



SCHOOL OF MEDICINE

Vanderbilt Department of Anesthesiology

DEPARTMENT PROFILE



Patient Care • Research • Education

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Message from the Chair

The Vanderbilt Department of Anesthesiology is besting the challenge posed by a volatile healthcare economy. Our members are creating new technology and leveraging existing systems to our best advantage; revolutionizing education for highly engaged learners; improving patient care and safety; and publishing ground-breaking research. We have become a more efficient, effective group in an era of tightening resources, and our achievements affirm our reputation as a leader in our field.

We have one of the largest clinical programs in the country, providing coverage for more than 90,000 adult and pediatric anesthetic encounters annually at more than 100 anesthetizing locations. We cover critical care, pain management, all perioperative anesthesia needs, and we are evolving a perioperative surgical home. Vanderbilt University Medical Center is at the top of its game as well. We are the region's only Level I Trauma Center. Additionally, we have an active high-risk obstetrics program, a busy Transplant Center, and the region's largest pediatric referral hospital. The Vanderbilt Health Affiliated Network is the largest of its kind and growing rapidly. All of these developments position us to lead into the future from a position of strength.

IMPROVING PERIOPERATIVE MEDICINE

Vanderbilt is a unique environment in which we have created and continue to develop our perioperative informatics tools. We own a wealth of historical data, which, along with our informatics infrastructure and scientific investigations, are driving rapid cycle process improvement projects to increase patient safety and clinician effectiveness, not just in the operating room, but across the entire perioperative continuum. For example, past research by our investigators that validated the merit of on-floor patient monitoring is being translated into routine physiologic monitoring of all surgical patients during hospitalization. Our Vigilance™/VigiVU™ situational awareness tools have been extended to an iPad application that can quickly identify patients experiencing clinical deterioration. This allows specialists to cover much more ground electronically than would be possible on foot, and the monitoring investment has already saved lives.

We have also steadily built our regional anesthesia program, which is a significant component of new "enhanced recovery after surgery" protocols being implemented by our anesthesiologists. This year we implemented a perioperative care protocol in the colorectal surgery population. Length of stay was reduced from 5.2 days to 4.2 days, outcomes were improved, and patient satisfaction increased, all within a month of implementation. Our faculty are currently developing perioperative care protocols for multiple additional surgical service groups.

COMMUNICATING OUR RESEARCH

For several years, we have successfully focused on better publicizing our many scholarly and scientific accomplishments, taking investigations out of the confines of laboratories and clinical settings and circulating them through publications and presentations. In academic year 2013-2014, our faculty and research staff published more than 180 peer-reviewed manuscripts – many in high-impact journals – more than doubling our publication count over three years. The department's researchers also organized, led, or presented

at more than a dozen national or international meetings in 2013-2014. At the 2013 Annual Meeting of the American Society of Anesthesiologists, department members contributed more than 100 entries, including oral presentations, medically challenging cases, poster presentations, problem-based learning discussions, workshops, panel discussions, and refresher courses.

We've also aggressively pursued additional extramural grants, and, again, the effort has been rewarded. The department increased National Institutes of Health funding from \$2 million in active grants in 2011 to \$3.93 million in 2013, rising in funding rank from 19th to eighth. Our total extramural funding is now more than \$4.5 million per year, including a new T32 training grant funded on the first round.

TRANSFORMING EDUCATION

Big changes are happening nationally in training anesthesiology residents and medical students, and our department is well ahead of the curve in transforming our educational program. In April 2013, Matthew McEvoy, MD, joined the department as vice-chair for Educational Affairs and residency program director. As the Next Accreditation System (NAS) requirements from the Accreditation Council for Graduate Medical Education were implemented in July 2014, a team including Dr. McEvoy quickly developed an automated case evaluation tool to accurately assess residents' performance as they meet these educational goals. In an unrelated honor, Vanderbilt anesthesiology resident Joel Musee, MD, PhD, was selected in early 2014 to serve on the Accreditation Council for Graduate Medical Education (ACGME) Review Committee for Anesthesiology. In this role, Dr. Musee represents our department in shaping the future of anesthesiology training.

In June 2013, the American Medical Association selected Vanderbilt University School of Medicine to receive a \$1 million Accelerating Change in Medical Education grant. For five years, Vanderbilt faculty are participating in a consortium of 11 top medical schools to identify changes in medical education that can be applied throughout the country to enable students to thrive in a changing health care environment and improve the health of patients.

As you read through the following report, you will realize that the Vanderbilt Department of Anesthesiology is a group that thinks fast, anticipating needs and responding with innovative solutions that truly meet our tripartite missions of clinical expertise, discovery and education. We welcome your feedback on our body of work.



*Warren S. Sandberg, MD, PhD
Chair, Department of Anesthesiology
Vanderbilt University School of Medicine*

Department Overview

The Vanderbilt Department of Anesthesiology was one of the first independent departments of anesthesiology in the United States, established on December 12, 1945. After observing that the battlefield-wounded of World War II were more likely to survive if they received immediate, skilled anesthesia care, Vanderbilt physicians advocated that anesthesiology be established as an autonomous department. At that time, few medical schools possessed an academic anesthesiology service of any type.

This tradition of pioneering in our specialty continues today. Our exemplary faculty provide top-quality clinical services for a full spectrum of medical specialties. Vanderbilt Anesthesiology is recognized as an innovator in perioperative management, healthcare information technology, and scientific discovery. We also have high-caliber basic science and clinical research teams pursuing fundamental and translational knowledge to directly improve patient safety and care.

Vanderbilt Anesthesiology is also:

- Ranked eighth in the nation among anesthesiology departments for National Institutes of Health funding.
- A national leader in developing and applying new technologies – often developed in-house by our own physicians and research personnel – to improve the effectiveness and safety of perioperative patient care. These include electronic medical record keeping, automated real-time decision support, and smart phone-based OR transparency software.
- Well-represented on the editorial boards of major anesthesia journals.
- Highly represented as educators at the Annual Meeting of the American Society of Anesthesiologists and at national anesthesiology, critical care, and pain medicine subspecialty conferences.
- Home to a number of NIH-funded principal investigators and six Board Examiners for the oral exams of the American Board of Anesthesiology.

In addition to our department's achievements, recent accolades for Vanderbilt's medical program are many:

- In 2014, Vanderbilt University Medical Center (VUMC) was recognized for the 14th consecutive year as one of the top 100 hospitals in the country in a study by *Truven Health Analytics* (formerly *Thomson Reuters Healthcare*).
- Becker's Hospital Review named VUMC in its "100 Best Hospitals in America" list released in March 2014.
- Monroe Carell Jr. Children's Hospital at Vanderbilt is among the nation's leaders in pediatric health care in *U.S. News & World Report* magazine's 2014 Best Children's Hospitals rankings. The hospital achieved top rankings in 9 out of 10 pediatric specialty programs.
- VUMC is ranked ninth in the nation among medical schools for National Institutes of Health funding, receiving more than \$292 million for research initiatives for calendar year 2013.
- For the 10th consecutive year, Vanderbilt University Medical Center was named one of the nation's 100 "Most Wired" hospitals and health systems (Most Wired Survey and Benchmarking Study, *Hospitals & Health Networks*, 2014).
- In *U.S. News & World Report*'s 2014-15 edition of "America's Best Hospitals," VUMC had 12 out of a possible 16 specialty programs either nationally ranked or designated as nationally high performing. VUMC was again also named the top hospital in Tennessee and the top health care provider in the Metro Nashville region.

Department Chairmen



Dr. Warren S. Sandberg
(2010-present)



Dr. Michael S. Higgins
(2004-2010)



Dr. Jeffrey R. Balsler
(2001-2004)



Dr. Charles Beattie
(1994-2001)



Dr. Bradley Edgerton Smith
(1969-1993)



Dr. Charles Bernard Pittinger
(1962-1969)



Dr. Benjamin Howard
Robbins (1946-1961)

Department Leadership

Vice-Chairs and Administrative Leadership



Suanne Daves, MD
Vice-Chair for Pediatric
Anesthesiology
Anesthesiologist in Chief, Monroe
Carell Jr. Children's Hospital at
Vanderbilt



Stephen Doherty
Department Administrator



William Furman, MD
Vice-Chair for Clinical Affairs



Matthew McEvoy, MD
Vice-Chair for Educational Affairs



Edward Sherwood, MD, PhD
Vice-Chair for Research



Matt Weinger, MD
Vice-Chair for Faculty Affairs



James Berry, MD
Division of Multispecialty Adult
Anesthesiology



David Chestnut, MD
Division of Obstetric
Anesthesiology



Suanne Daves, MD
Division of Pediatric Cardiac
Anesthesiology



Eric Delpire, PhD
Basic Science Research



Katherine Dobie, MD
Division of Ambulatory
Anesthesiology



Marc Huntoon, MD
Division of Pain Medicine



Lorri Lee, MD
Division of Neuroanesthesiology



Pratik Pandharipande, MD, MSCI
Division of Anesthesiology
Critical Care Medicine



Andrew Shaw, MB BS
Division of Cardiothoracic
Anesthesiology



Ann Walia, MD
Division of Veterans Affairs
Anesthesiology

Division Chiefs

CRNA Leadership



Buffy Lupear
Interim Chief CRNA

Administrative Staff



The Vanderbilt Department of Anesthesiology's administrative and research staff members provide critical support for every division of the department. From personnel who manage clinical scheduling and payroll, to staff members who provide research support and perform general administrative duties, each division of the department has assigned administrative staff members. There are approximately 36 administrative staff members and 24 research staff members. These individuals are vital to successfully achieving the department's three-fold mission of practicing excellent perioperative medicine; providing exemplary education for our medical students, residents and fellows; and conducting cutting-edge basic, translational and clinical research.

Endowments Support Special Lectureships & Awards

The Vanderbilt Department of Anesthesiology hosts several special lectureships throughout the year, as well as presenting distinct recognitions to department members who have provided exemplary service to both their patients and colleagues. Many of these are a direct result of philanthropic support from our alumni, as well as from current department members and other program supporters. Fortunately, such “seed” funding is within the reach of many private donors, whose gifts materially improve the academic life of the Vanderbilt Department of Anesthesiology.

“We are very appreciative of our many donors who support our department,” said Chairman Warren Sandberg, MD, PhD. “Through these gifts we are able to establish and strengthen programs; support innovative research endeavors; and advance the education and continued betterment of our faculty, staff, and students.”



Members of Dr. James Phythyon's family attend the annual lecture named in his honor. Shown here, left to right, Department Chairman Warren Sandberg, MD, PhD, Phythyon daughters Elizabeth Donner and Sarah Miller; and guest lecturer Lena Sun, MD.

Dr. James Phythyon Endowed Lectureship in Pediatric Anesthesiology

For the past nine years, the Dr. James Phythyon Endowed Lectureship in Pediatric Anesthesiology has brought renowned experts in the field to Vanderbilt's campus as visiting professors. At a special Grand Rounds lecture, these experts share their research findings and expertise with the department. During their visit, the speakers also meet with residents and fellows for small group teaching sessions and informal discussions. The lectureship was established by the family of Dr. James Phythyon, a founding member of the Pediatric Anesthesiology Division. Dr. Phythyon's widow, Mrs. Marlin Sanders, and the couple's daughters, Mary Neal Meador, Elizabeth Donner, and Sarah Miller, are strong supporters of the department. Each year, they attend the lecture and other events in honor of Dr. Phythyon.

In 2014, Lena S. Sun, MD, vice-chair of the Department of Anesthesiology and chair of the Division of Pediatric Anesthesiology at Columbia University Medical Center, New

York, New York, presented a well-received Grand Rounds lecture on “Anesthesia Neurotoxicity: A Clinical Update.”

Past Phythyon Lectureship speakers include: Randall Wetzel, MD, chair of the Department of Anesthesiology Critical Care Medicine at Children's Hospital in Los Angeles; Peter Marhofer, MD, director of Paediatric Anaesthesia and professor, Anaesthesia and Intensive Care Medicine, at the Medical University of Vienna, Vienna, Austria; Dean Andropoulos, MD, MHCM, chief of Anesthesiology at Texas Children's Hospital; Shobha Malvia, MD, of The University of Michigan Health System; Philip Morgan, MD, of the University of Washington and Seattle Children's Hospital; Francis X. McGowan Jr., MD, of the Children's Hospital Boston; Peter Davis, MD, of the Children's Hospital of Pittsburgh; and Myron Yaster, MD, of Johns Hopkins University School of Medicine.



Left to right: Vice-Chair for Pediatric Anesthesiology Suanne Daves, Sandidge Pediatric Pain Management Award winner Drew Franklin, MD, and Paula C. Sandidge, MD.

Sandidge Pediatric Pain Management Endowed Fund

Retired Vanderbilt anesthesiologist Paula C. Sandidge, MD, created The Sandidge Pediatric Pain Management Endowed Fund at Monroe Carell Jr. Children's Hospital at Vanderbilt in 2010 to recognize and encourage progress in pain management for children. An anesthesiologist for 30 years, Dr. Sandidge recognized how lacking her early training had been in controlling pain for the youngest of patients when her grandson was born with a painful form of osteogenesis imperfecta. He lived just one day, but Sandidge realized then that pain control provided infants something irreplaceable: the opportunity to be held comfortably by the people who love them for the few precious moments they have.

In 2013, Medical Director of Pediatric Pain Service Drew Franklin, MD, received the Sandidge Pediatric Pain Management Award in recognition of his work with patients at the Pediatric Pain Management Clinic at Children’s Hospital. Dr. Franklin presented a Grand Rounds lecture entitled “A multidisciplinary approach to the management of refractory pediatric complex regional pain syndrome.”

Past recipients of the Sandidge Pediatric Pain Management Award include Stephen Hays, MD, FAAP, associate professor of Anesthesiology and Pediatrics and former Pediatric Pain Service director; and Twila Luckett, BSN, RN-BC.



Winner of the 2014 Vuksanaj Award is Matthew Hamilton, MD. Shown with him, left to right, is Elisabeth Hughes, MD, past Vuksanaj Award winner, and Jill Kilkelly, MD.

Dila Vuksanaj Memorial Fund for Resident Education

Pediatric anesthesiologist Dila Vuksanaj, MD, practiced at Children’s Hospital for 13 years, dedicating herself to her patients and to the hundreds of trainees who looked to her as a role model, mentor, and friend. Following her death in 2009, her family, including her husband Jacques Heibig, MD, founded the Dila Vuksanaj Memorial Fund for Resident Education. The fund is used to present an annual award to the anesthesiology resident who demonstrates the best overall performance in pediatric anesthesiology. In 2014, Matthew Hamilton, MD, was recognized for his outstanding work at Children’s Hospital. Past award recipients include: Jenna Helmer-Sobey, MD; Korie Vakay, MD; Justin Sandall, DO; and Elizabeth Lee, MD.

Dr. Bradley E. Smith Endowed Lectureship on Medical Professionalism

Throughout his more than four decades of practice and leadership, former Anesthesiology Department Chairman Bradley E. Smith, MD, defined what it means to be a true professional, and in 2009 a lectureship on medical professionalism was established in his name by then Department Chairman Michael Higgins, MD. The goal of the lectureship is to reflect on the characteristics, responsibilities, and rewards of professionalism as applied to the practice of anesthesiology.



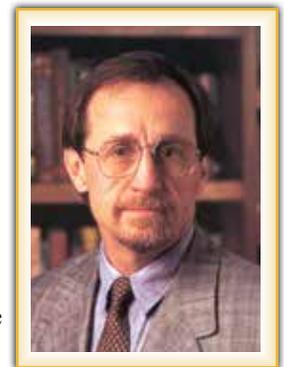
Department Chair Warren Sandberg, MD, PhD; Gretchen Smith; Bradley E. Smith, MD; Charles W. Whitten, MD; and his wife Cheri Whitten.

As chairman of the department for nearly 25 years, Dr. Smith was a national leader in the development of anesthesia subspecialties. He was a cofounder of the Society for Obstetric Anesthesia and Perinatology (SOAP), as well as the Society for Technology in Anesthesia (STA). He also represented the state of Tennessee on the Board of Directors of the American Society of Anesthesiologists (ASA) for many years.

Charles W. Whitten, MD, professor and chair of the Department of Anesthesiology and Pain Management at University of Texas Southwestern Medical Center, Dallas, Texas, was the guest speaker for the Smith Lectureship in 2014. Past speakers for this special lectureship include: David H. Chestnut, MD (now chief of the Division of Obstetric Anesthesiology at Vanderbilt); William D. Owens, MD, recipient of the ASA Distinguished Service Award; Peter McDermott, MD, PhD, past president of the ASA; and Joseph Gerald “Jerry” Reves, MD, dean of the College of Medicine at the Medical University of South Carolina (MUSC).

Dr. Charles Beattie Endowed Lectureship

Established in 2011 by the current chairman, this lectureship honors Charles Beattie, MD, the fourth chair of the department. “Dr. Beattie was many things to the many people who knew him,” said Dr. Sandberg. “He was at once a great humanist, a colorful character, and an early and forceful driver in the creation of what we now call ‘systems-based practice,’ the core competency which we exercise to create robust systems to assure that all patients receive consistent, safe, outstanding care in an environment that naturally performs well.”



Charles Beattie, MD

Dr. Beattie came to anesthesiology after first becoming a nuclear power engineer. This background surely informed and motivated his passions in anesthesiology. The lectureship is intended to bring innovators in anesthesiology from unique backgrounds and compelling world views to Vanderbilt as visiting professors.

Office of Educational Affairs

The Office of Educational Affairs for the Vanderbilt Department of Anesthesiology supports and oversees the full continuum of education related to anesthesiology and perioperative medicine, which includes undergraduate medical education, graduate medical education for residents and fellows, and continuing education for faculty and advanced practice nurses. The extensive education and training programs offered by the Department of Anesthesiology integrate scientific and clinical advances with current clinical practice to prepare medical students, residents, fellows, nurses, and faculty for productive careers as clinicians, academicians, and scientists.

A major factor in attracting residents, fellows, and faculty is the strength of the department's subspecialties, as residents and fellows benefit from in-depth training in all subspecialty disciplines of clinical anesthesiology, critical care, and pain management. An additional draw is the Vanderbilt International Anesthesia (VIA) rotation, which provides a month-long global health experience to residents and fellows who want to participate. Trainees are also attracted by the department's extensive research opportunities, in particular the BH Robbins Scholar Program, which offers one-on-one mentorship and collaboration for young physician-scientists preparing for careers as academic anesthesiologists.

"Vanderbilt offers a comprehensive clinical experience that spans the breadth of clinical anesthesia and perioperative medicine, and it does

this in the context of one institution," said Matt McEvoy, MD, vice-chair for Educational Affairs and program director. "We offer the full scope of training experiences, as well as opportunities for academic development in the fields of research, education, medical informatics, and leadership. Furthermore, we are leveraging our departmental and institutional resources to be a national leader in the new ACGME Milestones system and in the concept of the surgical home."

The Office of Educational Affairs, including oversight of the Residency Program, is led by Dr. McEvoy and is supported by Associate Program Director Michael Pilla, MD; Director of Medical Student Education Amy Robertson, MD; Director of Educational Research and Curriculum Development Leslie Fowler, MEd; and four administrative staff members. The department's specific educational offerings for each learner group are outlined below.

Medical Students

The department's faculty members contribute to Vanderbilt medical students' education throughout the four-year curriculum. Dr. Amy Robertson serves as the director of Medical Student Education for the department and oversees a wide range of clinical education programs for medical students. Having recently completed the Harvard Macy Program for Educators in Health Professions, her current research project focuses on learner-centered assessment and the use of



Office of Educational Affairs members: Front row, left to right, Manager Joyce Speer; Director of Education Development and Research Assistant in Anesthesiology Leslie Fowler, MEd; Program Coordinator Marsha Moore; and Director of Medical Student Education Amy Robertson, MD. Back row, left to right, Vice-Chair for Educational Affairs and Program Director Matthew McEvoy, MD; Associate Program Director Michael Pilla, MD; and Program Coordinator Debbie Nelson-Rouse.

mobile technology to facilitate near real-time feedback. Associate Program Director Michael Pilla, MD, serves in a leadership role as a Vanderbilt University School of Medicine (VUSM) college mentor. Dr. Robertson was recently selected as one of 10 portfolio advisors for the VUSM. Additionally, Dr. Jesse Ehrenfeld is a co-director of the Continuity Clinical Experience (CCX) for all medical students in Curriculum 2.0, a longitudinal clinical experience spanning all four years of medical school. Formal clinical courses provide numerous opportunities for clinical education in anesthesiology and perioperative medicine, including Basic Clinical Anesthesiology Elective, Anesthesiology Subspecialty Selective, Clinical Critical Thinking and Logic, Neurosciences in Clinical Care, Critical Care Skills Course, and Senior Anesthesia Elective. Many medical students also participate in research mentored by Anesthesiology faculty. Additionally, informal, as well as formal, mentorship of medical students by faculty and residents has advanced the understanding and appreciation of the specialty.

Residents

The department's fully accredited residency program is highly sought after by the nation's top medical students. Proof of this is in the numbers: in the 2014 National Residency Match, the department received more than 800 applications for 15 positions. The National Resident Matching Program report continues to rank Vanderbilt's program in the top quartile of all U.S. anesthesia residency programs for key quality indicators: number of positions offered, recruiting efficiency, Alpha Omega Alpha (AOA) Honor Medical Society membership (27%), mean USMLE Step 1 score (237), and mean USMLE Step 2 score (248). It is the department's goal to produce perioperative physicians who are prepared with all of the requisite cognitive, technical, and academic skills to be leaders in the future of the specialty and in medicine as a whole.

Vanderbilt Anesthesiology's four year residency program currently enrolls 15 resident physicians per year. Our physician educators are nationally and internationally recognized as leaders in their fields, and the department successfully supports residents interested in academic anesthesiology so they can develop careers focused on advancing knowledge in the specialty. The department typically has 25-30 residents who present original research and overviews of challenging cases at national meetings every year, a clear indication that the department's educational programs are creating physician-scholars who are prepared for both medical practice and scientific investigation.

The department's educational program for residents, as well as fellows, consists of a combination of comprehensive didactic conferences, mentored clinical training by subspecialists in every domain of anesthesiology, simulation training, and self-study. Simulation training features prominently in the cognitive, procedural, and teamwork aspects of anesthesia education, and Vanderbilt University School of Medicine's Center for Experiential Learning and Assessment is a nationally renowned, on-campus resource for this training. The Accreditation Council for Graduate Medical Education (ACGME) core competencies form a framework for the training program, and a major curricular revision is underway that is



Maintenance of Certification in Anesthesiology (MOCA®) simulation courses are taught at Vanderbilt's Center for Experiential Learning and Assessment where state-of-the-art immersive patient simulation training is offered.

targeting the new ACGME Milestones system, as well as the recent changes to the ABA Certification process.

On average, Vanderbilt Anesthesiology residents score higher than the 75th percentile on standardized examinations when compared with the national cohort. The goal of ongoing curriculum development and revision in the Milestones era will be to continue to achieve or exceed this level of academic achievement. Director of Educational Research and Curriculum Development Leslie Fowler, MEd, is overseeing the department's curriculum improvements. Among other projects, Leslie is working with the School of Medicine's VStar team to develop a "flipped classroom" model of learning for anesthesiology education. VStar is the school's new IT platform for learning management launched in 2014. A flipped classroom is a learning environment in which course content is accessed by learners outside of the classroom, and classroom time is used for interactive projects and discussion. Once the flipped classroom is complete, anesthesiology residents at every level of training will have access to rotation-specific curriculum and learning modules 24 hours a day. Future plans include rolling out the same concept in Kenya for nurse anesthetist training there.

