Canadian Anesthesiologists' Society 2011 Royal College Lecture: Anesthesiology: A Profession at a Crossroads

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Anesthesiology is on the cusp of an important transformation. To meet the growing demand for greater patient throughput, more efficient use of resources, and improved perioperative outcomes, the profession is adopting a new mandate. The goal this new mandate is to oversee perioperative clinical care—from preoperative assessment until discharge—and seamlessly integrate clinical and scientific discovery. The following three stories illustrate how this new mandate is being adopted. The first two address clinical care and research. The third is a tale from my own laboratory that illustrates the dynamic interplay between bench research and clinical practice. This notion of anesthesiologists providing comprehensive perioperative care founded on scientific discovery is not new but the time has come for this new mandate to be broadly implemented.

Editor's Note We are pleased to share, for the benefit of all our readers from Canada and internationally, the content of the Royal College Lecture that was presented by Dr. Beverley A. Orser at the June 2011 Annual Meeting of the Canadian Anesthesiologists' Society, held in Toronto, Ontario. Donald R. Miller, M.D. Editor-in-Chief

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Story 1: Rising to the challenge

The extraordinary Canadian physician who convinced me that my life's work would be anesthesiology was Dr. Vincent Hughes (Fig. 1). Sadly, Dr. Hughes passed away unexpectedly in May 2011. I met Dr. Hughes in 1980 while working as a medical student at St. Jude Hospital in Vieux Fort, St. Lucia. Several days before I arrived in St. Lucia, the island was ravaged by Hurricane Allen, a category 5 storm. With winds of up to $300 \text{ km}\cdot\text{hr}^{-1}$, the hurricane devastated the Caribbean region (Fig. 2), and the small town of Vieux Fort was particularly hard hit. The destruction was overwhelming: villages were destroyed, the death toll was high, and dead livestock contaminated the rivers that supplied water to the towns. St. Jude Hospital, which serves the entire southern region of St. Lucia, was severely damaged (Fig. 3). Airports and seaports were closed, and most of the country was left without power.

The British Navy had moored a ship, the HMS Glasgow, in Vieux Fort harbour. The marines had established a command centre in the hospital cafeteria and were slowly opening the roads and transporting the injured back to St. Jude Hospital. At the time of my arrival, Dr. Hughes, a Canadian-trained anesthesiologist, was the only doctor available to treat the injured at the hospital.

He rose to the challenge and worked tirelessly for several weeks. Each morning, he administered anesthesia in the operating rooms. From there, he went to the outpatient clinic to assist where needed and then wandered the wards to help in whatever way he could. On the pediatric wards, he started intravenous fluid therapy if required. On the surgical wards, he assisted the visiting surgeons, many of whom were unaccustomed to working in such limited medical facilities. After completing his clinical duties, he

Vincent Hughes

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Fig. 1 Dr. Vincent James Hughes, Canadian anesthesiologist and physician who worked at St. Jude Hospital in St. Lucia

Fig. 2 A community in St. Lucia, illustrating the damage caused by Hurricane Allen. This photograph was taken on patrol with soldiers from the HMS Glasgow

Fig. 3 St. Jude Hospital in Vieux Fort, St. Lucia sustained considerable damage following Hurricane Allen

met with hospital administration staff to discuss the optimal use of the scarce medical resources.

Vince Hughes was a doctor first and an anesthesiologist second. He remained focused on the well-being of the whole patient. He took full advantage of the knowledge he had acquired in the operating room and applied it beyond the surgical theatre. His patients benefited from his expertise at all stages of their perioperative journey.

Thinking about Vince Hughes and his approach to managing a crisis has led me to ask some probing questions. In the complex health environment of the early 21st century, what is the role of anesthesiologists? How can we emulate Dr. Hughes and apply our skills both inside and outside the operating room? More fundamentally, what are those skills? We are experts in the administration of high-risk drugs, but we are also leaders in managing high-stakes environments, allocating operating room resources, resolving crises by consensus, and team building. We have an unparalleled understanding of acute medical and surgical illness, trauma, inflammation, physiological instability, and tissue injury. The list goes on.

