sustained Production and Delivery of Peroxides. Ward KR, et al: WIPO/2007/134304
3. Device for Control of Difficult to Compress Hemorrhage: Ward KR: WIPO/2008/150966.
4. Self-Contained Oxygen Generating and Breathing Systems: Ward KR, et al: WIPO/2009/006586
5. Method and apparatus for determining critical care parameters. Andre D, Ward KR, et al: US 20120245439 A1
6. Gas Based Wound and Tissue Therapeutics: Ward KR, et al: WIPO/2009/102487.
7. Automated Measurement of Brain Injury Indices Using Brain CT Images, Injury Data, and Machine Learning. Najarian N, Chen W, Ward KR, et al: WIPO/2010/117573.
8. Method and Apparatus for Determining Heart Rate Variability Using Wavelet Transformation. Najarian K, Ward KR, et al: WIPO/2010/077997.

9. Methods and Apparatus for Determining Critical Care Parameters. Andre D, Ward KR, et al. US 2012/0245439 A1.
10. Use of Hemoglobin Effectors to Increase the Bioavailability of Therapeutic Gases. Ward KR, et al: 2012. PCT/US11/62826
11. Assessment and Prediction of Cardiovascular Status During Cardiac Arrest and the Post-Resuscitation Period Using Signal Processing and Machine Learning: Shandily S, Najarian K, Ward KR: 4/23/2014. 14/333,736.
12. Evaluating Cardiovascular Health Using Intravascular Volume Status: Ward KR, Tiba MH, Blum J: 7/29/2013: 61/859,615
13. Airway Support Device: Ward KR, Plott J, Shih C, Shih A. US Application No. 14/565,947 December 2014.
14. Nanoporous Bioelectrochemical Sensors for Measuring Redox Potential in Biological Samples. Daniels R, Ward KR, Collinson MA. PCT/US14/61461 December 2014.

Invention Disclosures and Provisional Patents Filed:

1. Methods and Apparatus for Optimizing Temperature Control: Ward KR, Najarian K, Gunnerson K: 4/29/2013: 61/985,860.
2. Early Detection of Hemodynamic Decompensation Using S-Transform and L-1 Norm on ECG Signals. Najarian K, Belle A, Derskin H, Ward KR: 4/23/2014: 62/018,336.
3. Miniature Piezoelectric Cardiovascular Monitoring System: Oldham K, Belle A, Najarian K, Ward KR: 03/13/2014: 61/792,750.
4. A Control Mechanism for Optimization of Negative Pressure Ventilation (NPV) and Positive Pressure Ventilation (PPV) Ventilation Systems: Ward KR, Najarian K, Blum J: 06/13/2014: 62/011,912.
5. Means for Continuous Monitoring of During Hypotensive Resuscitation: Ward KR, Najarian K, Alam H: 7/08/2014: 62/021,957.
6. Automated Analysis of Vasculature in Coronary Angiograms: Najarian K, Ward KR, etl: OTT File 6516 December 2014.

Commercialized Products and Products Being Commercialized:

1. WoundStat™: In 2006: Drs. Robert Diegelmann and Kevin Ward, invented and developed a mineral based hemostatic product. This product was licensed by the company TraumaCure and was named WoundStat™. In 2007, the product was approved by the FDA for control of moderate to severe external bleeding.
2. GetO2™ O2 in a Box: In 2008 Drs. Kevin Ward, Gary Huvad, and Everett Carpenter invented a small portable chemical oxygen generator. In 2011 this product was commercialized by GetO2 Inc. O2 in Box is a nonpressurized disposable device capable of producing 30-120 minutes of 100% medical grade oxygen. The device is meant to be used in emergency situations where use of traditional pressurized oxygen tanks is problematic. These include combat, rural health and tactical medical situations. The product is approved by the FDA. From 2008-2010 I served as the companies chief medical consultant.
3. Microvascular Tissue Oximeter: I am part of a team that since 2004 invented, patented, and developed a technique to measure tissue hemoglobin oxygen saturation using resonance Raman spectroscopy. The technique was reduced to practice and licensed to Pendar Medical

Inc. in 2010 while I was at Virginia Commonwealth University. The device is currently undergoing clinical trials and is expected to be FDA approved in 2015-16.

4. Noninvasive Central Venous Pressure Monitor: I am part of team that since 2002 invented, patented, and developed a bioimpedance methods of determining central venous pressure. This method was licensed to NiVASC Inc. in 2013 and will begin clinical trials in 2015.
5. Hemospray™: In 2012: Cook Medical utilizes hemostatic compound invented by Drs. Kevin Ward and Robert Diegelmann for development and commercialization of compound and system to treat life-threatening gastrointestinal bleeding.

Innovation and Entrepreneurship Related Presentations

1. Virginia Academy of Science: Sidney S. Negus Memorial Lecture: WoundStat: From Bench to Bedside and Beyond: May 29, 2009: Virginia Academy of Sciences 87th Annual Meeting, Richmond, VA
2. The Quantified Self: BioArbor and Fast Forward Medical Innovation. March 5, 2014: Ann Arbor, MI
3. Partnering with the Private Sector in Research: Featured Panelist: May 14, 2014: Sponsored by UM Office of the VP of Research: Ann Arbor, MI
4. The Future of Personalized Physiologic Monitoring: Apple Inc. Cupertino, CA. December 16, 2013.
5. A Vision for Multi-Echelon Clinical Decision Support Systems: IBM and Excel Medical Streaming Conference. IBM Watson Research Center: White Plains, New York. November 3, 2014.