Fellows

Building from the department's strength in subspecialties, seven clinical fellowships, as well as a research fellowship, are offered to individuals seeking advanced, focused training. The following clinical fellowships are offered at Vanderbilt:

- Adult Cardiothoracic Anesthesiology* – 3 fellows
 - Anesthesiology-Critical Care Medicine* – 8 fellows
 - Global Anesthesiology** – 1-2 fellows (first fellowship to be awarded in 2015)
 - Obstetric Anesthesiology* – 1 fellow
 - Pain Medicine* – 3 fellows
 - Pediatric Anesthesiology* – 4 fellows
 - Regional Anesthesiology** – 2 fellows
- *ACGME Accredited **ACGME Accreditation not offered

Advanced Practice Nurses

The Department of Anesthesiology has a unique partnership with the Vanderbilt University School of Nursing to offer an Acute Care Nurse Practitioner (ACNP) Intensivist track as part of the ACNP master's degree program. The program combines the didactic training of the School of Nursing's ACNP Program with supplemental specialty lectures in critical care medicine. Students perform their clinical rotations in seven of the Vanderbilt and VA ICUs. Students also receive additional exposure to ICU medicine through twice monthly simulation sessions and weekly clinical case conferences taught jointly by members of both faculties. Additional partnership programs between the Anesthesiology Department and the School of Nursing are being planned. Vanderbilt University Medical Center is one of the largest employers of nurse practitioners in the country, and the Division of Anesthesiology Critical Care Medicine has 35 Acute Care Nurse Practitioners who work in intensive care settings.

Nurse Anesthetists

The continuing education of more than 100 Certified Registered Nurse Anesthetists in the department is supported with recurring

programs, including Grand Rounds and Mortality, Morbidity & Improvement (MM&I) Conferences. In addition, Vanderbilt is a primary clinical affiliate of the Middle Tennessee School of Anesthesia (MTSA) in Madison, Tennessee, and of the Union University Nurse Anesthesia program in Jackson, Tennessee. Student nurse anesthetists participate in approximately 7,000 anesthetics per year while on Vanderbilt rotations, and their on-campus training is coordinated by the Department of Anesthesiology.

Continuing Medical Education

The Office of Educational Affairs oversees a full calendar of continuing medical education opportunities for faculty, residents, fellows, nurse anesthetists, and nurse practitioners. Examples are weekly Grand Rounds, which feature leading experts from throughout the world; Mortality, Morbidity & Improvement (MM&I) Conferences, which focus on recent cases with the goal of improving patient care; Faculty Development Seminars, which provide targeted training for professional development; and Combined Integrative Health and Pain Medicine Quarterly Rounds, which focus on issues related to the management and treatment of pain.



Vice-Chair for Educational Affairs and Residency Program Director Matthew McEvoy, MD, consults with anesthesiology residents and fellows before they begin their clinical workday.

Awarding and Recognizing Excellence

The department recognizes excellence in both its trainees and its faculty members. Outstanding performance by residents is acknowledged through annual Clinical Excellence Awards, and exceptional performance in teaching is recognized through the annual presentation of Golden Apple Awards and the Volker I. Striepe Award for Outstanding Teaching. In addition to these local awards, faculty members garner national and international recognition of their excellence in educational programs and research.

For example, Dr. Ehrenfeld is part of a VUSM team that was awarded a \$1 million grant from the American Medical Association (AMA) as a part of the Accelerating Change in Medical Education initiative. Dr. Ehrenfeld and the grant's co-investigators are serving on a national consortium of medical schools established by the AMA grant, giving Vanderbilt an exciting opportunity to exchange information with colleagues throughout the country as new innovations are implemented in medical education. Vanderbilt Pediatric Anesthesiologist Mark Newton, MD, was celebrated in 2012 by the American Medical Association with the Dr. Nathan Davis International Award in Medicine. The award recognized his many years of service at Kijabe Hospital as a leader of education for nurse anesthetists in Kenya. Excellence in anesthesia education at Kijabe has also been recognized by a \$3 million ImPACT Africa (Improving Perioperative & Anesthesia Care and Training in Africa) grant from the GE Foundation awarded to Dr. Newton and Dr. McEvoy as co-principal investigators. This grant focuses on increasing the capacity for training anesthesia providers in East Africa and linking this increased capacity of trained providers to improved patient outcomes.



Jesse Ehrenfeld, MD, MPH



Scott Watkins, MD

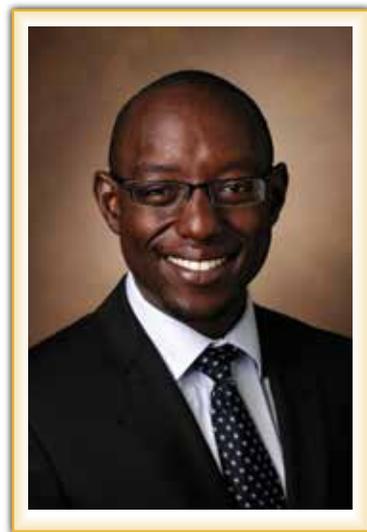
January 2014 marked the beginning of the Anesthesia Patient Safety Foundation/American Society of Anesthesiology President's Research Award grant received by Scott Watkins, MD, for "The Effect of Technical and Non-technical Decision Support Tools on Team Performance in

Simulated Perioperative Pediatric Crises." His research assesses the impact of different versions of an electronic decision support tool on team performance, as compared to memory alone. July 2014 marked the start of a Foundation for Anesthesia Education and Research (FAER) Research in Education Grant awarded to Julian Bick, MD, entitled "The Impact of Near Real-Time Continuous Feedback during Basic Transesophageal Echocardiography Training." The first aim of Dr. Bick's project is to validate a defensible method for defining basic perioperative transesophageal echocardiography (TEE) clinical competence. The second aim is to evaluate the impact of an automated near real-time performance feedback model on the rate of competency achievement. During the two-year project, CA-3 residents will receive the requisite experience to achieve basic TEE certification by the National Board of Echocardiography. Both of these grants will impact future curricular development and implementation, as well as improve patient safety and clinical outcomes.



Julian Bick, MD

In early 2014, Anesthesiology Resident Joel Musee, MD, PhD, was selected from a national pool of applicants to serve on the Accreditation Council for Graduate Medical Education (ACGME) Review Committee for Anesthesiology. The ACGME is a private, non-profit organization that accredits more than 9,000 medical residency and fellowship programs in 133 specialties and subspecialties. The Review Committee for Anesthesiology sets the accreditation standards and provides peer evaluation of anesthesiology programs or institutions to determine their compliance with educational standards. It also confers an accreditation status for programs and institutions meeting those standards.



Joel Musee, MD, PhD

These are just a few examples of the far reach and innovative nature of the educational programs of the Vanderbilt Department of Anesthesiology.

Educational Courses and Conferences

The Vanderbilt Department of Anesthesiology provides a full calendar of educational opportunities for anesthesiologists and other medical professionals. Our medical education offerings include:

For Medical Students

Critical Care Skills Week: Weeklong, quarterly workshop for third-year medical students to prepare them to recognize and manage critical problems encountered in clinical practice. This training includes hands-on education using simulation at Vanderbilt's Center for Experiential Learning and Assessment (CELA), as well as lectures by departmental faculty.

Anesthesiology Subspecialty Selective: This two-week rotation offered during the surgery clerkship provides a hands-on, continually monitored and mentored experience. Students become an integral part of an anesthesia care team and participate in perioperative management of adult patients presenting for surgical, diagnostic, or therapeutic interventions. Content emphasizes the following principles: preoperative assessment, development and execution of an anesthetic plan (including induction of anesthesia, airway management, maintenance of anesthesia, and emergence), and management of acute pain.

Basic Clinical Anesthesiology: This two-week elective rotation provides a hands-on, continually monitored and mentored experience. Students become an integral part of an anesthesia care team model (attending anesthesiologist and resident). Working side-by-side with this care team, students actively participate in the perioperative management of adult patients presenting for surgical procedures and diagnostic or therapeutic interventions requiring anesthetic care and management.

Clinical Critical Thinking and Logic: This two-week elective rotation allows students the opportunity to work with

anesthesiologists or intensivists or both in the operating rooms and intensive care units. Didactics about the principles of critical thinking in medical practice and other similar high-intensity environments are provided in the form of lectures, discussion groups, and simulations. This clinical rotation emphasizes the importance of applying critical thinking and reasoning to individual patient care, as well as generating relevant hypotheses on which future literature search and study design should rely.

Neurosciences in Clinical Care: The goal of this two-week elective is to have students apply their anatomy, physiology, and pharmacology knowledge to the presentation and management of common neurological disorders. Students participate as active team members in several settings, including the Neuroscience Intensive Care Unit and the operating rooms with neuroanesthesia and surgical teams.

Senior Anesthesia Elective: This four-week elective for fourth-year medical students provides a multidisciplinary experience in anesthesiology. With an emphasis on the continuum of perioperative medicine, students participate in the anesthetic care of patients undergoing complex surgical procedures, as well as patients requiring specialized anesthetic care, including pediatric anesthesia, obstetrical anesthesia, and comprehensive pain service.

For Interns

Boot Camp: Workshops held during orientation, as well as periodically throughout the year, focusing on developing specialized skill sets essential to anesthesia and perioperative care.

Intern Conferences: Introduction to Anesthesia Seminars; Matrix Seminars (QI training program); and practice-improvement discussions, organized using the Healthcare Matrix and Basics of Anesthesia lectures.

For Residents

ABA BASIC Exam Prep Series: Weekly conferences for CA-1 residents. The content of this didactic series maps directly to the ABA Content Outline for the new ABA BASIC Exam that began in August 2014.

Subspecialty Conferences: Conferences coordinated by individual divisions of the department, including Pediatric, Obstetric, Cardiothoracic, Neuroanesthesiology, Regional, Pain Medicine, Critical Care Medicine, and Multispecialty Adult Anesthesiology.

Senior Seminars: Seminar series for senior residents focused on problem-based learning and preparation for Oral Exams.

Professional Development Conferences: Resident conferences focused on elements of subspecialty selection, career paths, and business practices related to perioperative anesthesia.

For All

Journal Clubs: Informal meetings in which medical articles pertaining to the specialty are summarized and reviewed. Journal Clubs are held by department divisions, including Multispecialty Adult, Pediatric, Cardiothoracic, Critical Care, and Pain Medicine.

Academic Development Conferences: For fellows, residents, and faculty on topics related to educational theory and practical aspects of classroom and clinical teaching, mentorship, etc.



Transesophageal Echocardiogram training offered by the Department of Anesthesiology includes real-time cardiac simulation.

Grand Rounds: Formal, weekly lectures featuring recognized experts in the fields of anesthesiology, perioperative medicine, or pain medicine.

Mortality, Morbidity & Improvement Conferences: Monthly conferences focused on case studies, with the goal of improving patient care. Each quarter, Perioperative MM&I Conferences also include surgical specialties and nursing services to better facilitate the exploration of cases and the exchange of ideas.

Special Courses

Fundamentals of Critical Care Support (FCCS): Multidisciplinary, two-day comprehensive course addressing fundamental management principles for the first 24 hours of critical care. This course is sponsored by the Society of Critical Care Medicine and is directed by members of the Anesthesiology Department's Division of Anesthesiology Critical Care Medicine. Instructors for the FCCS course represent multiple specialties at Vanderbilt University School of Medicine.

Maintenance of Certification in Anesthesiology (MOCA®)

Simulation Courses: The Department of Anesthesiology, in partnership with the Center for Experiential Learning and Assessment (CELA) at Vanderbilt, offers realistic, immersive patient simulation education for American Board of Anesthesiologists (ABA) Diplomates seeking to fulfill their Practice Performance Assessment and Improvement (PPAI) requirement for the ABA's Maintenance of Certification in Anesthesiology (MOCA®) Program. This course fulfills the simulation education requirement of Part 4 of MOCA®. The Vanderbilt University Medical Center's simulation program has been endorsed by the American Society of Anesthesiologists' (ASA) Committee on Simulation Education.

Combined Integrative Health and Pain Medicine Quarterly

Rounds: Quarterly day-long course for anesthesiology faculty, as well as integrative health services providers, including rehabilitation physicians, physical therapists, psychiatrists, and others involved in treatment and management of pain.

Simulation Education Provides Invaluable Lessons

Simulation education is a virtual approach to training physicians and other medical providers in the management of complex clinical cases and challenging situations, especially those they might not encounter on a regular basis in the clinical setting. The Vanderbilt University School of Medicine has a remarkable on-campus resource for medical simulation training, the Center for Experiential Learning and Assessment (CELA), and our Anesthesiology Department faculty are national leaders in providing simulation training in anesthesiology airway management, critical care, perioperative management, and transesophageal echocardiogram procedures. Arna Banerjee, MD, an assistant professor of Anesthesiology in the Division of Anesthesiology Critical Care Medicine was named director of CELA in July 2013.

CELA is an 11,000-square-foot facility that is home to both the Program in Human Simulation and the Simulation Technologies Program. The center offers advanced simulation technologies, including computerized mannequins that can reproduce both routine and critical clinical situations. One floor of the facility includes flexible space that can serve as a six-bed emergency department, a four-bed intensive care unit, or a couple of operating rooms — all monitored by computer-controlled audio/video equipment.

In May 2009, the Vanderbilt Simulation Technologies Program, under the direction of Matthew B. Weinger, MD, was endorsed by the American Society of Anesthesiologists (ASA) as one of approximately 40 centers in the nation officially approved to deliver certified educational programs. Anesthesiologists can receive continuing medical education (CME) simulation training at CELA that qualifies for American Board of Anesthesiology Maintenance of Certification in Anesthesiology (MOCA®) credit. To achieve the ASA endorsement, the CELA program met strict criteria, including having strong leadership and the necessary equipment, facilities, and personnel to provide consistent, effective training.

Simulation has been an integral part of the training for Vanderbilt Anesthesiology residents for more than a decade, with the program initially developed and grown by Arna Banerjee, MD. Stuart McGrane, MBChB, recently assumed the role of Anesthesiology Resident Simulation Program director, and he is continuing and expanding the strong curriculum already in place. Currently, each anesthesiology resident participates in a minimum of six simulations per year of residency. Dr. McGrane is leading the way in mapping the simulation experiences to the Accreditation Council for Graduate Medical Education (ACGME) milestones so that in the future these events can be used as a component of the objective assessment of a resident's progression in training and his or her ability to meet the ACGME milestones required for graduation from residency.



At Vanderbilt's Center for Experiential Learning and Assessment (CELA), computerized mannequins, including obstetric and infant mannequins, are used to reproduce routine and critical care clinical situations.

BH Robbins Scholars Excel with Publications, Lectures



Benjamin Howard Robbins, MD, the Department of Anesthesiology's first Chair and a noted physician-scientist.

Building critical research skills under the mentorship of an established scientist helps prepare young investigators to eventually establish a vigorous, independently funded research program. With this goal in mind, the Benjamin Howard Robbins Scholar Program began in 2007 to support the professional development of young clinician-scientists within the Department of Anesthesiology. The program is named in honor of the Vanderbilt Anesthesiology Department's first chairman, himself a renowned physician-scientist. The BH Robbins Scholar Program is multidisciplinary, encouraging and supporting mentorships and collaborations that extend far beyond the traditional boundaries of anesthesia.

"This program provides a unique mentored research experience for young scholars that culminates in a two-year multidisciplinary fellowship, with at least one year devoted to research," said Department Chair Warren Sandberg, MD, PhD. "Our Robbins scholars benefit from one-on-one mentorship, a wealth of research and educational resources, protected research time, and a stipend during their residency and fellowship."

The BH Robbins Scholar Program is co-directed by Jerod Denton, PhD, and Frederic T. (Josh) Billings, IV, MD, MSCI. Scholars are selected through a competitive application process and enter the program during the CA-2 year. They complete six months of mentored research prior to the end of the CA-3 year, followed by a minimum of 10 months of research during the academic fellowship. The academic fellowship could comprise either a one-year research fellowship with 80 percent protected research time or a one-year clinical subspecialty fellowship plus a one-year research fellowship. Following fellowship, BH Robbins scholars are expected to join the faculty in the Department of Anesthesiology for a minimum period of two years and will be allocated protected research time based on their academic productivity, planned research/training, and faculty track (physician-scientist or clinician-educator). To date, BH Robbins scholars have collectively been awarded one R03 grant from the National Institutes of Health (NIH), four Mentored Research Training grants from the Foundation for Anesthesia Education and Research (FAER), and \$300,000 from the Vanderbilt Institute for Clinical and Translational Research (VICTR) funded by a Clinical and Translational Science Award (CTSA) from the NIH to support their studies. In addition to presenting their work at the annual research retreat held each May, scholars have been selected to present their research at premier national biomedical conferences and have published their work in high impact journals such as *Anesthesiology*, *Anesthesia & Analgesia*, and *Critical Care Medicine*. Eight scholars have completed the program. Of these, seven remain at academic medical centers and four are actively engaged in biomedical research. Following is an update on current scholars' progress and achievements in the past academic year.



Heidi Smith MD, MSCI

Heidi Smith MD, MSCI, (Scholar 2011-2016), studies delirium in critically ill pediatric patients. She is a recipient of a \$175,000 Foundation for Anesthesia Education and Research (FAER) Mentored Research Training grant to support her ongoing work for the validation of pediatric-specific delirium-monitoring tools for critically ill infants and children, and the study of delirium-associated risk factors and outcomes such as long-term cognitive impairment. She also received a VICTR grant for \$78,000 to support this important work. She has presented her research at regional and national meetings, including the American Society of Anesthesiologists, the Association of University Anesthesiologists, the American Thoracic Society, the American Delirium Society, and the Society of Critical Care Medicine. She has published her findings in *Critical Care Medicine*, *Seminars in Respiratory and Critical Care Medicine*, *Pediatric Clinics of North America*, and *Current Concepts in Pediatric Critical Care Medicine*. She is mentored by Pratik Pandharipande, MD, MSCI.



Patrick Henson, DO

Patrick Henson, DO, (Scholar 2010-2014), is studying immune suppression in critical illness and pharmacologic immunomodulation therapies. Currently, he is investigating the association of PD-1, PD-L1, and other markers of immune suppression in patients with severe burn injury. He has received grant funding from VICTR and is actively enrolling patients in the Burn Intensive Care Unit at Vanderbilt University Medical Center. He is mentored by Ed Sherwood, MD, PhD, and his preliminary work has been presented at the Shock Society's Annual Conference on Shock.



Marc Lopez, MD, MSCI

Marc Lopez, MD, MSCI, (Scholar 2014-2019), is investigating the impact of intraoperative oxidative stress on postoperative endothelial dysfunction in patients randomized to hyperoxia or normoxia during cardiac surgery. He has recently co-authored a research article examining the temporal distribution of postoperative hypoxemia and staffing at large academic centers and has previously published original research articles on the contributions of vasodilators to hyperemic responses in humans. Dr. Lopez is mentored by Josh Billings, MD, MSCI.



Adam Kingeter, MD

Adam Kingeter, MD, (Scholar 2013-2018), has developed a charge dashboard in collaboration with the Vanderbilt University Medical Center Department of Finance that allows for the real-time tracking of expenses on any patient admitted to an intensive care unit. His research focuses on health care economics and resource utilization, and his studies examine cost and value of care in the intensive care unit. He is mentored by Melinda J. B. Buntin, PhD, Department of Health Policy, as well as members of the Department of Health Policy.



Joseph Schlesinger, MD

Joseph Schlesinger, MD, (Scholar 2011-2016), is examining multisensory perceptual training, and specifically improving unisensory pulse oximetry pitch perception and attentional load processing. Dr. Schlesinger has received a VICTR grant for his research and is mentored by Mark Wallace, PhD, Director of the Vanderbilt Brain Institute, and Matthew Weinger, MD. Dr. Schlesinger has presented his work at the American Society of Anesthesiologists, the Society for Neuroscience, the American Society of Critical Care Anesthesiologists, and the American Medical Association. His original research articles have been published in *Anesthesiology* and *Anesthesia & Analgesia*.

GE Foundation Grant Expands International Reach

Vanderbilt's Department of Anesthesiology has always had a passionate commitment to improving perioperative and anesthetic care in medically underserved regions of the world, and that commitment received a huge boost in late 2013 when the faculty was awarded a \$3 million grant from the GE Foundation's Developing Health Globally program to fund international medical education and research in Kenya and other low-resource areas. The major focus of the ImPACT Africa (Improving Perioperative & Anesthesia Care and Training in Africa) grant is to develop training programs to expand anesthesia provider education in these regions, with the ultimate goal of lowering surgical and obstetric mortality. The scope of the grant includes the development of an innovative, interactive curriculum to train care providers who will then practice in rural Kenya and other underserved regions of the world. An additional goal of the grant is to establish a method of data collection in order to conduct groundbreaking investigations that previously could not be conducted in resource-poor areas.

"Vanderbilt Anesthesiology has an abundance of unique resources – our internally developed informatics systems, a

strong history of simulation training, a highly skilled pool of faculty, eager trainees who want to work in the international arena, and our understanding of remote educational tools," said Matthew McEvoy, MD, vice-chair for Educational Affairs for the department. "With the support of this grant from the GE Foundation, our knowledge and resources are now being put to even better use to directly impact the health care of individuals a continent away. I anticipate that we will soon witness measurable improvements in surgical and obstetric mortality in areas we are able to serve through this grant."

With the support of the GE Foundation grant, Vanderbilt has partnered with Kijabe Hospital and the Center for Public Health and Development (CPHD) in Kenya to develop an anesthesia training program for Western Kenya that can be scaled within the country. This program will serve as a model for the creation and expansion of sustainable, safe anesthesia services in other developing countries. The curriculum will include simulation training, an area in which Vanderbilt anesthesiologists are national leaders. Dr. McEvoy is the Vanderbilt-based primary investigator for the grant, while Mark Newton, MD, serves as the



Vanderbilt Anesthesiology residents provide direction to Kenyan Certified Registered Nurse Anesthetists as they care for a young patient.

Kenyan-based primary investigator. Kelly McQueen, MD, MPH, director of Vanderbilt Anesthesia Global Health and Development, also plays a key role in the grant's implementation.

Dr. Newton directs the well-established Vanderbilt International Anesthesia (VIA) program and divides his time between being a pediatric anesthesiologist at Vanderbilt and serving as chief anesthesiologist for Kijabe Hospital in rural Kenya. Under his guidance, young Vanderbilt anesthesiologists travel to Kenya to receive training and to educate others in providing anesthesia and pain management services. In partnership with the Kenya Ministry of Health, Newton also developed an anesthesia training program for Kenyan anesthesia providers, which has been a foundation for the GE Foundation work.

“Sub-Saharan Africa has one of the highest maternal mortality rates in the world, and preventable anesthesia-related mortality rates are estimated to be many times higher than in western countries,” said Dr. Newton. “This grant greatly enhances our efforts to directly save lives and dramatically improve health care by training providers.”



KRNA Student George Wasari reviews a patient's history and anesthetic plan with Dr. Matthew McEvoy.



KRNA Mary Mungai, front right, served as emcee and group leader for case-based discussions at the fourth annual AIC Kijabe Anesthesia Conference sponsored by the GE Foundation in June 2014. The theme was 'Maternal Mortality: The Role of Anesthetists in Africa.'