Despite our unique expertise, there is a growing concern that the speciality of anesthesiology is under threat. Around the world, the demand for anesthesia care now outstrips the capacity of anesthesiologists to provide it. In particular, patients in developing countries are rightly expecting basic anesthesia and surgical care that is not yet provided as a matter of course. Given the limited supply of anesthesiologists, allied health professionals are now administering anesthetics, sometimes without supervision from a physician. This constant need for service in operating rooms has limited the ability of anesthesiologists' to manage broader aspects of perioperative patient care. How should we respond?

New mandate

Simply working harder and doing more of the same will not solve the problem. Further, adopting the recalcitrant position that only fully trained anesthesiologists can administer anesthetic drugs will not help the situation. An obstructive stance will cause further bottlenecks in the delivery of care that our patients cannot tolerate and that our governments won't accept.

A reformed mandate for anesthesiologists is therefore proposed, one that is better suited to the current health care environment. Under this new mandate, anesthesiologists would oversee comprehensive care for patients throughout the entire perioperative period. This mandate has been proposed by others, and the time has come to heed the call.

The adoption of this new mandate requires a major evolution of the specialty. At present, most anesthesiologists typically provide services in preoperative assessment

clinics, operating rooms, and recovery rooms. Occasionally, we interact with patients on the wards while on pain service, but rarely do we manage patients during the period prior to discharge from hospital. To improve patient care and increase throughput, we need to move beyond the traditional boundaries of the operating room and pain service and provide comprehensive perioperative care, regardless of where the patient is physically located. Anesthesiologists can quarterback the perioperative care team by helping to define the care paths; we can work with allied health care workers, surgeons, and others to implement care paths. Innovative approaches are needed to train and incorporate “anesthesiologist assistants,” thereby extending our services inside and outside the operating room.

Let us consider one example where this new mandate of anesthesiology has already improved efficiency and the patients’ experience. I have the privilege of working at the Sunnybrook Health Sciences Centre. One campus of the hospital, the Holland Orthopaedics & Arthritic Centre, specializes in major joint replacement surgery. Since 2004, four anesthesiologists, Drs. Susan Belo, Gil Faclier, Joseph Kay, and Colin McCartney, have worked together with orthopedic surgeons Drs. Jeffrey Gollish and Hans Kreder and the nurses in transforming perioperative care paths for patients being treated at this centre.

The team’s vision was to create a high-throughput centre with *standardized* care paths that rely heavily on regional anesthesia. The results have been extraordinary. In 2004, a comprehensive program was introduced that included establishing a preoperative central assessment centre, greater use of regional anesthesia, and reliance on highly skilled anesthesia assistants. Prior to initiating the program in 2004, same-day cancellation rates (Fig. 4) and surgical wait times (Fig. 5) were high owing to inadequate operating room time or inadequate patient preparation. Operating room “overrun” time was also high. Almost all joint replacement surgeries were performed under general anesthesia. After the program was introduced, the number of hip and knee arthroplasty surgeries increased, with 90% of patients having regional anesthesia. A result was that surgical wait times and surgery cancellation rates were

Fig. 5 Ministry of Health and Long-term Care (MOHLTC) results for the Wait Time Strategy Program for patients waiting for hip and knee arthroplasty surgery at the Holland Campus, Sunnybrook Health Science Centre

reduced. Patients who underwent two surgeries at the Holland Centre on separate occasions—one under general anesthesia and the other with regional anesthesia—reported satisfaction with regional anesthesia.¹

This model of care for joint arthroplasty has now been widely adopted in Canada. Physicians from around the world come to Toronto to study how it works. In addition, because the Department of Anesthesia closely monitors patients’ outcomes—from the preadmission clinic to discharge—the Holland Centre is a hub for research on outcomes after joint replacement surgery.