The first phase of grant work began in mid-2014 as Dr. McEvoy and Department of Anesthesiology Chairman Warren Sandberg, MD, PhD, joined Dr. Newton in Kijabe, Kenya, to kick off the initiative. The group met a delivery of 30 new laptop computers that had been shipped from Vanderbilt and were already loaded with training software, as well as the software needed for reporting cases and recording other critical patient data. The data will be used for research projects and to develop quality improvement initiatives in patient care.

“Our faculty members have long been committed to international anesthesia education and training, and the work we are able to undertake through this award is a wonderful affirmation that those efforts have not gone unnoticed,” said Dr. Sandberg. “It is humbling to be a part of such an initiative.”

According to the *World Journal of Surgery*, it is estimated that in rural areas of Kenya, there is only one anesthesiologist for every 13 surgeons. Through the Developing Health Globally program,

GE has partnered with the Kenya Ministry of Health to improve the surgical capacity in Western Kenya by equipping operating rooms and providing training.

In addition to the grant activity, Vanderbilt residents in their CA-2 and CA-3 years have the option of participating in an Accreditation Council for Graduate Medical Education (ACGME)-approved, one-month, international anesthesia rotation at Kijabe Hospital. The program has funding to allow any resident who desires to work in Kenya the chance to do so, providing a unique educational experience unlike any other found in U.S. academic anesthesiology training programs. Each resident is exposed to a medical experience in a resource-poor setting where clinical skills must be sharpened to compensate for lack of technology and supplies. The residents also provide clinical training and give classroom lectures to local medical providers.

The nurse anesthetist training program in Kenya continues to expand under Dr. Newton’s leadership, with now up to 20



A goal of the ImPACT Africa grant program is capacity building by increasing the number of anesthetists and anesthesiologists that are trained throughout the country. Kisumu, Kenya, will be launched as a new training site in spring 2015, and here Drs. Sandberg, Newton and McEvoy meet with leaders at Jaramogi Oginga Odinga Teaching and Referral Hospital in Kisumu.

students per class. After graduation, these students provide anesthetic care in remote areas of Africa. In addition, multiple critical care fellows from Vanderbilt have had critical care rotations in Kenya while managing complicated, critically ill patients in an environment with few resources. Each of these rotations has been instrumental in preparing anesthesia care providers for a career that will include a global health focus.

“We have successfully positioned our department to lead in global anesthesia development from our home base at Vanderbilt,” said Dr. Sandberg. “It is rewarding to know that our efforts have a definitive impact on the provision of safe, effective anesthesia in parts of the world where people often die due to the lack of basic medical care. Going overseas to both train and be trained is invaluable to our residents and fellows, and they typically come back from VIA missions as changed doctors. They gain experiences there that cannot be learned from a textbook or from our clinical environments in the United States.”

The capacity building projects that have been developed at Kijabe Hospital over the past 17 years revolve around training physicians and non-physicians for rural anesthesia care in Kenya, South Sudan, and areas of the Horn of Africa. These programs have all been developed in coordination with the respective Ministries of Health and national (African) academic institutions. Partnerships between academic institutions in Africa (University of Nairobi, Department of Anesthesiology), Kijabe Hospital, and Vanderbilt University have provided the foundation for strengthening of physician anesthesia training in East Africa. Kijabe Hospital is now hosting one resident per month for clinical and didactic education as part of its program from the University of Nairobi. In addition, the East Africa Pediatric Anesthesia Fellowship began in September 2013 with the involvement of the World Federation of Societies of Anaesthesiologists (WFSA), many international pediatric anesthesia societies, and the University of Nairobi/Kijabe Hospital partnership. As a direct result of his long-term position in East Africa, Dr. Newton has had the opportunity to assist in the development of these exciting physician anesthesia capacity building programs.

“These are exciting times for our department, and our leadership in global health continues to attract some of the brightest residents and fellows who want to have an impact on the world with their specialty training,” said Dr. Sandberg.



While a resident at Vanderbilt, Department of Anesthesiology faculty member Jenna Helmer-Sobey, MD, completed an international anesthesiology rotation in Kenya.



Co-primary investigators for the ImPACT Africa grant, Matthew McEvoy, MD, and Mark Newton, MD, who is also director of Vanderbilt International Anesthesia, load thirty new laptop computers with needed software before they are shipped to Kenya. The computers are being used for training and research.

Clinical Overview

Serving in one of the largest clinical programs in the nation, the Vanderbilt Department of Anesthesiology's clinicians provide procedural, critical care, pain management, and all perioperative anesthesia services for more than 90,000 adult and pediatric patient encounters annually at more than 100 anesthetizing locations. Of these, more than 10,000 patients are seen annually in the Vanderbilt Interventional Pain Clinic, and approximately 20,000 Vanderbilt adult and pediatric patients receive an anesthetic during a radiologic, gastrointestinal, or other diagnostic or therapeutic procedure.

The department's faculty, residents, fellows, certified registered nurse anesthetists (CRNAs), and nurse practitioners provide care in our operating rooms, five adult intensive care units, and the pediatric and neonatal intensive care units, and perform approximately 4,000 anesthetics per year in the labor and delivery suite.

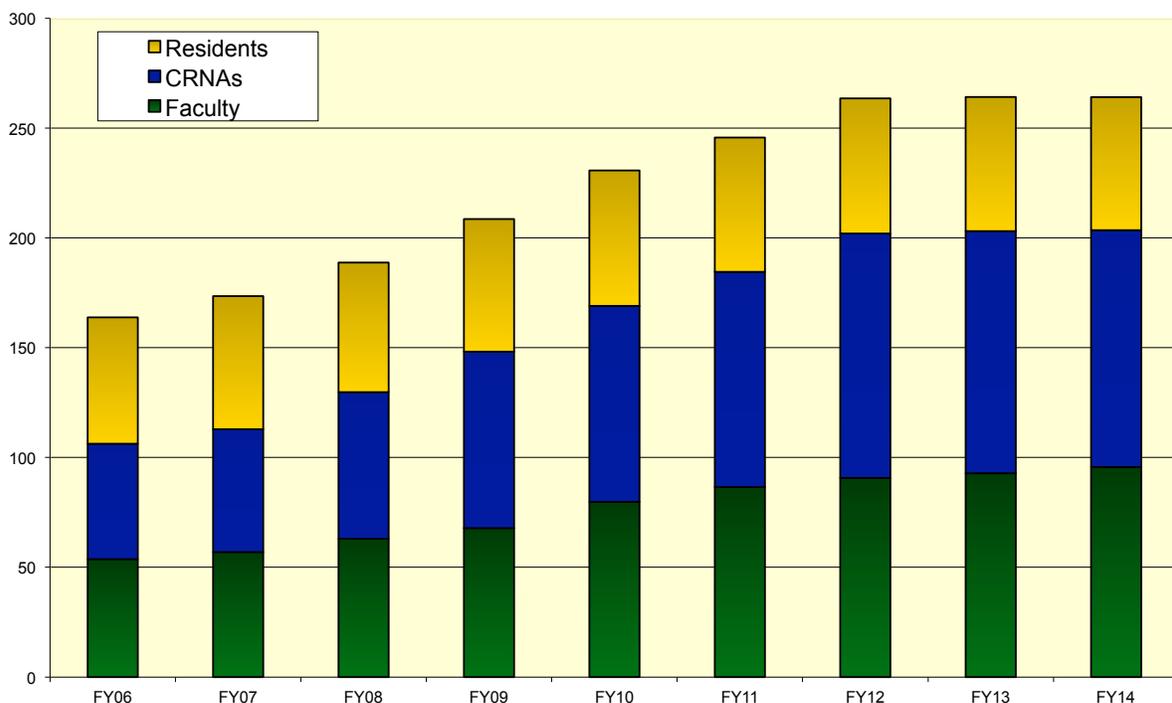
The clinical staff provides services in three hospitals (Vanderbilt University Hospital, Monroe Carell Jr. Children's Hospital at Vanderbilt, and the Nashville Veterans Administration Hospital) and five outpatient facilities. Specialized clinicians provide the full range of anesthetic techniques and procedures in the operating rooms, procedural suites, intensive care units, and pain management clinics. All surgical specialties are represented, including adult and pediatric cardiac surgery, all types of solid-organ transplantation, robotic surgery, neurosurgery, and high-risk obstetrics. Vanderbilt's trauma service, which includes the orthopedic trauma program, is among the busiest in the nation.



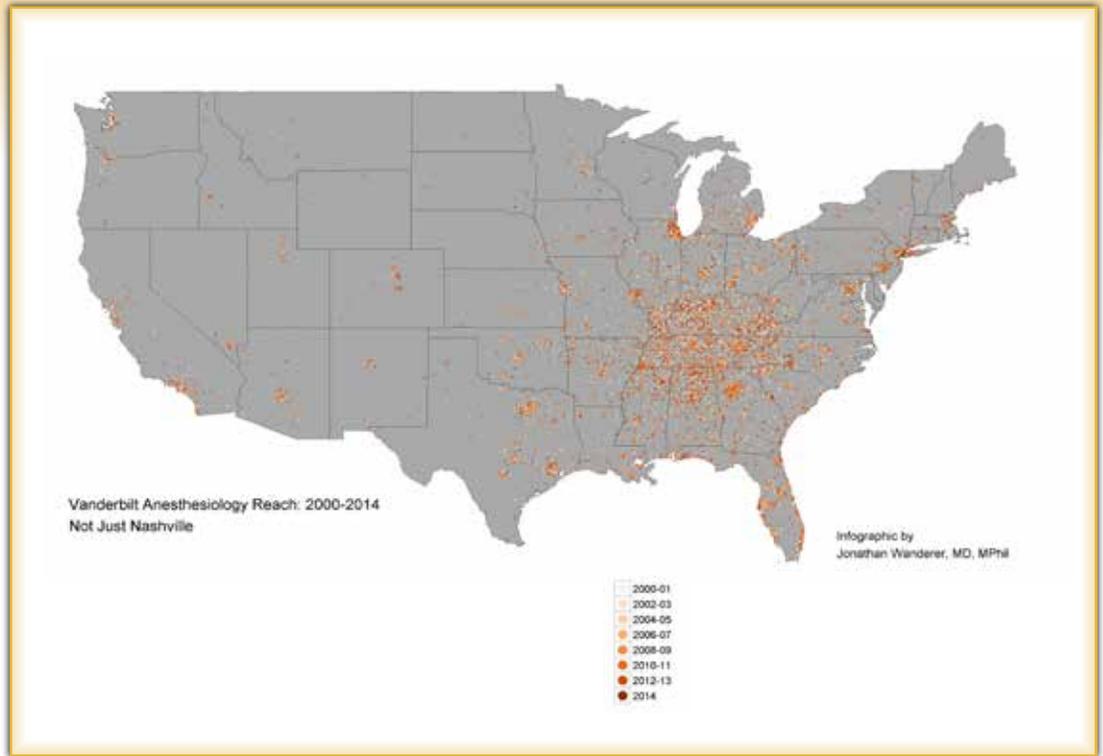
Tracy Jackson, MD, a member of the Pain Medicine Division, examines needle placement during a fluoroscopically guided radio frequency stimulation procedure.

The operating room staff practices anesthesia care according to the Anesthesia Care Team model. Anesthetics are provided by one of the department's highly skilled trainees or CRNAs under the direction of one of the medical faculty. By means of this model, the highest quality care is delivered in a safe and effective manner using the unique skills of all team members.

Department of Anesthesiology Clinical Staff

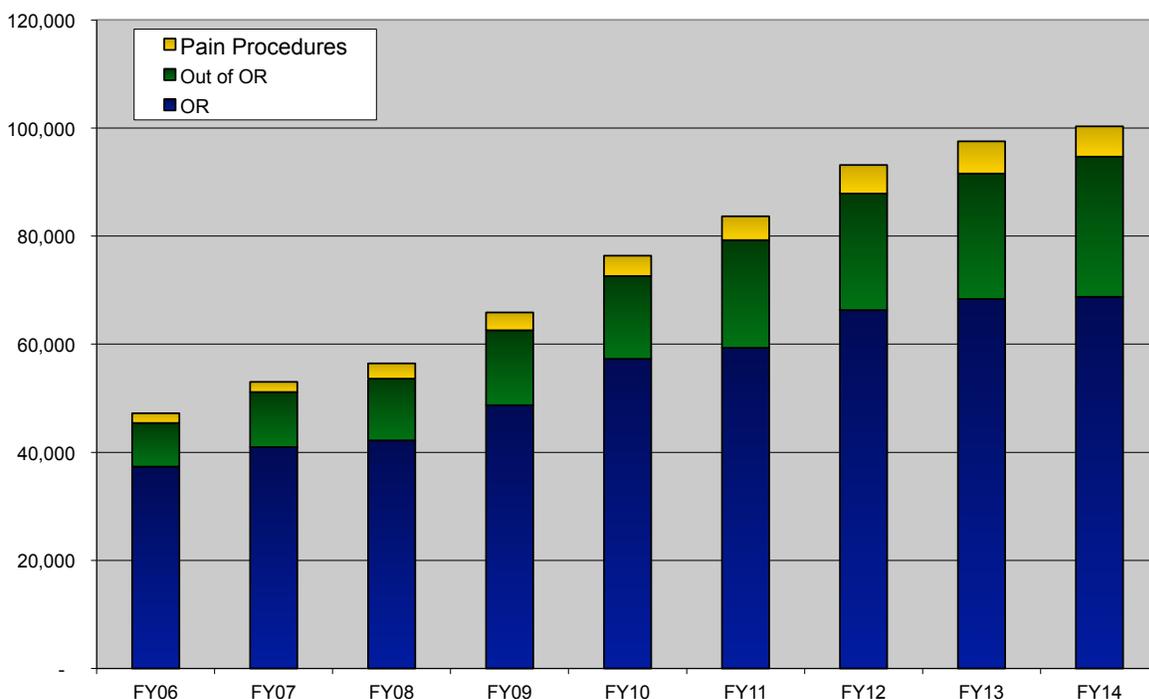


Vanderbilt Department of Anesthesiology is also known for innovation in the use and development of new technologies to deliver and improve patient care and to improve our educational offerings. The faculty use advanced human patient simulators to teach basic anesthesia skills, critical event response techniques, and team management in the operating rooms and intensive care units. Vanderbilt is one of the few medical training centers with a 3-D transesophageal echocardiography (TEE) simulator to teach the essential skill of cardiac ultrasound. The medical information systems at Vanderbilt are second to none and support the delivery of safe and efficient patient care. Perioperative record keeping is highly automated and managed through an anesthesia information management system developed by the Department of Anesthesiology. This system both enhances effective patient care and supports the clinical research program.



Highlighted on the following pages are the services provided by the Vanderbilt Department of Anesthesiology’s clinical divisions.

Department of Anesthesiology Clinical Volumes



Division of Ambulatory Anesthesiology

National statistics indicate that more than 70 percent of all surgeries are now performed in an outpatient setting. Vanderbilt's Division of Ambulatory Anesthesiology consistently meets increased demand for outpatient procedures in our service area, both in locations and in additional services.

Vanderbilt's Ambulatory Anesthesiology Division services are not only unique among other academic departments in the high volume of cases, but also in that two of the outpatient surgery centers are joint ventures locally, with the group providing services alongside community physicians in the greater Nashville area. In March 2011, the Division of Ambulatory Anesthesiology began providing anesthesia services at Vanderbilt's newest ambulatory surgery center, Vanderbilt Bone & Joint located in Franklin, Tennessee. The three-room center specializes in orthopedic procedures, and the expansion extended VUMC's regional anesthesia services, including an at-home peripheral nerve catheter program, to Williamson and neighboring counties. The new site also added more than 3,000 ambulatory cases per year, to total nearly 17,000 cases annually in all of our outpatient centers.

The Division of Ambulatory Anesthesiology was formed in 2008 and provides services for Vanderbilt University Medical Center satellite locations that include Nashville Surgery Center (NSC), Vanderbilt Outpatient Surgery (VOS), Cool Springs Surgery Center (CSSC), and Vanderbilt Bone & Joint Surgery Center. These centers provide for a broad base of cases rarely seen in an academic practice, including patients requiring GI, ophthalmologic, ENT, plastic surgery, pediatric, urologic, neurosurgical, spine, orthopedic, pain, gynecologic, general surgery, and dental procedures.

In October 2014, The Division of Ambulatory Anesthesiology will grow again, as Vanderbilt will open an 11-room outpatient, low acuity surgery center on campus. This center will provide a variety of outpatient procedures.

“At Vanderbilt, we remind ourselves every day that ambulatory anesthesiology is rapidly evolving as a subspecialty, and we are a big part of that,” said Ambulatory Anesthesiology Division Chief Katherine Dobie, MD. “With a diverse patient and case mix, we are continually looking for new practices to improve our safety and quality in the setting of higher acuity cases and sicker patients. Currently, we have one of the highest patient satisfaction ratings within the institution, with minimal complications and minimal hospital transfers, well below ASC national averages. At 17,000 patients and nearly 4,000 regional anesthetics

yearly, we are proud of this. We're also thrilled to have been asked to meet the challenges of opening a new, large outpatient center on campus this fall. Growth coupled with enthusiasm is something we feel fortunate to have in our division.”

As NSC is primarily an orthopedic/sports medicine center, the majority of training in peripheral regional anesthesia occurs there. Under the leadership of Randall Malchow, MD, NSC medical director, Vanderbilt residents receive training in the techniques of ultrasound-guided regional blockade and the placement of regional catheters for home-based postoperative pain management.

“We are unique among resident training programs in that we take the residents out of the OR for an eight-hour didactic training session at the beginning of their regional rotation,” said Dobie. “Attending anesthesiologists do the blocks that day, and residents do not start performing clinical regional anesthesia until we know they have a strong knowledge base. With the large volume of regional cases, residents and fellows leave our rotations equipped not only with technical skill, but also with an understanding of application in a high-volume, fast-paced environment. We have been able to do this without compromising efficiency.”

Successful implementation of an outpatient catheter program, pioneered by Dr. Malchow in 2008, has allowed the migration of complex shoulder and foot and ankle cases out of the inpatient setting into the more patient-friendly ambulatory setting. All regional blocks are documented in a comprehensive database, which now contains more than 12,000 cases, the foundation for future academic research.



Vanderbilt Bone & Joint Surgery Center in Franklin, Tennessee, is the newest ambulatory surgery center in Vanderbilt University Medical Center's network of satellite locations.

The volume of pain management procedures offered at Cool Springs has also increased, with the addition of a satellite location of the Vanderbilt Interventional Pain Center. Dan Lonergan, MD, who completed a Pain Medicine fellowship at Vanderbilt, performs interventional pain procedures at the Cool Springs location to serve Williamson and adjacent counties.

Outpatient GI endoscopies have been increasing in volume at CSSC, and pediatric volume has been increasing exponentially at every center, with the largest percentage being pediatric ENT cases from community surgeons. Under the leadership of Jane Brock, DO, Cool Springs Surgery Center was named Symbion's "Surgery Center of the Year" for 2011 and 2012.

"This is a national recognition that we have enjoyed two years in a row; Dr. Brock's leadership amidst tremendous growth and change has been outstanding. Just last year we provided nearly 8,000 anesthesia services at this center," said Dobie.

Vanderbilt Outpatient Surgery (VOS) is primarily an ENT center where complex ear, sinus, and voice cases are performed, along with routine tonsillectomies and adenoidectomies.

The Division of Ambulatory Anesthesiology is led by Dr. Dobie and includes nine full-time faculty, 21 certified registered nurse anesthetists, and two to three residents who rotate through the program monthly.



Cool Springs Surgery Center is located on Mallory Lane in Franklin, Tennessee.



Nashville Surgery Center is located on Patterson Street in Nashville, Tennessee.

Division of Anesthesiology Critical Care Medicine

The Division of Anesthesiology Critical Care Medicine strives to provide excellent patient care; embody professionalism; promote innovative educational programs for fellows, residents, medical students, the critical care team, and the community; and engage in scholarly activities to improve patient outcomes while effectively utilizing resources. The division provides critical care services in the Burn ICU, Cardiovascular ICU, Neuroscience ICU, and Surgical ICU at Vanderbilt University Medical Center and in the Surgical ICU at the Veterans Administration Medical Center in Nashville, Tennessee.

To meet growing demands for critical care services, the division has expanded to include 25 anesthesiology intensivists, as well as more than 35 acute care nurse practitioners (ACNPs) and physician assistants (PAs), making it one of the largest anesthesiology critical care medicine divisions in the country. Among the faculty are eight

neurointensivists certified by the United Council for Neurologic Subspecialties. The division operates using a multidisciplinary, intensivist-led critical care team model that includes fellows, residents, ACNPs, and PAs. Members of the division routinely participate in continuing medical education (CME) activities and workshops to maintain and acquire new skills to keep abreast of modern technology and the changing spectrum of skills required to care for the critically ill. This includes proficiency in ultrasound and echocardiography, and management of patients with ventricular assist devices or who are on extracorporeal membrane oxygenation (ECMO).

The division supports the Anesthesiology Critical Care Medicine fellowship, which is an Accreditation Council for Graduate Medical Education (ACGME)-accredited, one-year program that provides an unparalleled, innovative critical care training opportunity. The



The Division of Anesthesiology Critical Care Medicine includes a large group of faculty, nurse practitioners and eight fellows: Front row, left to right, Ariel Waters Kappa; Hannah Maloney; Pratik Pandharipande, MD, MPH; Lauren Nevells; and April Kapu. Second row, left to right, Kathleen Koehler; Katie Jackowski; Tracy McGrane, MD; Avinash Kumar, MD; Stephanie Mehr; and Kellie Sallis. Third row, left to right, Arna Banerjee, MD; and Chris Hughes, MD. Fourth row, left to right, Pranav Shah, MD (Fellow); Liza Weavind, MD; and Srinivas Tumuluri, MD (Fellow). Fifth row, left to right, Roy Neeley, MD; Nathan Ashby, MD; and Mary Henry, MD (Fellow). Sixth row, left to right, Antonio Hernandez, MD; Adam King, MD (Fellow); and Patrick Henson, DO. Seventh row, left to right, William Costello, MD; Frederic T. Billings IV, MD, MSCI; and Christopher Cropsey, MD. Eighth row, left to right, Adam King, MD; Joseph Schlesinger II, MD; and Bret Alvis, MD. Not pictured: Faculty: John Barwise MB ChB; John Hall, MD; Jason Kennedy, MD; Stuart McGrane, MB ChB; Nahel Saied, MB ChB; Chad Wagner, MD; and Sheena Weaver, MD. Nurse Practitioners: William Andrews, Wayne Babcock, Sarah Baggette, Jeff Barton, Justin Calabrace, Katherine Carroll, Debra Cirone, Jennifer Crichton, Scott Dennis, Edmund Donahue, Anna Fong, Jayme Gibson, Molly Goidel, Meredith Golden, Amanda Hill, Emily Holcombe, Michelle Kearney, Clint Leonard, Aimee Marlar, Jessica Needham, Andrea Primm, Christina Riley, Briana Rogers, Valerie Scarafia, Teresa Simpson, Emily Spring, Joshua Squiers, Lindsay Trantum, Maria Troche, Steve Widmar, Joey Williams, Melissa Wiley, and Briana Witherspoon. Fellows, Wendy Banfi, MD; Christina Hayhurst, MD; Merrick Miles, MD; and Melissa Stewart, MD.

critical care fellowship has received accreditation for five years and has recently been expanded to eight ACGME-accredited fellowship positions annually. Applicants with a training background in either anesthesiology or surgery or both are considered. Fellows have a diverse clinical experience in the subspecialty ICUs and through an innovative didactic program of lectures, problem-based learning discussions, simulation exercises, workshops, journal clubs, and an interactive web-based learning portal. Fellows also participate in teaching Fundamentals in Critical Care Support (FCCS) and the Advanced Trauma Life Support (ATLS) courses, as well as in resident and medical student critical care lectures and simulation training.

Division faculty are involved in the training and mentoring of critical care fellows and residents from many disciplines, and they also participate in educational activities at the local, regional, national, and international levels. Faculty from the division are active leaders at Vanderbilt University Medical Center, including holding positions as chief of staff, chairs of the Sedation Committee and the Vascular Access Safety Committee, executive medical director for Critical Care, and medical directors of the Burn ICU, Cardiovascular ICU, and Neuroscience ICU. In addition, division faculty fill many leadership roles in the Vanderbilt School of Medicine through the development of immersion courses, the research clerkship, and the critical care skill programs as part of the redesigned medical school curriculum. An ongoing alliance between the Division of Anesthesiology Critical Care Medicine and the Vanderbilt University School of Nursing also

supports an ACNP intensivist training program. Division faculty also direct the department's BH Robbins Scholar Program that provides a comprehensive, mentored research experience spanning anesthesia residency and an academic fellowship.

By encouraging research to identify better ways to care for perioperative and critically ill patients, the division takes a proactive approach to the ever-shifting demands and regulations in healthcare and the changing milieu of critical care. Active research programs in the Division of Anesthesiology Critical Care Medicine encompass both clinical and translational research and focus on perioperative risk factors and mechanisms of cognitive impairment; kidney injury in cardiac and non-cardiac patients; sepsis and its monitoring; education and implementation science; health resource utilization; multisensory training; and quality improvement projects such as remote bedside monitoring, use of rapid response teams, and optimal consultation of a palliative care team. Active grants in the division include a National Institutes of Health Research Project Grant (R01), an NIH Career Development Award (K23), an NIH Small Grant Program (R03), and a Foundation for Anesthesia Education and Research (FAER) Research in Education grant, in addition to numerous industry and Vanderbilt Institute for Clinical and Translational Research (VICTR) grants. Faculty have been involved in more than 20 peer reviewed manuscripts and textbook chapters in the past academic year alone, in addition to numerous abstracts and scientific presentations.



Critical Care Nurse Practitioners in the Division of Anesthesiology Critical Care Medicine: Front row, left to right, Ariel Waters Kappa, April Kapu, and Hannah Maloney. Middle row, left to right, Lauren Nevels and Stephanie Mehr. Top row, left to right, Katie Jackowski, Kellie Sallis, and Kathleen Koehler. Not pictured: William Andrews, Wayne Babcock, Sarah Baggette, Jeff Barton, Justin Calabrace, Katherine Carroll, Debra Cirone, Jennifer Crichton, Scott Dennis, Edmund Donahue, Anna Fong, Jayme Gibson, Molly Goidel, Meredith Golden, Amanda Hill, Emily Holcombe, Michelle Kearney, Clint Leonard, Aimee Marlar, Jessica Needham, Andrea Primm, Christina Riley, Briana Rogers, Valerie Scarafia, Teresa Simpson, Emily Spring, Joshua Squiers, Lindsay Trantum, Maria Troche, Steve Widmar, Joey Williams, Melissa Wiley, and Briana Witherspoon.

Division of Cardiothoracic Anesthesiology

The Division of Cardiothoracic Anesthesiology is a microcosm of the larger department within which it resides, supporting the tripartite missions of clinical excellence, academic pursuits in anesthesiology, and education. The division is led by Andrew Shaw, MB, FRCA, FFICM, FCCM, and includes 13 faculty members and 11 nurse anesthetists. Each month, three residents rotate through the service. The fellowship program, under the interim leadership of Dr. Shaw (pending appointment of a permanent fellowship director), expanded in 2013 to three clinical fellows trained annually.

Innovation, research, and education are all key components of the division, as is evidenced by its support of novel clinical environments in the hybrid catheterization lab/operating room, the routine use of transesophageal echocardiography as a diagnostic and monitoring tool in both operating rooms and intensive care units, many clinical and translational research initiatives, and the division's strong commitment to being a national leader in cardiothoracic anesthesia education.

The division works alongside the surgeons and cardiologists of the Vanderbilt Heart and Vascular Institute to perform approximately 1,500 adult cardiac procedures a year. These include coronary artery bypass grafting (on- and off-pump), valvular surgery, cardiac and lung transplantation, adult congenital procedures, hybrid bypass procedures, aortic aneurysm and dissection repair, and ventricular assist device (VAD) insertions. The VAD program at Vanderbilt is large and currently places about 100 devices per year for both bridge-to-transplant and destination therapy indications. The transcatheter aortic valve replacement (TAVR) program, which provides percutaneous aortic valve replacement in patients who are too high risk for open-heart surgery, began in 2011, and approximately 150 TAVRs are completed annually (both Corevalve and Sapien).

Division members also work with general thoracic surgeons to perform approximately 700 thoracic cases annually, including thoracotomy, mediastinoscopy, lung transplantation, and esophageal procedures. Anesthesia services are also provided for non-OR cases such as interventional pulmonology, cardiology, and electrophysiology procedures, which together account for approximately 3,000 cases annually. A subset of the division's faculty is also board-certified in intensive care medicine. These individuals rotate through the adult cardiovascular intensive care unit, under the medical direction of division faculty member Chad Wagner, MD.

Intraoperative transesophageal echocardiography (TEE) is

an integral part of the clinical practice and is performed on nearly all adult cardiac patients. The cardiothoracic anesthesiologists are also increasingly in demand to provide intra-procedure TEE in the electrophysiology suite to rule out thrombosis of the atrial appendage, to guide trans-septal puncture, and to look for evidence of cardiac tamponade. All studies are performed and interpreted by the cardiothoracic anesthesiologist, and cases are digitally archived for future study.

Division of Cardiothoracic Anesthesiology faculty conduct research in vascular system function, cardiopulmonary conditioning, acute kidney injury, and the perioperative inflammatory response. Extramural grant support comes from the American Heart Association and the National Institutes of Health.

The division also has a significant external and internal education presence; for example, Dr. Shaw serves as scientific program chair for the Society of Cardiovascular Anesthesiologists (SCA) annual meeting. Division faculty have hosted successful workshops in perioperative TEE and hemodynamic echo, drawing anesthesiology residents, fellows, faculty, and private practitioners from throughout the region. Cardiothoracic anesthesiologist Julian Bick, MD, received a \$100,000 Research in Education Grant from the Foundation for Anesthesia Education and Research which is used to train CA-1 residents in TEE. Two TEE/TTE simulators, which provide 3-D, computer-generated views of the heart as a probe is guided through a mannequin, are available for training in the division's echocardiography lab and at Vanderbilt's Center for Experiential Learning and Assessment (CELA).



Division of Cardiothoracic Anesthesiology: Left to right, Antonio Hernandez, MD; Frederick "Josh" Billings, MD; Bantayehu Sileshi, MD; Mias Pretorius, MD; Susan Eagle, MD; Jeremy Bennett, MD; Robert Deegan, MD, PhD; Julian Bick, MD; Andrew Shaw, MB, FRCA, FFICM, FCCM. Not pictured: Jason Kennedy, MD; and Chad Wagner, MD.

Certified Registered Nurse Anesthetists



More than 100 Certified Registered Nurse Anesthetists are a critical component of the anesthesia care team model used at Vanderbilt University Medical Center.

The Vanderbilt Department of Anesthesiology embraces the Anesthesia Care Team approach to patient care, involving anesthesiologists and residents, certified registered nurse anesthetists (CRNAs), student registered nurse anesthetists (SRNAs), and anesthesia technicians. The more than 120 CRNAs at Vanderbilt provide anesthesia for all types of surgical procedures, including cardiac, pediatrics, vascular, trauma, neurosurgery, plastics, radiologic, and special procedures. CRNAs administer general, regional, and monitored anesthesia care for scheduled and emergency surgical, obstetric, and diagnostic procedures.

Key CRNA job responsibilities include preoperative patient evaluation, management of the patient through completion of the operative procedure, transport of the patient to the recovery area, and assurance of the appropriate postoperative care. Additionally, CRNAs provide instruction and education for SRNAs. They also support the residency education mission by providing service coverage to allow residents to attend educational activities and participate in elective rotations. In terms of personnel, the CRNA Division is the largest division within the Department of Anesthesiology.

Vanderbilt is the primary clinical affiliate of the Middle Tennessee School of Anesthesia (MTSA) in Madison, Tennessee, which is the second largest nurse anesthesia program in the United States. Vanderbilt is also the primary clinical affiliate for the Union University Nurse Anesthesia program in

Jackson, Tennessee. Student registered nurse anesthetists assist in approximately 7,000 anesthetics per year while on Vanderbilt rotations. SRNA coordinators are CRNAs Brad Koss and Andrew Phillips.

The CRNA Division mirrors the VUMC operating room pod organization, and the service specialist position within the CRNA structure improves communication with all pod members. The six service specialists are Neurosurgery Service Specialist Tammy Freehling; AOS/Ortho Service Specialist Kathy Mitchell; General Oncology/Urology Service Specialist Ken Donnell; Ophthalmology/Otolaryngology/Oral Surgery/Plastics Service Specialist Shawnee Brenkman; Out-of-OR Service Specialist Ki Szymd-Hogan; and Pediatric Cardiothoracic Service Specialist Lewis McCarver.

In addition to providing SRNA training, the CRNA division has developed a strong program of continuing education unit-eligible educational programs designed specifically for CRNAs. These programs are overseen by CRNA Educators Mike Leersnyder and Heather Frankenfield. Interim Chief CRNA Buffy Krauser-Lupear directs the CRNA Division. Five designated lead CRNAs are Brian Reid in Ambulatory; Paul Wilson in Obstetric/Gynecology; Edith Newberry in Adult Cardiac; Amanda Dickert in Pediatrics; and John Butorac in Multispecialty Adult Anesthesia.

Anesthesia Technicians Provide Critical Support

Vanderbilt University Medical Center is staffed with 38 anesthesia technicians who contribute to safe, efficient anesthesia care by providing highly skilled assistance to anesthesiologists and nurse anesthetists at both on- and off-campus clinical locations. Anesthesia technician duties include equipment maintenance and servicing, running laboratory tests on blood samples, maintaining quality assurance records, and operating a variety of equipment used to monitor, evaluate, and manage the patient undergoing anesthesia.

As the level of the anesthesia technician's training, experience, and knowledge increases, the technician provides closer intraoperative support to the anesthesia provider. The department offers structured classroom lectures for ongoing anesthesia technician training. The anesthesia technician, the certified anesthesia technician, and the certified anesthesia technologist cover areas related to the following adult and pediatric services: neurosurgery, plastics, urology, ophthalmology, vascular, trauma, cardiothoracic, general surgery, orthopedics, obstetrics/gynecology, and ENT. They also provide support for special procedures in the radiology department that include MRI, PET scan, radiation oncology, GI Lab, CT Scan, nuclear medicine, and the cardiac catheterization lab.

Interim Chief CRNA Buffy Krauser-Lupear oversees the Anesthesia Technician Program. Sue Christian, a certified anesthesia technologist and long-time member of the Vanderbilt team, serves as the anesthesia technician manager/educator at Vanderbilt University Hospital, while Gwen Stafford serves in this role at Monroe Carell Children's Hospital at Vanderbilt.

Anesthesia technicians with specialized training operate autotransfusion equipment at Vanderbilt.



Members of Vanderbilt's anesthesia technician team include, front row, left to right, John Poland, CerAT; Joe Brock, CerATT; Mao Shinoda; and Cheryl Bales. Middle row: Paivi Belton; Ashley Atkinson; Ray Brazill; Julie Kapelan, CerATT; and Sharon Baskette, CerATT. Back row: Dewayne Campbell, CerAT; Tonia Rozell, CerAT; Walter Wooten; and Fred Dennis.

Division of Multispecialty Adult Anesthesiology

The Division of Multispecialty Adult Anesthesiology is the department's largest division, providing perioperative anesthetic care for more than 12,000 patients annually in 45 operating rooms and procedure suites for a wide variety of surgical services, including general surgery, orthopedics, urology, plastic surgery, ophthalmology, vascular surgery, otolaryngology, hepatobiliary surgery, liver and renal transplantation, and oral/maxillofacial surgery. MSA faculty and staff provide 24-hour coverage for emergency and trauma surgery for the region, as well as perioperative consultation and management. The division has 48 full- and part-time faculty members, most of whom have significant subspecialty training and expertise.

MSA Division faculty provide anesthesiology residents a variety of both introductory and advanced clinical experiences and make numerous contributions to the department's educational programs for medical students, residents, and fellows. Additionally, MSA

faculty teach and supervise residents from other specialties, as well as student registered nurse anesthetists who rotate in the MSA Division. Division faculty pursue a wide range of academic interests, including regional anesthesia, airway management, information technology, perioperative cognitive dysfunction, echocardiography, and ultrasound imaging.

The division's members are also highly active in research, with numerous investigator-initiated clinical research projects currently in progress. Work is ongoing in informatics, regional anesthesia, airway management, and drug protocols in an effort to improve perioperative care and throughput. MSA Division Chief James Berry, MD, believes the division's multi-year research efforts to demonstrate the value of wireless monitoring of postoperative patients will ultimately lead to widespread adoption of the technology.



Division of Multispecialty Adult Anesthesiology: Front row, left to right, Chris Canlas, MD; Brian Allen, MD; Michael Pilla, MD; William Furman, MD; Brian Rothman, MD; and Koffi Kla, MD. Second row, left to right, Jane Easdown, MD; Steve Hyman, MD; James Berry, MD; Edward Sherwood, MD; Matthias Riess, MD; Jonathan Wanderer, MD, MPhil; and John Corey, MD. Not pictured: James Blair, DO; Eswara Botta, MD; Clifford Bowens, MD; Jane Brock, MD; Susan Calderwood, MD; Tekuila Carter, MD; Meera Chandrashekar, MD; Jesse Ehrenfeld, MD, MPH; Raj Gupta, MD; Stephen Harvey, MD; Doug Hester, MD; Michael Higgins, MD; Scott Hoffman, MD; Kenneth Holroyd, MD; Lisa Jaeger, MD; Shannon Kilkelly, MD; Jason Lane, MD; Randall Malchow, MD; Letha Mathews, MD; Kelly McQueen, MD; Amy Robertson, MD; Warren Sandberg, MD; Paul St. Jacques, MD; Matthew Weinger, MD; and Robert Wells, MD.

Division of Neuroanesthesiology

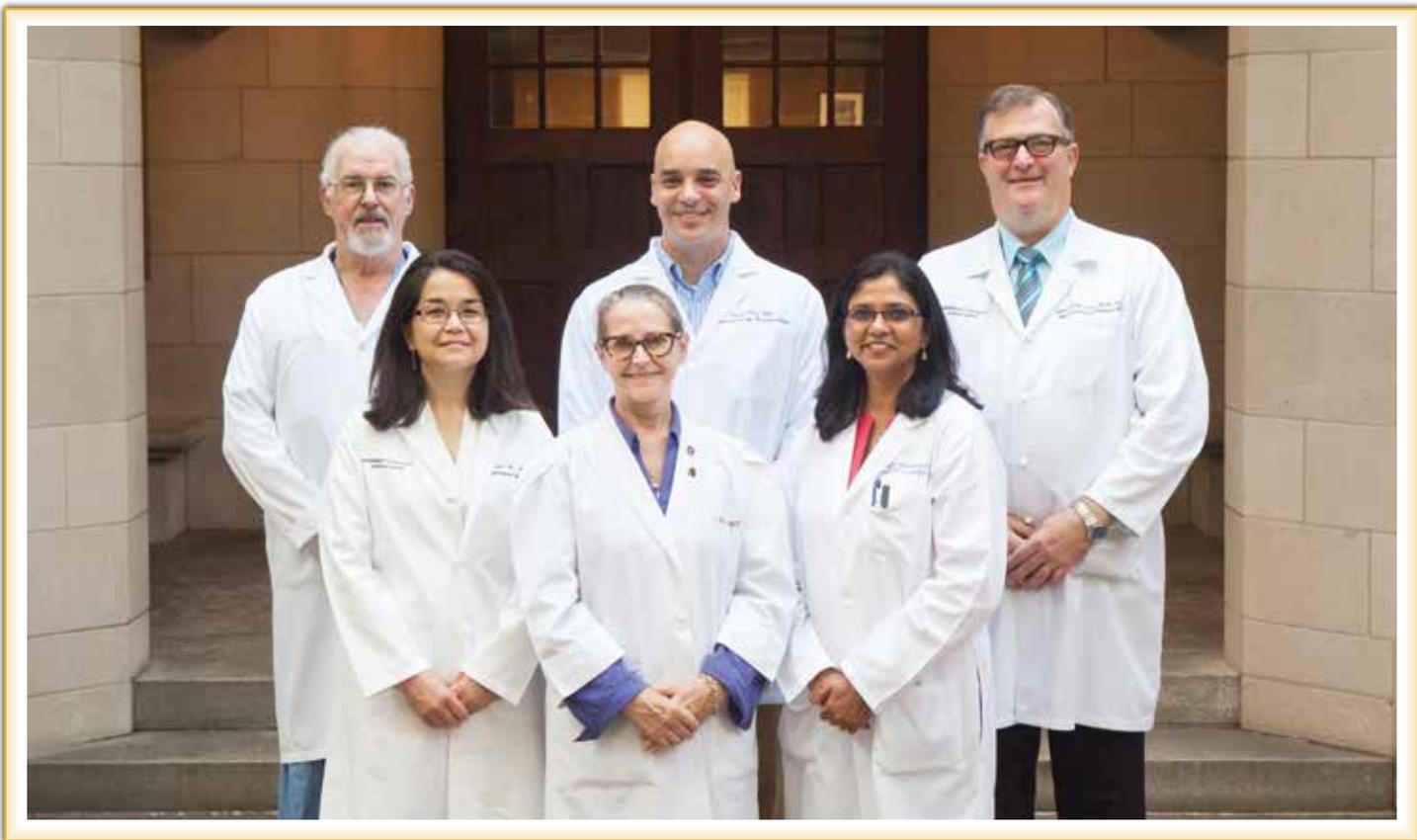
For the fourth year in a row, Vanderbilt's departments of Neurology and Neurological Surgery have ranked among the top of U.S. News & World Report's "America's Best Hospitals." Neurosurgery and other neurologic services continue to expand at Vanderbilt University Medical Center, and faculty specializing in neuroanesthesiology are providing increasingly complex anesthesia and sedation services.

The Clinical Neurosciences Institute, a collaborative group established at Vanderbilt in 2011 by the departments of Neurology, Neurological Surgery, and Psychiatry to provide comprehensive patient care, continues to attract increasing numbers of referrals for service. A second state-of-the-art neurointerventional radiology suite was opened in the operating room in 2014 because of the high demand for advanced services requiring angiographic visualization. The Vanderbilt Department of Neurological Surgery currently has the highest volume of deep brain stimulator implantation in North America. The Vanderbilt Brain Tumor Center provides comprehensive care for patients with brain tumors, and more than 400 major brain tumor operations are performed annually. Annual surgical volume is approximately 3,000 neurologic cases per year.

The Division of Neuroanesthesiology engages in research aimed at improving patient outcomes and cost-effectiveness, as well as expanding the clinical knowledge about certain diseases. Paramount to the success of our division is the collegial working relationship among operating room and intensive care unit team members. Our

experienced and dedicated neurosurgical, neuroanesthesiology, and neurointensivist faculty, certified registered nurse anesthetists, acute care nurse practitioners, and residents ensure that the quality and continuity of care for patients is outstanding, resulting in one of the shortest average lengths-of-stay in the country following brain tumor surgery.

Vanderbilt University Medical Center has seven designated neurosurgical operating rooms where anesthesia services are provided for operations, including brain tumor, blood vessel malformation, aneurysms, stroke intervention, trauma, complex spinal procedures, functional neurosurgery, and chronic pain management. The Division of Neuroanesthesiology, which was formed in 2013, also provides specialized anesthesia services for "awake craniotomies," where patients are intermittently awake to facilitate speech and motor mapping during surgery to preserve the most vital areas of the brain. Anesthesia is also provided by the division in neurointerventional radiology suites and at Monroe Carell Jr. Children's Hospital at Vanderbilt. Like their surgical colleagues, neuroanesthesiologists face many unique challenges, including the length of procedures, which may last more than 16 hours, unusual patient positioning, and unexpected intraoperative events such as seizures or intracranial hemorrhage. Residents on the neuroanesthesia rotation discover that the ability to make an immediate impact on an operation is both exciting and gratifying, as do the faculty leading the training.



Division of Neuroanesthesiology: Front row, left to right, Lorri, Lee, MD; Jane Easdown, MD; and Letha Mathews, MD. Back row, left to right, James Blair, DO; Koffi Kla, MD; and John Barwise, MD. Not pictured: Nathan Ashby, MD; Jesse Ehrenfeld, MD, MPH; Doug Hester, MD; Avinash Kumar, MD; Stuart McGrane, MD; Roy Neeley, MD; Joseph Schlesinger II, MD; and Sheena Weaver, MD.

Division of Obstetric Anesthesiology



Division of Obstetric Anesthesiology: Left to right, Ray Paschall, MD; Jill Boyle, MD; Maryann Otto, MD; Donna Ray Anthony; John Downing, MD ChB; David Chestnut, MD (in rear); Curtis Baysinger, MD; and Michael Richardson, MD. Not Pictured: Tekuila Carter, MD; Mary DiMiceli, MD; Benjamin Johnson, MD; and Mary Jennette, MD.

The Division of Obstetric Anesthesiology provides dedicated, 24-hour, in-house obstetric care for approximately 4,500 deliveries at Vanderbilt University Medical Center annually, over half of which are considered high risk. The division also provides anesthesia services for approximately 2,500 gynecologic and other surgical procedures in a suite of three operating rooms. In addition to offering the full complement of techniques for labor analgesia, the division provides consultation and critical care management services for high-risk obstetric patients, as well as specialized anesthesia care for fetal surgery.

The resumption of in utero repair of myelomeningocele, a procedure pioneered at Vanderbilt University Medical Center in 1997, has brought an added dimension of specialized clinical service to the Division of Obstetric Anesthesiology. The results of a seven-year National Institutes of Health-funded trial, Management of Myelomeningocele Study (MOMS), demonstrated a clear benefit for babies who undergo fetal surgery to treat spina bifida. These surgeries began again at VUMC in April 2011.

The MOMS trial found that fetal surgery significantly improved the child's chances of being able to walk. There was no increased risk of death for the baby or the mother when the fetal surgery group was compared with a group that received surgery after birth. With patients being referred from across the nation, approximately 15 of these procedures are performed annually at VUMC, with obstetric anesthesiologist Ray Paschall, MD, taking the lead in providing anesthetic care for these complex cases.

Trainees in the Division of Obstetric Anesthesiology, including both residents (four each month) and fellows, receive extensive experience in the care of clinically challenging patients. In 2012, the Division of Obstetric Anesthesiology received Accreditation Council for Graduate Medical Education (ACGME) accreditation of its fellowship program. The division was among the first 11 programs in the country to receive approval from the ACGME Residency Review Committee. The program received the full, three-year accreditation, and two fellows have completed their training since accreditation was received.