Let us next consider, in contrast, two examples where there is an urgent need to transform care, each of which involves providing anesthesia in “remote” locations. The first is the growing demand for anesthesia care in environments remote from the operating room (OR), such as radiology suites and endoscopy centres. Advances in minimally invasive surgical techniques, along with constraints of the traditional OR and the rising costs of hospital care are driving this demand. Anesthesiologists working in these “remote” locations experience certain challenges. For example, the anesthesia support team may not be as

Fig. 4 Average hours of staff overtime for four-month periods in 2004 (red) and 2007 (black). Similarly, average number of surgical cancellations during four-month periods in 2004 (red) and 2007 (black)

Fig. 6 Results from the American Society of Anesthesiologists Closed-Claims analysis program. A) Severity of injury for care in remote locations versus the operating room. B) Mechanisms of injury for claims involving care in remote locations as compared to the operating room. (Reproduced with permission from the Anesthesia Patient Safety Foundation 2011 Spring-Summer Newsletter)

familiar as the OR staff with such concerns as emergency management of the difficult airway.

A recent analysis of the American Society of Anesthesiologists (ASA) closed-claims database, which reviews medicolegal claims reported to insurance companies, suggests that major changes are needed to improve safety in “remote” care areas.² A comparison of adverse events associated with anesthesia inside and outside the OR revealed a higher mortality rate for anesthesia applied in the latter setting (Fig. 6). The proportions of patients with permanent brain damage were similar, although out-of-OR anesthesia is generally used for lower-risk patients. Adverse respiratory events were more common with anesthesia outside the OR, as were episodes of hypoxia. Not surprisingly, expert reviewers judged a substantially greater proportion of adverse events as preventable for anesthesia service outside the OR. Adopting the new mandate to provide comprehensive care, from preoperative assessment to discharge, would compel us to develop standardized care paths for remote care settings, which would in turn ensure that procedures are performed safely.

The second example of a situation in Canada where more work is needed involves Ms. Adell Robson, who resides with her family in the remote town of Bella Coola, British Columbia (Fig. 7). For more than ninety years, mothers such as Ms. Robson had access to birthing services

Fig. 7 Newspaper clipping from the *Costal Mountain News*, [March 3, 2011] the local paper in Bella Coola, British Columbia shows Ms. Adell Robson and her family. Reproduced with permission

and anesthesia care through a family physician program at the Bella Coola General Hospital. Maternal and newborn outcomes at the hospital were excellent, but today these services are no longer available.^{3,4} Women must travel six hours over a treacherous road in the weeks before their anticipated delivery date and wait to deliver in the hospital at Williams Lake. This lack of local birthing services is destructive to the community and is also expensive, as families must absorb the costs of housing and child care while staying in hotels and hostels.

Bella Coola is not the only Canadian community where anesthesia and birthing services have been withdrawn. The town of Bella Bella has suffered the same fate, and towns as large as Fort Nelson sometimes lack anesthesia services. Sadly, this is not progress; it is a step backward, amounting to denial of adequate health care to our fellow Canadians. An analysis of the demise of the birthing services suggested that a lack of anesthesia care was a contributing factor.⁵

How can we address the problem of limited access to care and develop new care options? For patients living in geographically remote settings, we must develop comprehensive care pathways, from preoperative assessment to discharge. Part of this new anesthesiology mandate is to assist the care teams that include family physicians, nurses, surgeons, and allied health professionals to implement care programs in remote regions.

Lesson learned from Vince Hughes

The St. Lucian story and the three additional examples outlined above teach us that to improve patient safety and throughput, anesthesiologists must focus on the whole patient and transform the current care pathways.

Dr. Hughes taught that the commitment of the anesthesiologist begins in the OR but extends throughout the patient's hospital stay.

Story 2: Scientific inquiry

The second story begins on my birthday. I was born as a second twin by breech delivery, sustaining a fracture of the clavicle. The fracture developed nonunion, so at age seven I underwent surgery at The Hospital for Sick Children in Toronto, Ontario.