The division is taking a leadership role in the use of in situ simulation training for obstetric emergencies. Planned clinical research projects include: 1) an assessment of the effect of intrathecal clonidine on maternal outcomes after cesarean delivery, 2) an assessment of the accuracy of noninvasive blood pressure measurements in morbidly obese preeclamptic women, 3) measurement of maternal local anesthetic concentrations following extension of preexisting epidural analgesia for emergency cesarean delivery, and 4) development and assessment of a standardized obstetric life support curriculum and cognitive aids in the multi-disciplinary management of obstetric emergencies. Ongoing laboratory research includes an assessment of the effects of obstetric and anesthetic drugs and PDE5 (phosphodiesterase type 5) inhibitors on both the maternal and fetal placental vasculature using a dual-perfusion technique of isolated placental tissue subunits. Research examining the maternal-fetal transplacental transfer of drugs is also planned, as well as work to understand the ion channel expression within in the placental vasculature.

The Division of Obstetric Anesthesiology is directed by David H. Chestnut, MD, who came to Vanderbilt from Gundersen Health System and the University of Wisconsin School of Medicine and Public Health in April 2014. Dr. Chestnut, an internationally renowned leader in obstetric anesthesiology, is the senior editor of Chestnut's *Obstetric Anesthesia: Principles and Practice*. The fifth edition of this textbook was published in April 2014. He has a longstanding reputation in innovative research, an impressive list of academic accomplishments, and a strong record of national leadership.

The Division of Obstetric Anesthesiology includes six other faculty members, three CRNAs whose primary focus is obstetric anesthesia, and one administrative assistant. The division's faculty members have all completed obstetric anesthesia fellowship training and have extensive experience in obstetric anesthesia care, neuraxial anesthesia, and acute pain management.

Division of Pain Medicine

Chronic pain affects an estimated 100 million people in the United States – more than diabetes, heart disease, and cancer combined – according to the Institute of Medicine of the National Academies. In particular, persistent chronic pain states for some post-surgical patients and for those patients with certain cancers are a growing challenge for anesthesiologists. Because pain is complex and often involves physiological, psychological, emotional, and environmental factors, clinicians at Vanderbilt University Medical Center’s Interventional Pain Center utilize a multidisciplinary approach to pain care, offering thorough evaluations, consultations, and referrals in order to employ the most advantageous treatment modalities.

“The Center is for all patients who have pain, regardless of cause and what has or hasn’t been done previously,” said Marc Huntoon, MD, chief of the Division of Pain Medicine and director of the Vanderbilt Pain Management Center. “It is the first stop for pain patients at Vanderbilt.”

The Interventional Pain Center sees patients with all types of pain, including back, neck, abdominal, pelvic, nerve and joint pain, and chronic headache. During the first clinic visit, a patient’s medical history is thoroughly reviewed, and his or her

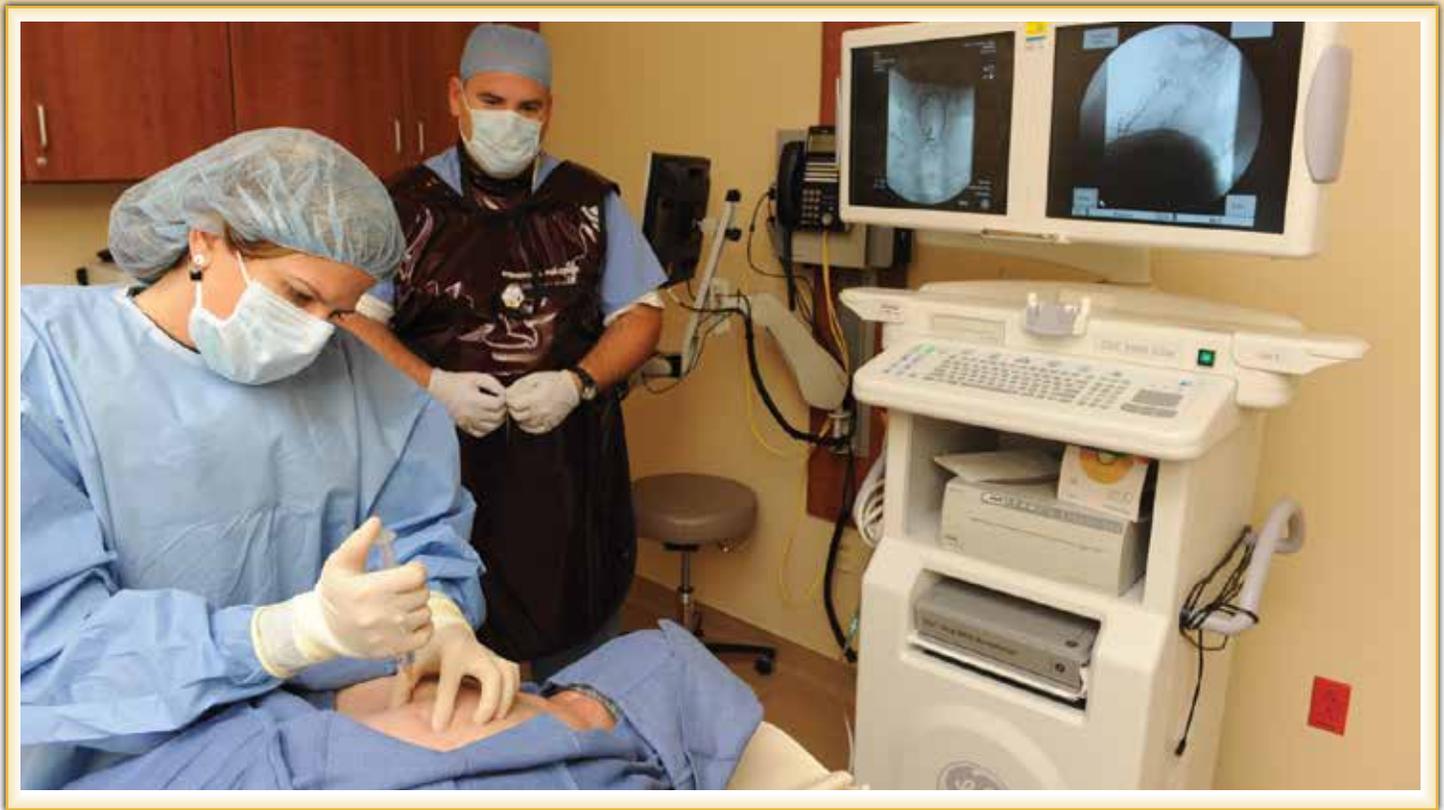
condition is evaluated by Vanderbilt pain specialists to develop a team-based treatment plan. This team could include specialists from anesthesiology, psychology, psychiatry, neurology, neurosurgery, orthopedics, or rehabilitation. Interventional Pain Center physicians also work closely with a patient’s primary care providers to close the loop effectively and foster shared responsibility of patient health.

“Providers at the primary care level often haven’t had the right resources for pain care,” Dr. Huntoon said. “At the Interventional Pain Center, we build relationships with primary care providers, get patients the care they need, and work on an ongoing basis with the providers. We see it as a very collaborative and supportive relationship. In the future, with new state laws for opioid prescribing, these relationships must get stronger.”

The Interventional Pain Center is housed at Vanderbilt Health One Hundred Oaks, just off Interstate 65 in Nashville, Tennessee. The Interventional Pain Center’s space includes state-of-the-art procedure rooms, exam rooms, recovery bays, and multidisciplinary rooms. In 2011, a branch of the Interventional Pain Center opened in the Cool Springs area of Williamson County, under the direction of Vanderbilt Pain Medicine faculty



Division of Pain Medicine: Front row, left to right, Irina Phillips, MD; Meenal Patil, MD; Heather Jackson, APRN-BC; Tracy Jackson, MD, and Becca Ognibene, PT. Second row, left to right, Dan Lonergan, MD; Kurt Dittrich, MD; Marc Huntoon, MD; Chris Sobey, MD; and Amy Turner, RN. Not pictured: Robyn Packer, MSN, RN; Linda Pearson, MD; Brandon Sutton, MD; and Jenna Walters, MD.



Tracy Jackson, MD, performs a fluoroscopically-guided block for a patient at the Vanderbilt Interventional Pain Center.

member Dan Lonergan, MD. Services are provided at the Cool Springs Surgery Center on Mallory Lane in Franklin. Future expansion clinics are anticipated.

Monroe Carell Jr. Children's Hospital at Vanderbilt is the site of a unique pediatric pain clinic, where Vanderbilt providers work with patients, their families, and their physicians to provide the best pain management for the pediatric patient's specific needs. The clinic sees two to three new patients every week, and additional patients who live at a distance are monitored by telephone. The Neonatal Intensive Care Unit at the Children's Hospital also has its own specialized pain management program, and there is a regional anesthesia program to treat young patients as well.

The Comprehensive Pain Service (CPS) at VUMC also continues to grow as patients are benefitting in increasing numbers from epidural catheters, peripheral nerve blocks, and peripheral nerve catheters for pain management for complex shoulder and arm surgery, lower extremity surgeries, and repeated burn debridements. The CPS began in August 2012 as a new vision for in-hospital pain care that builds on the overall mission of the pain program. The CPS has its sights set on patient throughput initiatives and improved care pathways for the future. The new service continues to build its capacity and capability to see patients referred from any medical and surgical service who have pain syndromes requiring the expertise of Division of Pain Medicine faculty. The belief is that patients admitted to Vanderbilt University Hospital should have access to expert pain

care, regardless of the reason for admission. The Department of Anesthesiology's interventional pain implantable device practice also continues to grow, and the CPS also manages patients who are admitted for either device trials or permanent implants. Providing targeted pain control for both chronic and acute pain at the area of injury has produced better pain control, improved patient satisfaction, and the ability to reduce patients' time in the hospital.

Expanding pain medicine education at Vanderbilt, from the medical student level up, is a goal of Dr. Huntoon and the division. The Regional Anesthesia and Acute Pain Fellowship has already proven successful under the leadership of Lisa Jaeger, MD, with two fellows in 2014-2015 learning advanced regional anesthesia and acute pain, developing into educators for residents, and growing to be scholars by developing research studies for publication. In addition, the division's chronic pain fellowship grew to include three fellows in 2012-2013. Both the acute and chronic pain fellowships are integral parts of the educational continuum. Dr. Huntoon hopes to incorporate pain medicine topics into the medical student curriculum and to improve both resident and fellow initiatives in the specialty, making use of Vanderbilt's advanced simulation technology, as well as the anatomy lab setting.

Division of Pediatric Anesthesiology

When a \$30 million, 33-bed expansion at the Monroe Carell Jr. Children's Hospital at Vanderbilt opened in 2012, the Division of Pediatric Anesthesiology was well ahead of the curve, proactively implementing ways to deliver top-quality clinical services more efficiently, while also keeping young patients and their families happy. The division now provides perioperative care for more than 13,000 patients annually at the Children's Hospital, the region's major pediatric referral center. The division's 21 attending physicians, 22 certified registered nurse anesthetists (CRNAs), and four fellows provide services for a variety of pediatric surgical procedures, including general surgery, ENT, neurosurgery, urology, and orthopedics.

In September 2013, Suanne Daves, MD, chief of the Pediatric Cardiac Division, was named vice-chair for Pediatric Anesthesiology, a key leadership role for both the Department of Anesthesiology and the Children's Hospital. In 2013, the Division of Pediatric Anesthesiology joined efforts with the Children's Hospital sedation service to provide a streamlined, consistent sedation/anesthesia service to pediatric patients. Peter Chin, MBBS, was selected to spearhead this initiative, and he is now the medical director of Sedation Services at the Children's Hospital. The new care model provides patients and their care providers many choices for care to best ensure a comfortable and safe patient experience. For example, improved options for quality sedation services include offering inpatient sedated echocardiograms at a child's bedside while the family is present and providing sedation/anesthesia care for sedated echocardiograms for children during their preoperative visit to the cardiology clinic.

The Pediatric Pain Service continues to grow and impact a growing number of children with acute or chronic pain. New members to the service in 2014 include Jenna Sobey, MD, and Carrie Menser, MD. Drew Franklin, MD, was named medical director of the Pediatric Pain Service in 2014. Stephen Hays, MD, and Dr. Franklin both have dedicated clinical time to see patients in the pediatric pain clinic, and the number of patients seen at the clinic is growing, as both internal and external referrals continue to increase. The acute pain service also provides an increasing number of inpatient consultations and works closely with the many surgical services at the Children's Hospital to provide a full spectrum of perioperative pain management strategies.

Jill Kilkelly, MD, an assistant professor in the division, spearheads a unique service at Children's Hospital known as Complex Coordination of Care (CCoC). Many children require frequent sedation or anesthesia for procedures or diagnostic testing. Frequent anesthetics create a tremendous burden for these patients and their families in terms of time away from school and work, as well as restrictions on eating and drinking before procedures. The goal of the CCoC is to provide a single, continuous anesthetic for multiple procedures or scans. While this sounds simple, scheduling multiple surgical and interventional services, often in different locations, is challenging. Jill Kinch, MSN, is the manager for the nurse practitioners who work with the Division of Pediatric Anesthesiology in preoperatively preparing patients for anesthesia or sedation. Jill and her team work with Dr. Kilkelly in the scheduling and coordination of various care teams, as well as helping families navigate the process.

Education and training of medical students, anesthesia residents, nurses, and associated healthcare personnel is a major faculty commitment. Several anesthesiology residents rotate on pediatric anesthesiology services each month and gain experience in the

management of patients undergoing both routine and complex surgical procedures, as well as diagnostic and interventional procedures performed outside the operating room. The Division of Pediatric Anesthesiology fellowship program offers a year of subspecialty training in pediatric anesthesia and perioperative care, including critical care and pain management.

Areas of academic interest for the division's faculty include safe transfusion practices, multidisciplinary approaches to decreasing surgical-site infections, situational awareness during hand-overs in care, difficult airway management, pediatric pain management, regional anesthesia, extracorporeal membrane oxygenation (ECMO), and perioperative care of cardiovascular patients.

The Division of Pediatric Anesthesiology is an active member of Wake Up Safe, a quality improvement initiative of the Society for Pediatric Anesthesia. Wake Up Safe is a Patient Safety Organization (PSO), as defined by The Patient Safety and Quality Improvement Act of 2005, and its participants are leading children's hospitals throughout the country. Through voluntary reporting from its member institutions, Wake Up Safe has developed the first-ever national registry of adverse perioperative events in pediatric patients. Its goal is to help define quality in pediatric anesthesia and develop quality improvement systems in an effort to help improve anesthetic care for children of all ages.

The division is also an active partner with the quality improvement office of the Children's Hospital and participates in Solutions for Patient Safety, a national network of more than 80 children's hospitals in 34 states that partners with Child Health Patient Safety Organization (PSO), the nation's only PSO dedicated to the safety of hospitalized pediatric patients.



Division of Pediatric Anesthesiology: Front row, left to right, Jill Kilkelly, MD; Eric Stickles, MD; Thanh Nguyen, MD; and Vikram Patel, MD. Second row, left to right, Amanda Lorinc, MD; Elisabeth Hughes, MD; Jenna Helmer-Sobey, MD; and Stephen Hays, MD. Third row, left to right, Peter Chin, MBBS; Laura Zeigler, MD; and Camila Lyon, MD. Top row, left to right, Humphrey Lam, MD; and Kevin Saunders, MD. Not pictured: Thomas Austin, MD; Brian Emerson, MD; Andrew Franklin, MD; Carrie Menser, MD; Mark Newton, MD; Dan Roke, MD; and Thomas Romanelli, MD.

Division of Pediatric Cardiac Anesthesiology

As demand for pediatric cardiac anesthesia services at Monroe Carell Jr. Children's Hospital at Vanderbilt continues to grow, the anesthesiologists providing those services are committed to ensuring that the quality and safety of patient care is continually improved as more patients are served. Seven anesthesiologists and five certified registered nurse anesthetists (CRNAs) provide care to cardiac patients in the operating rooms, cardiac catheterization and electrophysiology laboratories, the cardiac critical care unit, and at off-site radiology and procedural areas.

Children with heart defects represent a complex group of patients who often require intensive surgical repairs to thrive or even survive into adulthood. The Division of Pediatric Cardiac Anesthesiology was formed in 2007 to support the growth of the program that cares for these patients at the Children's Hospital. The Pediatric Heart Institute at the Children's Hospital is a high-volume regional referral center and is ranked 17th in US News and World Report's list of top hospitals in the care of pediatric patients with congenital heart disease. With more than 1,000 surgical or catheter-based interventions annually, the division recruited two additional faculty members in 2013. Heidi Smith, MD, a critical care physician at Monroe Carell Jr. Children's Hospital at Vanderbilt, joined the team after completing an anesthesia residency and a fellowship in pediatric anesthesiology at Vanderbilt. Claudia Benkwitz, MD, PhD, was recruited from Stanford University where she completed her pediatric anesthesia fellowship and was on faculty. Three of the seven anesthesiologists are dual-trained in critical care.

In 2012-13, the division's efforts examining transfusion practices reduced the number of transfusions by anesthesiologists in pediatric cardiac operating rooms by an average of 40 percent. And their success did not go unnoticed. The Pediatric Cardiac Anesthesiology Division was selected to be in the inaugural Vanderbilt Quality and Patient Safety Pioneer Program. Selection

was based on proposed improvement goals, evidence of past improvement efforts, and leader participation. Through the Quality and Patient Safety Pioneer Program, the division's members received training, as well as support, to design, implement, and test additional performance improvements. Two new areas of focus for the division's quality improvement efforts are decreasing the incidence of early surgical re-intervention in the cardiac surgical patient and identifying effective strategies in the prevention of catheter-related venous thrombosis in the pediatric cardiac population.

Training pediatric anesthesiology fellows in the care of the critically ill child undergoing cardiac surgery or catheterization is a core mission of the division. Fellows spend two months on the cardiac service, and many elect to spend part of their training in the cardiac critical care unit.

"Understanding the physiologic complexity of these patients is vital to delivering the right care when pediatric anesthesiologists enter their practice," said Vice-Chair for Pediatric Anesthesiology and Chief of the Pediatric Cardiac Division Suanne Daves. "Many patients may be at an institution where pediatric cardiac specialists do not exist, and knowing who requires transfer to a regional center with these services is critical to safe care of these patients."

The division's academic interests include postoperative delirium, cerebral and somatic oximetry validation, critical event analysis, training aids in management of perioperative cardiac arrest, management strategies for the perioperative care of the cardiac patient undergoing non-cardiac surgery, and the anesthetic impact on morbidity and mortality.



*Division of Pediatric Cardiac Anesthesiology:
Front row, left to right,
Scott Watkins, MD; Claudia Benkwitz, MD; and Heidi Smith, MD, MSCI.
Back row, left to right,
Brian Donahue, MD, PhD; Alex Hughes, MD; and Suanne Daves, MD.*

Vanderbilt Preoperative Evaluation Center



Staff members of the VPEC location at Vanderbilt University Hospital with their 5-Star Award for Overall Quality of Care. Front row, left to right, Debbie Smith, APRN-BC; Rebecca Robinson ANP-BC; Melissa Smith DNP, ANP-BC; and Ruth Johnson, LPN. Back row, left to right, Austin Kirkham; Laura Hollis MSN, RN, CCRN; Joan King PhD, ACNP; Melissa Archibald; and DC Washington.

The Vanderbilt Preoperative Evaluation Center (VPEC) continues to earn praise from the patients that come through its doors for preoperative evaluation prior to undergoing procedures at Vanderbilt University Medical Center. In 2014 – for the sixth year in a row – the Vanderbilt University Hospital location of VPEC received a Professional Research Consultants, Inc. patient satisfaction award, the coveted 5-Star Award for Overall Quality of Care. The One Hundred Oaks location, which opened in 2009, has received the same award for three years in a row. This indicates that the center scored in the 90th – 99th percentiles based on 2013 calendar year results, compared with similar centers nationwide.

“The goal of VPEC faculty and staff is to thoroughly evaluate patients prior to their surgical procedure,” said VPEC Clinic Manager Laura Hollis, MSN, RN. “Nurse practitioners and registered nurses perform comprehensive patient assessments to identify gaps in patient care that could lead to surgical cancellations. Working with our patients’ primary care physicians, specialists, and surgeons, we use protocols and algorithms to order necessary testing, ensuring quality and safe patient outcomes. All information obtained from outside facilities and within the preoperative assessment is added to the patient’s electronic medical record. This makes our work easily accessible to all members of the healthcare team.”

Preoperative evaluation is an important piece of healthcare and the patient experience. These evaluations have changed as healthcare evolves. A shift in communication options has allowed the addition of new and innovative ways of reaching preoperative patients. Over the past year, VPEC staff have seen almost 19,000 patients between both locations. In addition to these contacts, VPEC has expanded to reach patients through phone interviews conducted by registered nurses. VPEC administrators continue to evaluate telemedicine and other virtual processes that could further enhance the evaluation process.

VPEC’s primary location is now at the Vanderbilt Health at One Hundred Oaks campus, which has seven exam rooms and is conveniently just down the hall from outpatient lab and radiology services. VPEC’s second location is on the main campus of Vanderbilt University Hospital within The Vanderbilt Clinic. This location has four exam rooms and is also located adjacent to outpatient lab and radiology on the first floor of The Vanderbilt Clinic. VPEC includes 23 staff members, including nine nurse practitioners. Jonathan P. Wanderer, MD, MPhil, serves as VPEC’s medical director, and Michael Pilla, MD, serves as the center’s associate medical director.

Veterans Affairs Anesthesiology Service

The Veterans Affairs Anesthesiology Service provides perioperative patient care services for more than 10,000 procedures annually at the Veterans Administration Medical Center in Nashville and the medical center at the Alvin C. York campus in Murfreesboro, Tennessee. These two facilities make up the core of the Tennessee Valley Healthcare System (TVHS), which also includes 11 community-based health clinics.

The anesthesiology service provides anesthesia care for the full range of surgical procedures, including cardiac and thoracic surgery; orthopedic procedures including joint replacements; as well as major vascular, neurosurgical, ENT, ophthalmic, urologic, plastic, bone marrow, and transplant surgeries. In addition, sedation services are provided in several out-of-OR sites, including electro-convulsive therapy, diagnostic and therapeutic radiology procedures, pulmonary procedures, cardiac catheterization, electrophysiologic studies, cardioversion, and transesophageal echocardiography and gastroenterology services. Areas of particular clinical interest in the division include airway management and ultrasound-guided regional anesthesia liver transplantation. The group also supports an active Pre-Anesthesia Evaluation Clinic, with an annual workload of more than 3,000 visits. The service also provides primary coverage for the VA Surgical Intensive Care Unit, acute and chronic pain management, and emergency airway management.

“Even though 80 percent of our surgical patients are classified as ASA3 and 4, our morbidity and mortality rate is lower than the national average,” said Veterans Affairs Anesthesiology Service Chief Ann Walia, MBBS. “We have 85 percent on-time first-case

starts, and a day-of-surgery case cancellation rate of less than one percent. For the past five years, we have achieved 100 percent compliance with all national performance measures. We have a great team here, and they work hard to provide excellent care to our veterans.”

In addition to patient care, education is a prime mission of the VA Anesthesiology Service. In addition to training senior anesthesiology residents and fellows, the service also educates critical care and emergency room physicians and other allied personnel in airway management skills outside the operating room. This excellence in teaching is demonstrated by the fact that each year since 2009 a VA faculty member has received either a Golden Apple Award (given by Anesthesiology Department residents for superior teaching) or the Volker Striepe award (given by residents for superior teaching and mentorship).

The TVHS Anesthesiology Service was one of the first in the nation to implement e-Consults for preoperative anesthesia evaluations. This initiative saves the patient’s travel cost incurred by the VA, as well as decreases unnecessary testing. This has increased both patient and provider satisfaction. The TVHS has also been selected as a beta test site for the National Surgical Quality and Workflow Management initiative.

The division, led by Dr. Walia, is staffed by 21 anesthesiologists, 15 certified registered nurse anesthetists, eight nurse practitioners, three residents, a critical care anesthesiology fellow, four health technicians, and four administrative staff members.



Veterans Affairs Anesthesiology Service: Front row, left to right, Kevin Preece, MD; Pratik Pandharipande, MD; Ricky Sierra-Anderson, MD; Ann Walia, MD; Vidya Rao, MD; Tracy McGrane, MD; and Kelly Ortega, MD. Back row, left to right, Michael Chester, MD; Erin Brockway, MD; Amr Waly, MD; Ram Pai, MD; Andrea Feilner, MD; John Foster, MD; John Barwise, MD; and Jeffrey Waldman, MD.

Research Overview

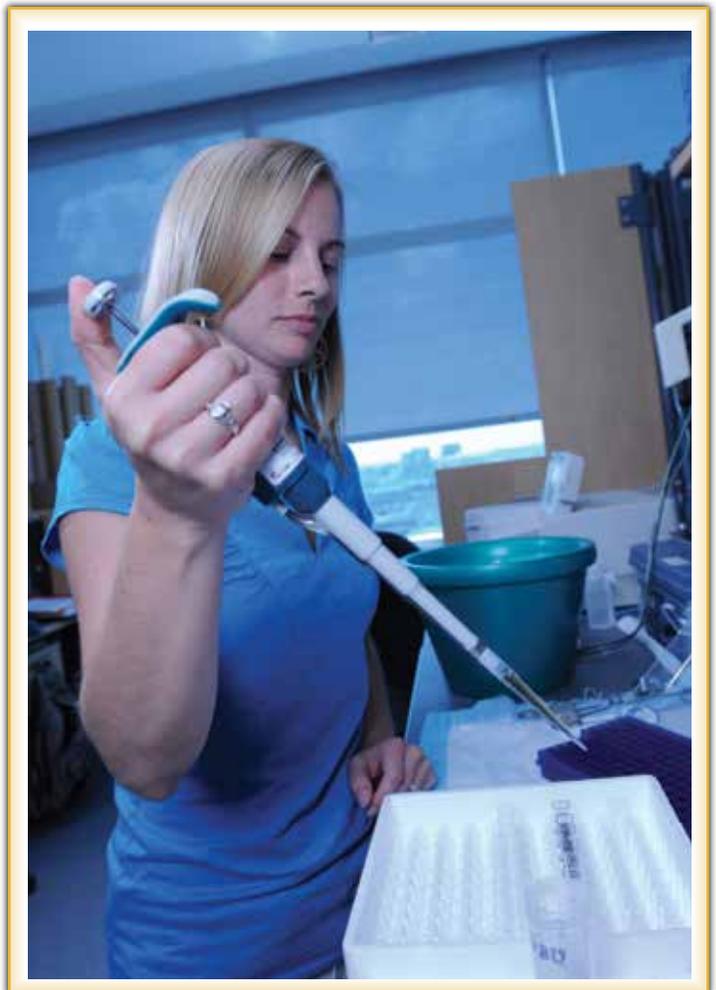
Major translational research initiatives at Vanderbilt University are moving discoveries from the bench to the bedside, and our scientists are working to transform both health care and health care delivery. In federal fiscal year 2013, the Vanderbilt University School of Medicine (VUSM) ranked 9th among U.S. medical schools for National Institutes of Health (NIH) funding, and VUSM funding from all sources has more than doubled since 2001. In academic year 2013, faculty across all disciplines received more than \$521 million in external funding for research. The Vanderbilt Department of Anesthesiology is a key contributor to the institution's standing, as it is consistently ranked one of the top extramurally funded anesthesia research programs in the nation. In 2013, the department's investigators brought in more than \$6.9 million in total extramural research funding. This includes more than \$3.9 million in awarded NIH grants in federal fiscal year 2013, which placed Vanderbilt Anesthesiology 8th among U.S. academic anesthesiology departments in NIH funding.

Edward Sherwood, MD, PhD, joined Vanderbilt's Department of Anesthesiology faculty in July 2012 as vice-chair for Research, and he oversees all of the department's investigational endeavors. A distinguished translational physician-scientist, Dr. Sherwood previously served as vice-chair for Research and Professor/James F. Arens Endowed Chair of the Department of Anesthesiology, as well as Director of the MD-PhD Combined Degree Program at the University of Texas Medical Branch in Galveston, Texas.

The vision of the Research Division is to improve upon the department's currently successful program by fostering excellence, collaboration, and the development of young investigators. The Vanderbilt Department of Anesthesiology has a strong, multifaceted approach to research, including:

- A strong Basic Science Research Division, under the leadership of Eric Delpire, PhD, focusing on ion channel physiology and pain mechanisms.
- Excellent clinical and translational research programs in the areas of ICU delirium, sepsis, pharmacogenomics, oxidative injury, and preconditioning.
- The Perioperative Clinical Research Institute (PCRI), which provides all support services needed for successful clinical research. Numerous investigator-initiated and industry-sponsored clinical studies are conducted with the support of PCRI.
- Best-in-class anesthesia and perioperative information systems, with complete control of application development and a dedicated team of analysts devoted to making electronic data widely available to investigators and quality improvement teams. These systems are managed by Perioperative Informatics, an institutional entity directed by Brian Rothman, MD.
- The Vanderbilt Anesthesiology & Perioperative Informatics Research (VAPIR) Division, which actively leverages historical and current clinical data, with the goal of generating research and new control algorithms to positively impact patient safety. The VAPIR Division is under the leadership of Jesse Ehrenfeld, MD, and Jonathon Wanderer, MD, MPhil.
- Strong support from statisticians within our faculty, with expertise in experimental design and complex analyses of large datasets.

- The Center for Research and Innovation in Systems Safety (CRISS), which serves as an institution-wide resource for basic and applied research in healthcare informatics, patient safety, and clinical quality. This group also designs and evaluates informatics user interfaces, care processes, and medical technology.
- BH Robbins Scholar Program that supports the academic development of promising physician-scientists. This program provides a mentored research experience that begins during residency and culminates in a two-year clinical/research fellowship. Scholars may request to participate in clinical or basic science fellowship training or pursue additional formal education (e.g., Master of Science in Clinical Investigation, Master of Public Health, and Master of Science in Statistics) offered at Vanderbilt during the latter part of the program.
- NIH T32-supported Training in Perioperative Sciences. This program provides young physician-scientists with a two-year research fellowship focused on basic, translational, and clinical aspects of perioperative medicine. Two fellows are recruited annually, and the program is open to applicants that have completed residency training and that have an interest in perioperative science.



Research Assistant Kerri Rios works in the lab of Eric Delpire, PhD, where the group identifies inhibitors of a transporter, KCC2.



Research Division Members: Front row, left to right, Naeem Patil, PhD; Daniel Kashima; Tom Austin, MD; Eric Delpire, PhD; Kevin Currie, PhD; and Jinlong Ding. Second row, left to right, Ben Fensterheim; Sujay Kharade, PhD; Lianyi Chen; Jingbin Wang; Julia Bohannon, PhD; Yin Guo; Kerri Rios; Carrie Greuter, PhD; and Christine Goldsberry. Third row, left to right, Rebecca Brindley, PhD; Mary Beth Bauer, PhD; Raymond Johnson; Qunli Cheng; Matthias Riess, MD, PhD; Brad Greuter, PhD; Edward Sherwood, MD, PhD; Jerod Denton, PhD; and Ghali Abdelmessih. Back row, left to right, Melissa Chont, Kristie Lee, Stephen Bruehl, PhD; Max Joffe; and Brandon Turner. Not pictured: Liming Luan, Michele Salzman and Daniel Swale.

In addition to providing a solid research infrastructure, the Department of Anesthesiology places a strong emphasis on faculty and fellow career development in academic anesthesiology. Active mentoring programs pair young and mid-level investigators with experienced scientists in both basic and clinical research. Our research productivity, as determined by publication in peer-reviewed journals, has more than doubled since 2010. In academic year 2014, faculty members published 149 papers in the peer-reviewed literature. Many of the papers were published in high impact, multi-disciplinary journals such as *New England Journal of Medicine*, *Lancet*, *Physiological Reviews*, and *American Journal of Respiratory and Critical Care Medicine*. Our faculty members regularly publish in *Pain*, *Anesthesiology*, and *Anesthesia & Analgesia*. Several faculty members are members of the FAER (Foundation for Anesthesia Education and Research) Academy of Research Mentors in Anesthesiology.

Read more about the Vanderbilt Department of Anesthesiology's specific research strengths on the department's web site under the Research heading: www.vandydreamteam.com.



Senior Research Specialist Qunli Cheng works in the lab of Matthias Riess, MD, PhD, as the group investigates ways to improve neurological outcomes after cardiac arrest.

Labs Focus on Translational Science

The major focus of the Basic Science Research Division is the study of the physiology, pharmacology, and cell biology of ion channels, transporters, and receptors. These membrane proteins are involved in functions as diverse as shaping the cardiac action potential, salt and water homeostasis in the kidney, hormone and neurotransmitter release, modulation of synaptic transmission, and the gating/processing of pain signals. Because the disruption of each of these physiological processes has a significant impact on human health, research in the Basic Science Research Division addresses the translational missions of the National Institutes of Health and of private biomedical research-oriented foundations. Currently, there are two major themes that cut across multiple laboratories: drug discovery and the study of pain mechanisms. Three laboratories within the Research Division are actively pursuing drug discovery for clinically relevant ion channel and transporter targets. This work is sponsored by the National Institutes of Health Molecular Libraries Probe Center Network.

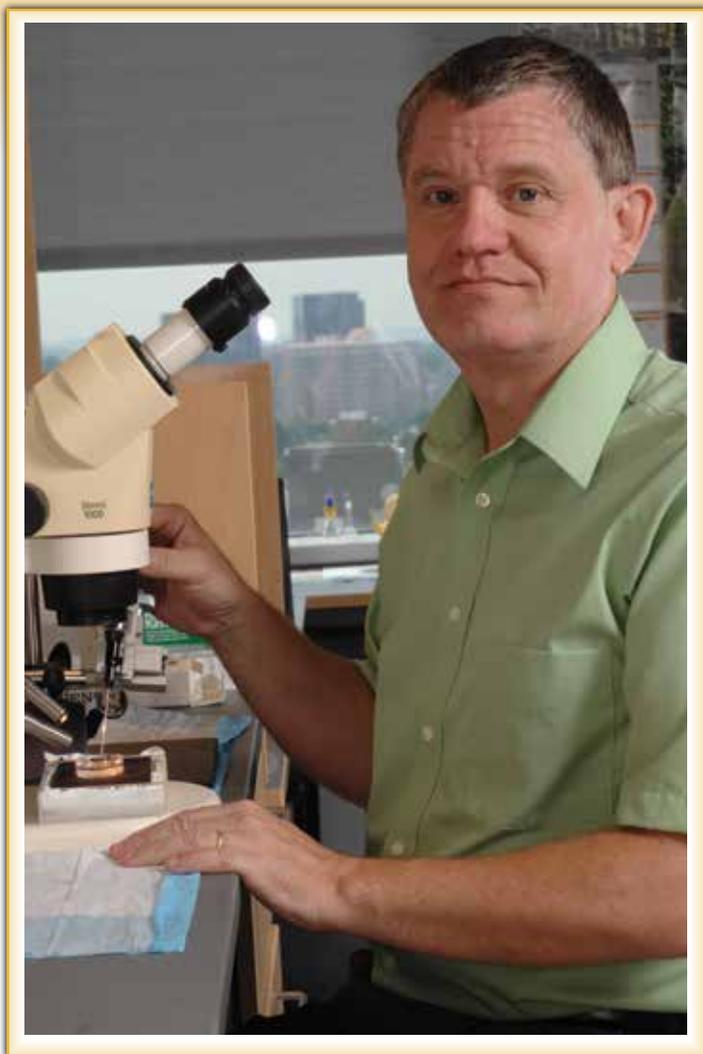
Work in the laboratory of Jerod Denton, PhD, is aimed at understanding the integrative physiology and therapeutic potential of inward rectifier potassium (Kir) channels. Dr. Denton's group employs high-throughput screening, medicinal chemistry, ion channel electrophysiology, and molecular modeling to develop small-molecule Kir channel probes used to interrogate Kir channel structure, function, and physiology. The Denton lab developed the first small-molecule probes of the renal outer medullary potassium channel, ROMK (Kir1.1) (Lewis et al., *Mol Pharmacol*, 76: 1094-1103, 2009; Bhave et al., *Mol*

Pharmacol, 79: 42-50, 2011), an emerging diuretic target for hypertension (Denton et al., *Am J Physiol Renal Physiol*, 305: F931-F942, 2013). They are also developing pharmacological probes of the astroglial Kir channel, Kir4.1, which may represent a novel target for hypertension and epilepsy. Dr. Denton's team was awarded a Grand Challenges in Global Health grant from the Foundation for the National Institutes of Health to develop chemicals to induce "kidney" failure in the mosquito *Anopheles gambiae* to help fight malaria. Other work in Dr. Denton's lab is funded by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) and the National Institute of Neurological Disorders and Stroke (NINDS).

Eric Delpire, PhD, studies the regulation of intracellular Cl^- in central and sensory neurons, and the regulation of renal salt transport mechanisms. The lab devised a screen to identify potent and specific inhibitors of a transporter, KCC2, involved in modulating inhibitory neurotransmission. By pumping Cl^- ions out of neurons, this K-Cl cotransporter maintains a low intracellular Cl^- concentration, strengthening inhibitory GABA- and glycine-mediated inhibition. This cotransporter is therefore involved in preventing hyper-excitability and the development of epileptiform activity. After developing a fluorescence-based methodology to visualize the activity of KCC2, Dr. Delpire's group screened a 250,000 compound library and identified multiple inhibitors and some putative activators of KCC2 (Delpire et al., *Proc Natl Acad Sci*, 106: 5383-5388, 2009). Synthesis and analysis of a number of chemical variants of the



Jerod Denton, PhD, at left, and Rene Raphemot work together to develop novel methods of mosquito control in order to combat malaria.



Eric Delpire, PhD, is a top NIH-funded investigator in the department, and his genetically modified knockout and knock-in mice have served as the basis for many high-impact journal articles.

most promising chemical scaffold yielded more potent inhibitors whose properties are being further analyzed (Delpire et al., *Bioorganic & Med Chem Lett*, 22: 4532-4535, 2012). The Delpire group also uses computational modeling to study protein-protein interaction and to design drugs that interact with the regulatory domains of protein kinases which regulate the ion transporters.

Another interest in the Basic Science Research Division is the study of pain and pain mechanisms. Leading the effort in translational work bridging the basic and clinical sciences is Stephen Bruehl, PhD, who studies endogenous pain modulatory systems, links between these systems and psychological factors, and mechanisms contributing to chronic pain and pain-associated cardiovascular co-morbidities. Work in his lab has identified pain-related alterations in interacting cardiovascular-pain modulatory systems that contribute to enhanced pain responsiveness (Bruehl et al., *Pain*, 149: 57-63, 2010) and may elevate future risk for both chronic pain (Walker et al., *Pain*, 150: 568-572, 2010) and hypertension (Chung et al., *Pain*, 138: 87-97, 2008). Work in Dr.

Bruehl's lab also explores how endogenous opioid pain inhibitory systems are intertwined with brain mechanisms underlying regulation of negative affect (Bruehl et al., *Psychosom Med*, 73(7): 612-619, 2011) and how these opioid systems are altered by persistent pain (Bruehl et al., *Pain*, 148: 167-171, 2010). His current National Institute on Drug Abuse-funded project examines predictors of responsiveness to opioid analgesic medications and the role of individual differences in endogenous opioid function in those predictive effects (Bruehl et al., *Pain*, 154: 1856-1864, 2013). Dr. Bruehl is also collaborating with Dr. Denton to identify variants in genes encoding G protein-coupled Kir (GIRK) channels that may influence opioid modulation of pain pathways, including responsiveness to opioid analgesic medications (Bruehl et al., *Pain*, 154: 2853-2859, 2013). Dr. Bruehl mentored former BH Robbins Scholar Carrie Menser, MD.

Kevin Currie, PhD, investigates the regulation of voltage-gated calcium channels and neurotransmitter/hormone release. Members of the CaV2 calcium channel family are expressed on presynaptic nerve terminals of primary afferent nociceptors and play key roles in pain transmission. The Currie lab investigates how neuromodulators, inflammatory mediators, and drugs alter channel function and transmitter release (Jewell et al., *Mol Pharmacol*, 79: 987-996, 2011; Zamponi & Currie, *Biochim Biophys Acta*, 1828: 1629-1643, 2013). This includes dissecting the cellular mechanisms by which gabapentin acts (Todd et al., *Anesthesiology*, 116: 1013-1024, 2012). Gabapentin is commonly used to treat chronic neuropathic pain but can also exert acute perioperative analgesic effects and blunt intraoperative hemodynamic perturbations. The sympatho-adrenal stress response, in particular release of adrenal catecholamines and neuropeptides, is another area of focus in the Currie lab. Current projects investigate how G protein coupled receptors (including opioid receptors) and the serotonin transporter, an important target for antidepressants, orchestrate precise control of catecholamine secretion. The Currie lab, in collaboration with Dr. Franz Baudenbacher in the Department of Biomedical Engineering, is also developing novel microfluidic devices for "lab-on-a-chip" analyses of neurosecretion (Ges et al., *Biosensors & Bioelectronics*, 34: 30-36, 2012).

Eric Delpire, PhD, is also involved in pain research, including the examination of the role of ion co-transport mechanisms in the modulation of GABA and glycine neurotransmission in the terminals of primary afferent fibers and in spinal cord neurons. The presynaptic terminals of primary afferent fibers are loaded with Cl⁻ anions through a secondary active transport mechanism (NKCC1) that pumps Cl⁻ into the cell against its electrochemical gradient equilibrium potential. High Cl⁻ allows depolarization of the terminals upon GABA release and presynaptic inhibition. On the postsynaptic side, a different transporter, KCC2, pumps Cl⁻ out of the cell, strengthening GABA and glycine inhibition. Tom Austin, MD, a former BH Robbins scholar in the Delpire laboratory, devised a method of implanting intrathecal catheters in mice for the delivery of novel compounds targeting the postsynaptic transporter. The study showed that inhibition of KCC2 shortened the response to heat-evoked nociceptive signals (Austin and Delpire, *Anesth Analg*, 113(6): 1509-1515, 2011). Dr. Austin is supported by a T32 training grant on Perioperative Sciences.



Stephen Bruehl, PhD, and Research Assistant Melissa Chont study endogenous pain modulatory systems and the links between these systems and psychological factors.

The husband-wife research team, Brad Grueter, PhD, and Carrie Grueter, PhD, joined the Department of Anesthesiology in October 2012, and the pair are doctoral graduates of the Department of Molecular Physiology and Biophysics at Vanderbilt University. The goal of their research program is to advance the current understanding of the nucleus accumbens (NAc), a brain region responsible for integrating information from diverse inputs and modifying complex motivated behaviors, including its involvement in adaptive responses to rewarding and aversive stimuli. Specifically, the lab strives to elucidate the molecular constituents in the NAc that are necessary and sufficient to drive complex motivated behaviors. As part of the mesolimbic dopamine system, the NAc integrates a complex mix of excitatory, inhibitory, and modulatory inputs to optimize adaptive motivated behaviors. Dynamic alterations in synaptic transmission within this circuitry are strongly implicated in the development and expression of many neuropsychiatric disorders. Thus, two broad questions addressed are: 1) How does in vivo experience such as cocaine exposure, pain, or a high-fat diet alter the neurocircuitry of the NAc? 2) What are the synaptic mechanisms underlying the behavioral adaptations to in vivo experience? The approaches the Grueter lab incorporates allow the researchers to thoroughly characterize the synaptic circuitry of the NAc in basal and pathophysiological conditions using a combination of cutting-edge techniques in electrophysiology, molecular biology, metabolic phenotyping, optogenetics, and behavior. These studies will provide information on how the NAc circuits integrate environmental stimuli and allow for specific behavioral responses. This enhanced understanding of NAc function may provide a basis for a more individualized approach to the treatment of many psychiatric disorders.

Edward Sherwood, MD, PhD, is studying several aspects of sepsis and the systemic inflammatory response syndrome. A major interest is to define mechanisms of sepsis-induced systemic inflammation and organ injury, with emphasis on the roles of natural killer (NK) and T lymphocytes. Current studies are being performed to evaluate the mechanisms of NK and T cell activation and chemotaxis during sepsis, with emphasis on the chemokine receptor CXCR3 and its ligands, CXCL9 and CXCL10. The Sherwood group showed that CXCR3 activation is crucial for NK cell trafficking during sepsis and that CXCR3 blockade will decrease inflammation and organ injury in experimental models of sepsis. The underlying goal is to further understand the contribution of CXCR3 activation in the pathogenesis of sepsis and develop clinically relevant interventions to block CXCR3 and improve outcome.

In further studies, Dr. Sherwood's lab group is evaluating the immunomodulatory properties of TLR4 agonists and their ability to modify the host response to systemic infection. The group showed that the TLR4 agonists lipopolysaccharide and monophosphoryl lipid A are potent immunomodulators that alter systemic cytokine production and enhance innate resistance to bacterial infections. The improved resistance to infection is caused by neutrophil expansion and enhanced neutrophil functions. The group is working to define the mechanisms by which TLR4 agonists promote the antimicrobial functions of neutrophils and develop TLR4 agonists as agents that can be used clinically to improve the resistance of critically ill patients to infection. Dr. Sherwood mentors BH Robbins Scholar Patrick Henson, DO.

Andrew Shaw, MBBS, joined Vanderbilt as chief of the Division of Cardiothoracic Anesthesiology in June 2014, coming from Duke University Medical Center. In addition to being a top clinician, he is also a leading investigator. Dr Shaw's investigations are centered on translational research, including the use of metabolomics, proteomics, and genomics for biomarker discovery in acute illness and injury. In particular, his group looks for common mechanistic factors leading to organ failure after cardiothoracic surgery. The group has a developing interest in peripheral leukocyte phenotype switching as a central mechanism for post cardiopulmonary bypass morbidity and is investigating the genetic and epigenetic factors involved. Dr. Shaw's clinical research interests include observational and interventional trials of candidate interventions to prevent and treat adverse outcomes following surgery, particularly acute kidney injury. His research is funded by the National Institutes of Health, the US Department of Defense, private philanthropy, and by industry.

Matthias Riess, MD, PhD, is the newest member of the Vanderbilt Anesthesiology Research Division, having joined the department in July 2014 from the Medical College of Wisconsin. His team currently focuses on three translational projects: 1) Genetic mechanisms of protection against myocardial ischemia/reperfusion (IR) injury in a consomic rat model. While some rats are very resistant against IR injury and can be additionally protected by ischemic or anesthetic preconditioning, others are highly susceptible to IR injury and cannot be preconditioned. Crossing over genetic information from one strain into the other strain yields important information on cardioprotective mechanisms. Altered mitochondrial function appears to play

a key role in these genetically determined differences. 2) In collaboration with investigators from Duke University and the University of Alaska Fairbanks, Dr. Riess' team studies the protective role of fatty acids against myocardial IR injury in Arctic ground squirrels. Administration of a clinically used fat emulsion, Intralipid, confers nearly complete abrogation of myocardial dysfunction following IR in isolated hearts, challenging the paradigm of glucose being the fuel of choice during oxidative stress. 3) Together with colleagues at the University of Minnesota, the University of Michigan, and the Medical College of Wisconsin, Dr. Riess' team investigates novel strategies to improve neurological outcome and survival after cardiac arrest and CPR in a porcine model. With currently only a 5 to 7 percent survival rate after out-of-hospital cardiac arrest, the ground-breaking findings of this inter-institutional and interdisciplinary collaboration are highly promising and may change the outcome for hundreds of thousands of individuals who suffer cardiac arrest each year.

Together, the members of the Basic Science Division of the Department of Anesthesiology pursue a mutually complementary and collaborative program of research to create new knowledge leading to improved practice in anesthesiology and critical care medicine. Moreover, the division provides critical mentorship to a new generation of anesthesia clinician scientists who will help bind the basic science and clinical missions of the department together even more effectively.



Matthias Riess, MD, PhD, center, along with Research Assistant Michele Salzman, left, and Senior Research Specialist Qunli Cheng, right, investigates intracellular mechanisms of cardioprotection, especially the role of mitochondrial function as a trigger and effector of cardioprotection.

Key Clinical Research Studies

Bret Alvis, MD: Continuous Supraglottic pH Monitoring in Prolonged Intubated Intensive Care Patients and High Risk Aspiration Intraoperative Patients

Rigid and Flexing Laryngoscope (RIFL) vs. Fiberoptic Bronchoscope: A Comparison of the Ease of Use During Intubation on Difficult Airways

Curtis Baysinger, MD: Effects of Tadalafil (Cialis), a Long-acting PDE5 Inhibitor, on the Human Fetoplacental Microcirculation: A Study Using the in Vitro, Dual-perfused, Single-isolated Cotyledon, Human Placental Model

Multi-center, Double-randomized, Double-blind, Placebo-controlled Study to Evaluate the Analgesic Efficacy and Safety of Intravenous CR845 Dosed Preoperatively and Postoperatively in Patients Undergoing a Laparoscopic Hysterectomy

Claudia Benkwitz, MD, PhD: Validation of the FORE-SIGHT Elite Tissue Oximeter in Pediatric Subjects for Cerebral and Somatic Applications

Frederic T. Billings, MD: The Effect of Short-term Atorvastatin Use on Acute Kidney Injury Following Cardiac Surgery

A Phase II Multicenter, Parallel-group, Randomized, Double-blind, Proof-of-Concept, Adaptive Study Investigating the Safety and Efficacy of THR-184 Administered via Intravenous Infusion in Patients at Increased Risk of Developing Cardiac Surgery Associated-Acute Kidney Injury (CSA-AKI)

James L. Blair, DO: Does Continuous Perioperative Dexmedetomidine Infusion Reduce Time to Discharge in Patients Undergoing Major Lumbar Fusion? A Double-blind, Placebo-controlled Study

Peri-anesthetic Imaging of Cognitive Decline (PAICOD) – A Prospective Pilot Study

Clifford Bowens, MD: Comparison of Perineural Catheter Depth for the Continuous Popliteal Nerve Block Using Ultrasound Guidance and Dermabond

Christopher Canlas, MD: Perioperative Pulse Oximetry in Obstructive Sleep Apnea Patients in the Ambulatory Setting

Elizabeth Card, MSN, APRN, FNP-BC: Prevalence of Delirium in the Post Anesthesia Care Unit

Michael Chi, MD: Reducing Serious Peripheral Intravenous Catheter Infiltrations Intraoperatively with Electronic Reminders

Christopher Cropsey, MD: Effects of an Electronic Decision Support Tool on Team Performance During In-situ Simulation of Perioperative Cardiac Arrest

Katherine Dobie, MD: Ultrasound-guided Isolation and Blockade of the Upper Trunk for Shoulder Surgery: Time to Replace the Traditional Interscalene Approach?

Susan Eagle, MD: Measurement of the Pressures at Which Intravenous Fluids are Electromechanically Infused

Jesse M. Ehrenfeld, MD, MPH: Are Residents Comfortable Caring for Lesbian, Gay, Bisexual and Transgender (LGBT) Patients?

Automatic Identification of Postoperative Events Using Advanced Informatics Tools

Awareness and Prevention of Acute Lung Injury

Conscious Sedation Management with Mixed Patient Simulators

Evaluation of Disparities in Care of Perioperative Patients

Genomic Impact on Patient Response to Anesthesia

Homeless Surgical Patients: Optimizing Care and Follow-Up

Impact of Sexual Orientation and Gender Identity on Health Outcomes

Incidence and Impact of Hypoxemia During Surgery and Anesthesia

Information Management Systems for Continuous Evaluation and Feedback

Perioperative Risk Stratification of Surgical Patients

Predictors of Post-operative Deterioration

Preoperative Hyperglycemia in Undiagnosed Diabetics

Role of B Blockers in Stroke after Non-cardiac Surgery: An Observational Study from the Multicenter Perioperative Outcomes Group

Understanding the Impact of Health Literacy and Perioperative Outcomes

Utility of the Surgical Apgar Score on Postoperative Outcomes in Pediatrics

Leslie Fowler, MEd: Ongoing Professional Performance Evaluation (OPPE) Using ACGME Six Core Competencies for Anesthesiology Residents

Andrew Franklin, MD: Open-label, Extension Study to Assess the Long-term Safety of Twice Daily Oxycodone Hydrochloride Controlled-release Tablets in Opioid Experienced Children Who Completed the OTR3001 Study

Open-label, Multicenter Study of the Safety of Twice Daily Oxycodone Hydrochloride Controlled-release Tablets in Opioid Experienced Children from Ages 6 to 16 Years Old, Inclusive, with Moderate to Severe Malignant and/or Nonmalignant Pain Requiring Opioid Analgesics

A Phase IV Study to Evaluate the Pharmacokinetics and Safety of Oxycodone Oral Solution in Pediatric and Adolescent Subjects

Stephen R. Hays, MD: Multicenter Study of the Safety, Tolerability, Effectiveness, and Pharmacokinetics of Oxymorphone HCl Extended-Release Tablets in Pediatric Subjects Requiring an Around-the-Clock Opioid for an Extended Period of Time

Multisite RCT Comparing Regional and General Anesthesia for Effects on Neurodevelopmental Outcome and Apnea in Infants

Open-label, Non-randomized, Multicenter, Ascending Dose by Age, Single- and Multiple-dose Evaluation of the Effectiveness, Safety, and Tolerability of Oral Liquid Oxymorphone HCl Immediate-release Oral Liquid for Acute Postoperative Pain in Pediatric Subjects

Pediatric Anesthesia NeuroDevelopment Assessment Study (PANDAS)

Randomized, Placebo Controlled, Multicenter Study of the Efficacy, Pharmacokinetics (PK) and Pharmacodynamics (PD) of Intravenous (IV) Acetaminophen for the Treatment of Acute Pain in Pediatric Patients

Patrick Henson, DO: Study Evaluating the Expression of Effectors of Immune Tolerance and Associated Infectious Outcomes in Burn Patients

Antonio Hernandez, MD: Comparison of Endotracheal Intubation Over the Aintree via the I-gel and Laryngeal Mask Airway Supreme

Douglas Hester, MD: Cost Containment of Anesthetic-related Intra-operative Costs

King Vision Video Laryngoscope vs. Glidescope Video Laryngoscope: A Comparative Study in Ambulatory Surgery Center Patients

Poetry for Professionalism: A Pilot Intervention Assessing Attitudes About the Use of Creative Writing to Further Resident Core Competency of Professionalism

A Retrospective Review :“Take-Back” Surgeries in a Large Academic Center

Marc Huntoon, MD: Controlled, Two-arm, Parallel Group, Randomized Withdrawal Study to Assess the Safety and Efficacy of Hydromorphone Hydrochloride Delivered by Intrathecal Administration Using a Programmable Implantable Pump

Phase 3, Open-Label, Single-Arm Study To Assess The Safety Of Hydromorphone Hydrochloride Delivered By Intrathecal Administration

Prospective, Randomized, Multi-Center, Controlled Clinical Trial to Assess the Safety and Efficacy of the Spinal Modulation AXIUM Neurostimulator System in the Treatment of Chronic Pain

Tracy Jackson, MD: A Retrospective Comparison Study of Narcotic Prescriptions with the Prescription Monitoring Protection Database

Avinash Kumar, MD: Risk Factors for New Onset Acute Kidney Injury Following Aneurysmal Subarachnoid Hemorrhage: A Single-center Retrospective Cohort Study.

Lorri Lee, MD: Moyamoya in Non-Asian North Americans

Daniel Lonergan, MD: Opioid Detoxification Outcomes in an Outpatient Chronic Pain Clinic

Letha Mathews, MBBS: The Effects of Dexmedetomidine and Remifentanyl on Microelectrode Recordings During Deep Brain Stimulation Surgery: A Retrospective Analysis of the Vanderbilt Experience

Radiographically Measured Neck Motion During Intubation with MILS by Two Different Video Laryngoscopes

Matthew McEvoy, MD: Assessment of Intraoperative Temperature and Postoperative Delirium in the HIPEC Surgical Population

Assessing the Reliability of Applicant Commitment Statements and How They Correlate to a Successful Match

Effect of a Cognitive Aid on Adherence to the American Society of Regional Anesthesia Guidelines for Management of Patients on Anticoagulation

Effect of a Cognitive Aid on Adherence to Perioperative Guidelines

Effect of an Electronic Decision Support Tool on Team Performance During Perioperative ACLS Simulation Scenarios

Perioperative Fluid Management and Outcomes

Teaching CA-1 Anesthesia Residents by “Flipping the Classroom” Improves Knowledge Acquisition and Resident Satisfaction

Kelly McQueen, MD, MPH: The Global Burden of Pain Evaluation Proposal

Impacting the Global Trauma Crisis: Pilot Study in Mozambique

Thanh Nguyen, MD: Do Transfusion Algorithms Decrease Blood Transfusions in Children Undergoing Craniofacial Surgery?

Pediatric Craniofacial Surgery Perioperative Registry (PCSPR)

Phase IV, Open-label, Safety Study Evaluating the Use of Dexmedetomidine in Pediatric Subjects Undergoing Procedure-type Sedation

What is the Prevalence of Vitamin D Deficiency Among Children Undergoing Posterior Spinal Fusion?

Brian O'Hara, MD: Procedures and Outcomes of Airway Management

A Survey Assessing the Comfort Level of Residents in Performing Emergency Airway Techniques, Cricothyrotomy, and Thoracoscopy Before and After ATLS Training

Michael Pilla, MD: Outcomes Associated with a CPAP Program in a Large Academic Medical Center

A Study of Belmont Rapid Infusion Devices

Nahel Saied, MB BCh: Risk Factors of Airway Complications in Ischemic Stroke

Edward Sherwood, MD, PhD: Baseline Quantitative Neuromuscular Monitoring in the PACU

The Impact of Quantitative Neuromuscular Monitoring in the PACU on Residual Blockade and Postoperative Recovery

A Study Evaluating Gene Expression Response to TLR4 Agonists

Heidi Smith, MD: Assessing the Compliance and Reliability of a Unit-wide Rollout of a Nursing Delirium Screening Tool in a Pediatric Critical Care Unit

Pediatric Delirium: Validation of the Preschool Confusion Assessment Method for the Intensive Care Unit (psCAM-ICU)

Paul St. Jacques, MD: Identification of Post-Operative Renal Failure and Myocardial Infarction

King Vision Video Laryngoscope vs. the McGrath Video Laryngoscope: A Comparative Study

Chad Edward Wagner, MD: Multicenter Retrospective hTEE Review

Jonathan P. Wanderer, MD, MPhil: An External Validation of the Z-Score System for Normalizing Residency Evaluations

Description and Prediction of Intraoperative Tidal Volume Habits

Determinants of Variation in Anesthetic Drug Costs

Development and Validation of Prediction Models for Hospital Morbidity and Mortality

Evaluation of Electronic Screening Tools for Functional Status Assessment

Evaluation of Electronic Screening Tools for Preoperative Assessment

Impact of a Case Cancellation Review System on Systems-Based Practice in Anesthesia Residency Training

Perioperative Outcomes Awareness Project

Quantification of Variability in Anesthesia Residency Training

The Electronic Medical Record Habits of Highly Effective Anesthesia Residents

The Use of Electronic Pre-operative Notes

Understanding the Use of Electronic Pre-operative Notes through EMR Audit Logs

Utilization of Perioperative Antiplatelet Drugs in Patients with Coronary Stents

Scott Watkins, MD: Improving Team Performance in Simulated Pediatric Emergencies Through Incorporation of Non-technical Skills into an Electronic Decision Support Tool

Sheena Weaver, MD: Characterizing Palliative Care Presence in Acute Stroke Patients Admitted to the Neurological & Neurosurgical ICU

Liza Weavind, MB BCh: Does Anemia Contribute to End-organ Dysfunction in ICU Patients?

Phase III, Randomized, Double-blind, Placebo-controlled, Adaptive Design Study of the Efficacy, Safety, and Tolerability of a Single Infusion of MK-3415 (Human Monoclonal Antibody to Clostridium difficile toxin A), MK-6072 (Human Monoclonal Antibody to Clostridium difficile toxin B), and MK-3415A (Human Monoclonal Antibodies to Clostridium difficile toxin A and toxin B) in Patients Receiving Antibiotic Therapy for Clostridium difficile Infection

Perioperative Clinical Research Institute



Members of the Perioperative Clinical Research Institute: Front row, left to right: Susan Taylor, MSN, RN; Cynthia Cannon; Jennifer Morse, MS, CCRP; Kiersten Card; Misty Hale, CCRP; Martha Tanner; and Mary Hamilton Chestnut, MSN, APRN. Second row, left to right, Edward Sherwood, MD, PhD; Damon Michaels, Steve Klintworth, RN; Elizabeth Card, MSN, APRN; and Travis Spain.

Navigating regulations, mastering the nuances of grant writing, and properly managing finances in order to conduct clinical research is enough to fray the nerves of any fledgling investigator. To keep the process running smoothly, from initial concept to published research, the Department of Anesthesiology's Perioperative Clinical Research Institute (PCRI) provides a full range of support services, including regulatory management, data management, contracts management, biostatistics, bioinformatics, and financial oversight. The group also trains new investigators so they can grow to the point of having their own funded research that leads to major publications.

"We are here to facilitate the research process for our investigators," said Clinical Trials Research Director Damon Michaels. "We assist with compliance with federal, state, and local regulations and other details so the investigators can focus on their science. The end goal is stronger research, with an eye toward publication in leading journals."

Clinical research within the department includes both industry-sponsored and investigator-initiated clinical projects and focuses on the advancement of medical practice in the fields of perioperative care, chronic pain, and medical devices. Most of the department's investigators are practicing physicians who use their clinical expertise to develop research protocols that seek to answer clinically significant questions.

The PCRI oversees more than 90 active clinical trials, with many more studies in development. PCRI is directed by Vice-Chair for Research Edward Sherwood, MD, PhD, and Director of Clinical Trials Research Damon Michaels. The team consists of highly trained and broadly experienced research professionals, including five research nurses, one research assistant, one clinical trials associate, one senior clinical trials associate, one senior regulatory specialist, and one administrative assistant.

"It has been exciting to see the growth in clinical research since PCRI was founded in 2007," said Michaels. "When I started, the department was mainly focused on basic science research. We added

industry-funded studies to help new investigators learn about the research process. As they've progressed in their research careers, our investigators have started developing their own complex questions that will improve the quality of patient care for years to come."

PCRI Supported Nursing Research

The Perioperative Clinical Research Institute includes five research nurses, two of whom are research nurse practitioners. All are practicing registered nurses with specialized training in conducting clinical research. The research nurses provide support for clinical investigators, assisting in the design of clinical research and ensuring the integrity and quality of clinical research trials. Over the past three years, the nurses' role has expanded to the point that they are now presenting their own research at national conferences and have published in the academic press.

"These individuals support our ongoing investigations, and their contributions are invaluable," said Michaels. "They are often the critical contact point 'in the trenches' and are able to make sure nothing falls through the cracks or lags for any reason. They have been growing professionally so that they are more responsible, and are now pursuing their own research."

The role of the research nurse practitioner is being developed within the Department of Anesthesiology to expand the responsibility that nurses have traditionally played in support of clinical trials. This role allows nurses with advanced degrees and appropriate licensure to have increased research responsibilities. Unlike other nurse practitioners, who primarily work in a clinical role, the research nurse practitioner focuses primarily on scientific investigations. The department envisions utilizing research nurse practitioners as sub-investigators working closely with their principal investigators. They are also principal investigators on their own research studies and apply for grants, obtain their own extramural funding, and participate in the dissemination of research findings.

The clinical research nurses in PCRI are:

Elizabeth Card, MSN, APRN, FNP-BC, CPAN, CCRP

A practicing registered nurse since 1990, Elizabeth Card's nursing background includes working in cardiovascular intensive care units, post-anesthesia care units, the holding room, pediatrics, as well as transplant and vascular case management. She completed her master of science in nursing degree in 2013 and is a board-certified family nurse practitioner. She has served as a sub-investigator or key study personnel in more than 75 clinical research studies at Vanderbilt involving drugs, devices, observational, or survey studies. Her research includes ongoing studies on pain, burnout, delirium, or cognitive impairment. Presently, Elizabeth serves as the National Chair for the American Society of PeriAnesthesia Nurses (ASPAN) Evidence Based Practice Committee. In 2014, Elizabeth was awarded a Joanna Briggs Educational Scholarship. She has authored, co-authored, and presented (abstracts, poster and podium presentations) numerous times on a variety of subjects, including postoperative or emergence delirium, pain, healthcare worker burnout, the research process, and professional nursing development.



Elizabeth Card, MSN, APRN, FNP-BC, CPAN, CCRP

Mary Hamilton Chestnut, MSN, APRN, FNP-C

Mary Hamilton joined the Anesthesiology Department in November 2012, and she has been a certified family nurse practitioner since 2010. She is involved with several perioperative clinical research projects at Vanderbilt, primarily in pediatrics. She is a member of the ICU Delirium and Cognitive Impairment Study Group and works closely with Heidi Smith, MD, MSCI, on developing tools to detect delirium in pediatric patients. She is also involved with several studies on liquid oxycodone for acute postoperative pain and on the safety of oxycodone CR tablets in opioid-experienced children. She is an active member of American Society of PeriAnesthesia Nurses and the Society of Clinical Research Associates. She has presented posters on pediatric delirium for Tennessee Nurses Association, Tennessee Society of PeriAnesthesia Nurses (TSPAN), and the American Delirium Society.



Mary Hamilton Chestnut, MSN, APRN, FNP-C

Patricia Hendricks, RN, CCRP

A practicing registered nurse since 1978, Patty Hendricks' nursing



Patricia Hendricks, RN, CCRP

background includes working in the intensive care unit and the post-anesthesia care unit/holding room, cancer pain and symptom management therapies, and home health care. She has served as a sub-investigator or research coordinator on more than 16 clinical research studies at Vanderbilt involving drugs, devices, observational, or survey studies. Patty works exclusively with Josh Billings, MD, MSCI, on several studies focusing on acute kidney injury and delirium following cardiac bypass surgery. She is a certified clinical research professional and the treasurer for Middle Tennessee Society of PeriAnesthesia Nurses (MTSPAN). She is an active member of the American Society of PeriAnesthesia Nurses and the Society of Clinical Research Associates.

Steve Klintworth, RN, COHN

Steve Klintworth has been a practicing registered nurse since 1986, and his background includes providing critical care in medical intensive care units and surgical intensive care units, general surgery, occupational health, and nursing supervision. He's been a sub-investigator or research coordinator on more than 25 clinical research studies at Vanderbilt involving drugs and devices. Steve's current focus is on chronic pain research focusing on novel devices designed to help patients with pain management. He serves on the advisory board for the Vanderbilt Program in Research Administration Development (VPRAD), a group that is dedicated to educating and equipping researchers at the hospital and university with the skills needed to be excellent research administrators. He has presented posters for the Tennessee Nurses Association, the Tennessee Society of PeriAnesthesia Nurses (TSPAN), and the American Association of Nurse Practitioners (AANP).



Steve Klintworth, RN, COHN

Susan Taylor, MSN, RN

Susan Taylor graduated from a diploma school of nursing in 1980, then acquired her bachelor of science in nursing degree in 1984. Her early years of practice were in several adult care areas including cardiovascular intensive care units, neurological intensive care units, and post-anesthesia care units. Travel nursing brought Susan to Nashville where she continued adult critical care and then transitioned to Vanderbilt where she continued her career in pediatric nursing. After seven years in the Neonatal Intensive Care Unit (NICU), Susan transferred to the pediatric float pool and worked in all patient care areas including Acute Care Pediatrics, Pediatric Cardiac Intensive Care Unit, Pediatric Intensive Care Unit, Post-Anesthesia Care Unit, and the Pediatric Emergency Department and occasionally "floated" back to the NICU to take care of her favorite patient population. Susan joined the Anesthesiology Department, as well as completed her master in nursing informatics degree from Vanderbilt University School of Nursing, in July 2014.



Susan Taylor, MSN, RN

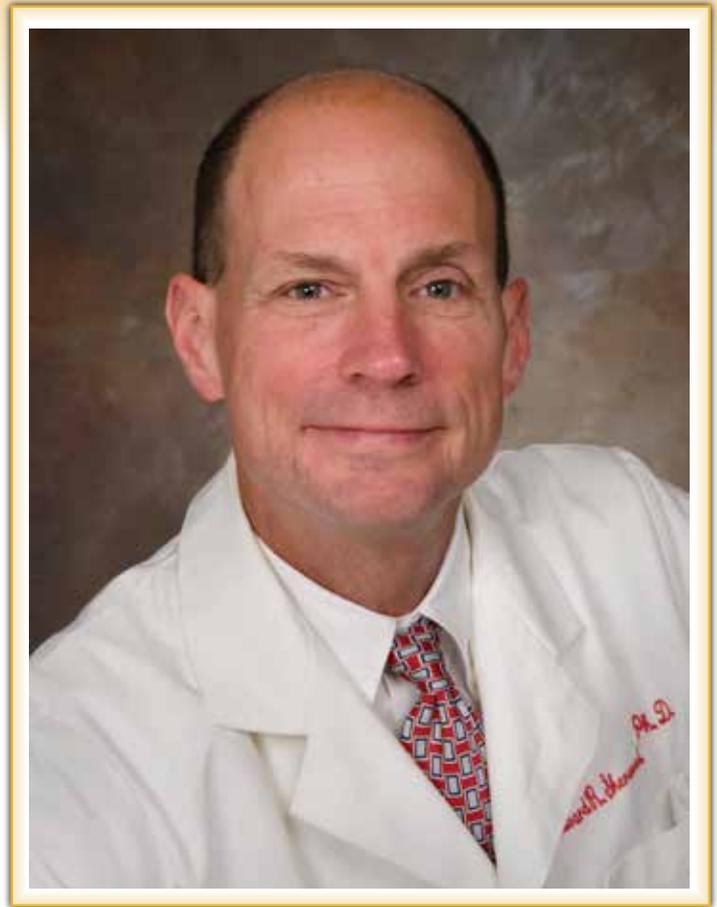
Special Committee Supports New Investigators

In partnership with the Perioperative Clinical Research Institute, the Vanderbilt Anesthesiology Clinical Research Advisory Committee (VACRAC) was formed in 2009 to promote clinical research within the department. The committee supports new investigators in developing clinical research projects that will lead to publication and, if possible, extramural funding. The committee also oversees the development and conduct of industry-sponsored and investigator-initiated research by developing and managing essential research support services and programs.

The committee mentors potential investigators throughout the research development process and provides regular opportunities for ongoing learning about research methods, proposal writing, Institutional Review Board (IRB) applications, data management and analysis, and presentation/publication skills. The committee also reviews new research proposals and regularly audits ongoing investigations for effectiveness and compliance with regulatory and safety guidelines. Projects that are determined to require more than minimal resources, for example those that need more than simple IRB regulatory support and/or significant statistical consultation, are referred to the Anesthesiology Research Executive Committee (AREC) for consideration for departmental Innovation grants.

VACRAC reviews all ongoing projects at least annually to ensure that goals are being met, resources are appropriately allocated, and regulatory requirements are met. The VACRAC Chair provides summary reports of the committee's activities to Anesthesiology Research Executive Committee (AREC) at least annually.

Committee members are Edward Sherwood, MD, PhD (chair); Matt Shotwell, PhD (co-chair); Josh Billings, MD, MSCI; Brian Donahue, MD, PhD; Matthew McEvoy, MD; Damon Michaels; Pratik Pandharipande, MD, MSCI; and Matthew Weinger, MD.



Edward Sherwood, MD, PhD, chairs the Vanderbilt Anesthesiology Clinical Research Advisory Committee.

Perioperative Clinical Research Institute (PCRI), by the Numbers

PCRI Research Protocols

Approved Research Protocols.....	54
Pending Research Protocols.....	6
Total Research Protocols.....	60

Active PCRI Projects

Investigator Initiated.....	37
Industry.....	14
Grants.....	3
Clinical Projects.....	54

Abstracts & Podium Presentations at Scientific Meetings

State or Local Meetings.....	5
National Meetings.....	9
International Meetings.....	1
Total Original Research Presentations.....	15

Vanderbilt Anesthesiology & Perioperative Informatics Research Division

The Vanderbilt Anesthesiology & Perioperative Informatics Research (VAPIR) Division, led by Jesse M. Ehrenfeld, MD, MPH, and Jonathan P. Wanderer, MD, MPhil, focuses on utilization of information technology within the perioperative environment to improve patient safety and the quality of care delivered. The multidisciplinary group, which has grown from just three full-time research support staff in 2010 to eight in 2014, manages more than 80 active clinical research projects and has taken the lead on developing methodologies for evaluating the impact of technology and information management systems within the operating room.

Milestones Achieved

Major achievements have included successful competition for a grant from the Anesthesia Patient Safety Foundation (APSF) and a complete redesign of the Perioperative Data Warehouse (the 11-year historical archive of data from the Vanderbilt Perioperative Information Management System). Realization of these steps was an important milestone for the group, as demand for perioperative data continues to grow in support of the Anesthesiology Department's research mission. Additionally, VAPIR has supported a number of important operational initiatives, such as the development, launch, and maintenance of the Perioperative Dashboard Project, which provides a real-time overview of a series of OR management and cost metrics to front-line managers and clinicians.

“We have successfully positioned the VAPIR group to lead informatics research at Vanderbilt,” said Department Chairman Warren Sandberg, MD, PhD. “It is rewarding to know that our

efforts in informatics research will ensure that the decisions made by researchers based on the information we are able to provide them will help ensure that patient safety and quality of patient care are never compromised.”

Novel Collaborations, Here and Abroad

The work accomplished by VAPIR has led to recognition of Vanderbilt as home to one of the premier anesthesia informatics research programs in the world, and this has resulted in many fruitful partnerships and collaborations.

“We are appreciative for the opportunities for our group to partner not only with collaborators at Vanderbilt, but also with colleagues performing research across the nation and the world,” said Dr. Ehrenfeld. “Through these collaborations, we have been able to establish and strengthen our group's mission to promote patient safety and quality of care, both here and abroad.”

One such collaboration is with the National Institutes of Health-sponsored U.S. Critical Illness and Injury Trials Group, in which Vanderbilt is co-leading an effort to bring together de-identified, high-resolution intensive care unit data from a consortium of medical centers. This unprecedented effort is allowing researchers across the country to answer important questions quickly and efficiently about how best to care for critically ill patients. One example project centers on determining the ideal post-surgical blood pressure for preventing the development of acute renal failure after surgery.

Innovations in Quality and Delivery of Care

Discoveries made by researchers in the VAPIR group have led not just to the creation of new knowledge, but in many cases, have resulted in the direct improvement of care and operative outcomes of Vanderbilt patients—and thousands of patients undergoing surgery and anesthesia worldwide. Three projects are highlighted below.

Better Care for Diabetic Patients

Vanderbilt is leading a multicenter effort to understand the impact of providing real-time clinical decision support for the management of glucose during surgery. Preliminary results from the study have demonstrated an improvement in a variety of outcomes and, most notably, a reduction in post-surgical readmission rates in diabetic patients at Vanderbilt.

Perioperative Cost Containment

This endeavor provides a mechanism for tracking surgical supply costs and understanding differences in supply costs between surgeons. Existing processes capture surgical supplies as they are used, and the data from that workflow have been harnessed to give surgeons case-level access



VAPIR Division members, front row, left to right: Frank Aline, Lana Sain, Susan Taylor, Karen McCarthy, Maxim Terekhov, and Jonathan Wanderer, MD, MPhil. Back row, left to right, Michaelene Johnson, Michael Plante, Damon Michaels, and Jesse Ehrenfeld, MD, MPH.

to their costs. The ability to compare the same procedure between different surgeons has enabled a data-based dialogue on supply cost reduction within the surgical sciences.

Preventing Post-Operative Deterioration

While the morbidity and mortality attributed to anesthesia is low, there continues to be a high postoperative complication rate. Supported by a grant from the Anesthesia Patient Safety Foundation (APSF), VAPIR members have set out to identify characteristics that may be predictive of adverse events in the immediate postoperative setting (i.e., within 72 hours of surgery). To date, VAPIR researchers have identified a cohort of 35,090 adult patients who had a surgical procedure and were admitted to the hospital after surgery. Of these patients, 689 had an unanticipated transfer to the ICU within 72 hours. The team is now modeling the differences between patients who experienced these unexpected transfers and those who did not. Ultimately, the plan is to automate a predictive model in order to provide real-time model output to clinicians in the OR.

Teaching the Next Generation

Consistent with the department’s educational mission, VAPIR actively educates and trains students, residents, and fellows through a variety of mechanisms, including seminars, journal clubs, and a successful summer research training program. During the 2013-2014 academic year, VAPIR provided mentorship and research opportunities for more than 20 students – including undergraduate, medical, and graduate students – who joined VAPIR from Vanderbilt and seven other academic institutions.

VAPIR continues to attract renowned experts in the fields of biomedical informatics and clinical research to Vanderbilt’s campus as visiting scholars. At the monthly Anesthesia Informatics Research Seminar, which is open to the entire Vanderbilt University community, these specialists share their research findings and expertise.

Vanderbilt Anesthesiology and Perioperative Informatics Research (VAPIR) Division, by the Numbers

VAPIR Research Protocols

Approved Research Protocols.....	51
Pending Research Protocols.....	4
Total Research Protocols.....	55

Active VAPIR Projects

Clinical Research & Quality Improvement Projects.....	80
Technical Team Projects	36

Grant Applications

Applications Submitted.....	15
Applications Funded.....	3

Manuscripts

Papers Under Review.....	26
Papers Accepted.....	32
Total Papers.....	58

Abstracts & Podium Presentations at Scientific Meetings

National Meetings.....	48
International Meetings	6
Total Original Research Presentations.....	54

Collaborations

Vanderbilt Departments	15
Departments at other U.S. Institutions.....	14
International Departments.....	5

Information Systems Evolve to Improve Patient Care

The Vanderbilt Department of Anesthesiology has long been a national leader in the development and advancement of perioperative informatics, and there has been an increased focus in recent years to further strengthen the informatics initiatives at Vanderbilt.

“This department has always had a very strong commitment to informatics and has had many notable accomplishments in the field,” said Department Chairman Dr. Warren Sandberg. “By bringing some key talent on board and by providing the faculty already here the dedicated time and necessary staff to expand and improve our informatics programs, we are looking forward to dramatically impacting our specialty, and patient care in total, through new research and technology.”

A combination of world-class research, active software development, and utilization of the latest clinical applications allows the department to drive the use of technology within anesthesiology to improve patient safety and quality. Advances in both research and clinical care are being facilitated by several faculty members in the department, many of whom have additional faculty appointments in the Department of Biomedical Informatics. The two key groups affiliated with the department driving this effort are the Vanderbilt Anesthesiology & Perioperative Informatics Research (VAPIR) Division and Perioperative Informatics.

Perioperative Informatics, a group led by Brian Rothman, MD, medical director of Perioperative Informatics, and Jonathan Wanderer, MD, MPhil, associate medical director of Perioperative Informatics, is a hospital entity that develops and manages the clinical applications used within the perioperative setting. The Vanderbilt Perioperative Information Management System (VPIMS)[™] application suite, developed and commercialized by Vanderbilt, includes GasChart[™] for electronic anesthesia documentation, Vigilance[™] which improves clinicians’ situational awareness, the iOS-based situational awareness mobile application VigiVU[™], and PatientTracker[™] for electronic nursing documentation during each perioperative phase of care.

“Our job is to solve known or previously unidentified issues related to workflow and system functionality while understanding how these two elements intersect,” said Rothman. “We are identifying unique solutions that improve patient safety, operating room efficiency, the quality and character of the data collected, and staff workflow, as well as solutions that decrease cognitive workload on our staff, through a combination of creative software design and development, with a particular focus on user interface.”

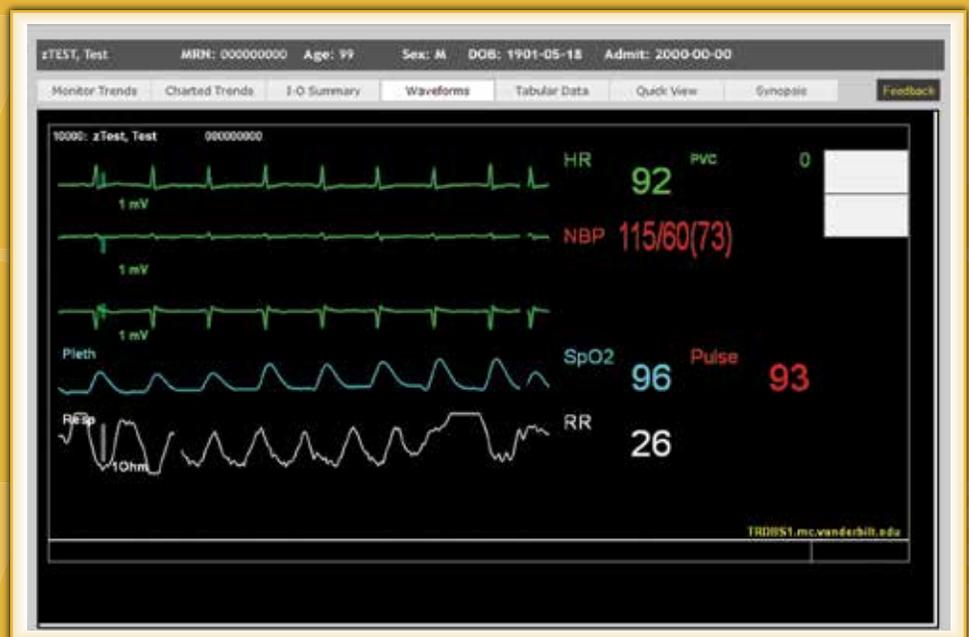
Following are a few recent Perioperative Informatics successes.

- **Integrated Presence:**

Perioperative Informatics has partnered with Vanderbilt’s Informatics Center to pilot a new web-based version of Vigilance[™] called Integrated Presence. Vigilance[™] has delivered situational awareness in the perioperative environment since 2004. Integrated Presence was created to bring situational awareness to the bedside for every provider. Situational awareness is an understanding and awareness of what is happening around you, accomplished by the perception of environmental elements, comprehension of their meaning, and prediction of a future state based on those elements and their meaning. Improving situational awareness is thought to improve patient safety and work efficiency while reducing costs, and it is especially effective when providers are responsible for more than one active care location. Integrated Presence is now implemented and in use by a rapidly growing number of clinicians in the inpatient care environments across Vanderbilt in conjunction with our bedside monitoring initiative. Anecdotally, inpatient providers are now experiencing the many advantages of increased situational awareness that have already been realized in the perioperative space.

- **Documentation Compliance:**

Anesthesiology - The VPIMS[™] anesthesia documentation module, GasChart[™], effectively collects a large amount of data for compliance and billing purposes. However, in response to recent changes in compliance regulations, the Perioperative Informatics team has further improved the documentation



A new web-based version of Vigilance[™] called Integrated Presence increases situational awareness for care providers. Here, a demonstration mode view shows a patient’s vital signs. Making this real time information available to care teams is expected to improve patient safety and work efficiency, while also reducing costs.

processes. Implementation of a forced function now ensures that attending physicians clearly document their involvement in line and monitor placement, the indication for the placement, any complications during placement, and if placement was successful. In addition, a new Postoperative Anesthesia Visit (PAV) web application, which is also part of VPIMS™, is entering the pilot phase. This new app is designed to facilitate postoperative anesthesia note compliance using mobile devices. These changes continue to result in improved documentation quality and significant time savings for Vanderbilt's billing staff. Over the next year, the development team will implement a new anesthesia attending clinical documentation system that will further improve documentation quality and reduce ambiguity.

Nursing – Several changes to nursing documentation were implemented in the past year, including improved documentation of implants to now include explants (i.e., a previously implanted medical device that is being removed). Explant documentation ensures proper billing and credits for any implant that is recalled. Medication verification was improved to better meet compliance guidelines. Postoperative nausea and vomiting (PONV) is now a required data point for every patient chart, and the discrete data collected will enable outcomes analysis for interventions performed throughout the perioperative process. Finally, a generic framework for nursing checklists was employed to aid in standardizing care for colorectal service patients. This framework will be extended as care standardization is applied in other services.

- **Infrastructure Improvements:**

VPIMS™ is a real-time documentation system on which most, if not all, perioperative providers rely. Making improvements to the system's infrastructure was a major initiative this past year to enhance uptime, reliability, and performance. The VPIMS™ database underwent a significant retuning and optimization to increase efficiency and decrease system response times, and the hardware was optimized to augment database server stability. Finally, most of the custom interfaces, which allow users to exchange necessary data with other systems, were migrated to an industry-standard, scalable interface engine, Mirth™.

On a larger scale, Perioperative Informatics is working toward data “interoperability” by providing patient information collected

A recent VPIMS™ addition ensures that attending physicians clearly document their involvement in line and monitor placement, any complications during the placement, and if the placement was successful.

through VPIMS™ in a form useful to the institution. Exchanging data with the Core Data institutional information database and Star are examples of how the group is opening doors to exchange information throughout the continuum of patient care.

“The interoperability with the institution is essential,” said Rothman. “Because we have such a large volume of Vanderbilt patients passing through our area, we see it as our vital mission to communicate data we collect to other care providers across the institution. Likewise, the availability of important care information when a patient receives care in the perioperative space is equally vital. We don’t focus on inbound or outbound data. We focus on bi-directional communication with all systems. That is our goal in the years to come.”

Taken together, the informatics effort in the Department of Anesthesiology seeks to close the loop, ensuring that patients are fully protected from harm and that beneficial interventions are always executed. Because Vanderbilt “owns” its information systems, both literally and figuratively, rapid cycle processes of hypothesis generation, pilot demonstration, and

full scale implementation of quality improvement projects are uniquely supported.

One change to nursing documentation implemented in the past year requires that postoperative nausea and vomiting (PONV) status be recorded in every patient chart. The data collected will enable outcomes analysis for interventions performed throughout the perioperative process.

Center for Research and Innovation in Systems Safety

Vanderbilt University School of Medicine's Center for Research and Innovation in Systems Safety (CRISS), directed by Matthew B. Weinger, MD, is an institution-wide resource for human factors, usability, and systems engineering and design located within the Department of Anesthesiology. CRISS is an integral part of Vanderbilt's Institute for Medicine and Public Health (IMPH), led by Robert Dittus, MD, MPH.

To fulfill its mission of enhancing healthcare quality and safety, CRISS conducts basic and applied research in healthcare informatics, patient safety, and clinical quality; designs, assesses, and improves care processes, medical technology and electronic health record (EHR) user interfaces; and utilizes state-of-the-art simulation facilities to test and analyze medical equipment and procedures.

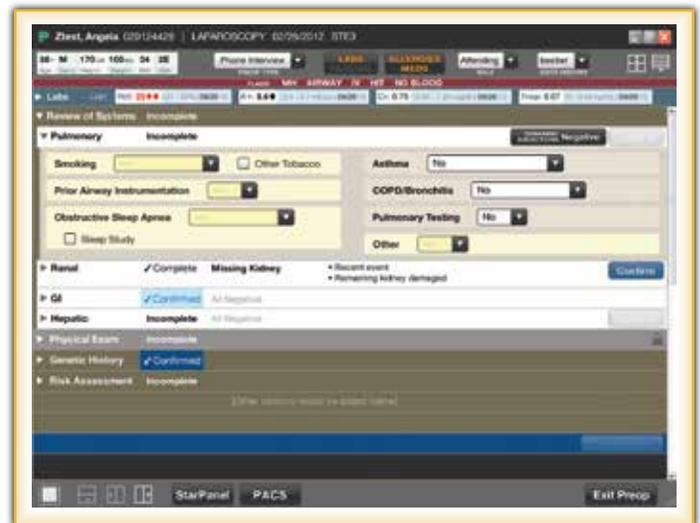
Current research includes an Agency for Healthcare Research and Quality (AHRQ)-funded multicenter study to develop and deploy standardized simulation scenarios to assess the performance of board-certified physicians. In July 2012, CRISS was the recipient of one of only 50 pilot grants (out of 1,400 applicants) from the Patient Centered Outcomes Research Institute (PCORI). In this project, the group is analyzing the occurrence of non-routine events reported concurrently by patients and their clinicians in four different domains – pediatric cardiac surgery, pediatric oncology, adult cardiac catheterization, and adult ambulatory surgery. CRISS is also actively involved in two federal contracts to conduct informatics research: a National Institute of Standards and Technology (NIST)-funded project to define best practices for the design of electronic medical records (EMRs), and an AHRQ-funded project to study the relationship between workflow and electronic health record (EHR) use in ambulatory settings.

Previously, in an AHRQ-funded study, CRISS members showed that a simulation-based training intervention enhanced the quality of handovers and communication between anesthesia providers and PACU nurses. In a Department of Veterans Affairs-funded study of 1,000 surgical cases, CRISS investigators found that operating room teams' workload ratings were strongly associated with reported intraoperative events; the relationship of workload and reported events to 30-day morbidity and mortality is being analyzed. For a National Heart, Lung, and Blood Institute (NHLBI) R21 grant, Dan France, PhD, modeled the factors affecting the ability of patients presenting to the emergency department with acute coronary syndrome to receive evidence-based care. In a study funded by the Anesthesia Patient Safety Foundation, Anne Miller, PhD, and her colleagues implemented and evaluated goal-directed care protocols in the Cardiovascular Intensive Care Unit.

CRISS involvement with Vanderbilt University Medical Center operational initiatives in quality improvement ranges from participating in the review and analysis of serious clinical events at VUMC to re-engineering blood transfusion processes, improving clinician handovers, and enhancing compliance with perioperative timeouts and checklists. CRISS faculty and staff are integrally involved in user interface design and evaluation on numerous applications for VUMC's Informatics, including the next-generation EHR, SmartVU™, which will be a platform-independent, web browser-compliant application that is being designed to model clinicians' mental models of care and their workflow. SmartVU™ includes application modules for patient intake, clinical note

writing, medication and order management, results tracking, patient education/communication, and clinician communication. SmartVU™ also includes state-of-the-art clinical decision support. CRISS is also helping design several Vanderbilt Perioperative Information Management System (VPIMS) modules, including the new preoperative application Perioperative Readiness and Evaluation Program (PREP). Finally, CRISS continues to assist Vanderbilt Informatics in obtaining meaningful use certification from the federal government for its clinical applications. The Medicare and Medicaid EHR Incentive Programs provide financial incentives for the meaningful use of certified EHR technology to improve patient care. To receive an EHR incentive payment, providers must show they are meaningfully using EHRs by meeting specific thresholds for a number of objectives.

CRISS faculty members include Director Matthew B. Weinger, MD, MS; Arna Banerjee, MD; Daniel France, PhD, MPH; Kevin Johnson, MD; Amanda Lorinc, MD; Anne Miller, PhD; Laurie Lovett Novak, PhD, MHSA; Joseph Schlesinger, MD; Matt Shotwell, PhD; Jason Slagle, PhD; Theodore Speroff, PhD; Kim Unertl, PhD; Jonathan Wanderer, MD, MPhil; Scott Watkins, MD; and Gina Whitney, MD. CRISS staff include: Russ Beebe; Christine Goldsberry; Jeff Hottle; Andrew Kline; Eric Porterfield, MS; Taylor Rudolph; Christopher Simpson, MS; Mindy Smith, MS; and Tony Threatt, PhD.



A mock-up of the Preoperative Readiness and Evaluation Program (PREP) workspace illustrates what clinical providers at Vanderbilt might see as they prepare a patient for a procedure.



Selected Publications, 2013-2014

Peer-reviewed Original and Review Articles

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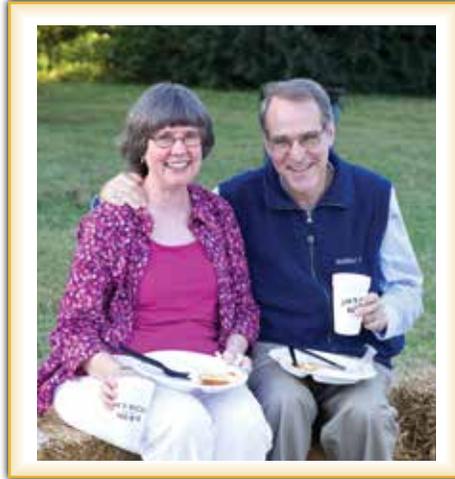
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Achieving Balance

The Vanderbilt Department of Anesthesiology is a dynamic group, providing the very best in patient care, presenting challenging educational programs for our trainees, and leading our specialty in investigational research. But productivity and career satisfaction isn't all about work. We know how to take that same energy and have a great time.

We gather regularly for family-friendly events, events to welcome new residents, fundraisers for our Vanderbilt International Anesthesia program, and other fun activities throughout the year. Here are just a few images from our events.





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