Twenty years later, I was working as an anesthesia resident at the same hospital. Astonishingly, I found that the anesthetic drugs used for my surgery during the mid-1960s were essentially the same as those that my children might receive now: an intravenous induction agent, a muscle relaxant, intubation, and an inhaled anesthetic with a low therapeutic index. In principle, the drug regimens have not changed even though monitoring and drug delivery systems have improved.

The notion that anesthesia safety has reached a plateau is supported by a study by Lagasse et al., (2002).⁶ The report documents that anesthesia-related mortality did not change over a 32 year period from 1960 to 1992. The mortality rate remains at approximately 1 per 13,000 patients. In poorer countries, like Togo, anesthesia-related mortality remains 100-fold higher.⁷

Given that anesthesia mortality rates have “flat-lined,” quantum improvements in morbidity and mortality rates can occur only with new drugs and treatments. Such advances are not likely to happen in ORs but, rather, in research laboratories. Indeed, game-changing discoveries that could enhance anesthesia practice may be unfolding right now in laboratories around the world. To take full advantage of the latest scientific discoveries and to translate such discoveries to patient care in a timely fashion, anesthesiologists need to participate in biomedical research. Our primary responsibility is to provide patient care but we also have a responsibility to bring the best science to bear on anesthesia-related problems. We cannot stand on the sidelines and expect others to address the limits of our knowledge base related to perioperative care.

Some argue that anesthesia is now so safe that bench research is not required and that any advances are merely incremental. This is a false argument for several reasons. First, it relies on a narrow definition of our profession. It assumes that the work of anesthesiologists is related only to care in the OR. Second, anesthesia is generally safe but only because of the tremendous resources and expense that are required to administer anesthetic drugs safely. Finally, we are beginning to understand that anesthesia care in the OR influences long-term outcome. Take, for example, the

studies of Dr. Terri Monk, who showed that previous brain injury that has left no overt residual deficits increases the risk of postoperative cognitive deficits. This observation leads to important questions.^{8,9} Preclinical studies are needed to determine the underlying mechanisms that lead to cognitive decline and to identify possible prevention strategies for patients at risk.

Top three reasons for biomedical research

Anesthesiologists are in an excellent position to undertake biomedical research for three reasons. First, such research is our heritage. Many departments of anesthesia were founded on a commitment to science. For example, at the University of Toronto, the Dean of Medicine recommended formation of an independent anesthesiology department in 1951 because “anesthesia has made considerable advances in the past 15 years” and “there is constantly a search for new methods of inducing anesthesia which constitute a greater measure of safety in seriously ill and injured patients.”

Second, our clinical practice offers a unique perspective, as it is aligned with the most important advances in science, including genomics and molecular medicine. Every day we witness the variability of patient responses to high-risk drugs that needs to be understood. We are also well aware that acute pain can lead to chronic pain; yet the factors that facilitate or prevent the transition from acute to chronic pain await elucidation.

Third, we are in the enviable position of being able to translate knowledge rapidly from the bench to clinical practice. The high acuity of the patients we treat, our keen observational skills, and our ability to monitor patients carefully and acquire large amounts of quantitative data provide an ideal environment for implementing new treatments.

Anesthesiologist as clinician-investigator

A cohort of anesthesiologists needs to be developed to undertake such research. An example of an anesthesiologist who is also an innovative biomedical researcher is Dr. Gregory Hare, who works with a team of investigators at St. Michael's Hospital in Toronto. He has been using mouse models to address important knowledge gaps such as how the brain responds to low concentrations of hemoglobin.¹⁰

How do we encourage the development of more anesthesiologists like Dr. Hare to undertake biomedical research? Expanding the cohort of clinician-investigators is not easy. More than three decades ago, a director of the U.S. National Institutes of Health described physicians who conduct research as “an endangered species” because the

number of medical doctors applying for major research grants was decreasing while the number of PhD applicants was rapidly rising.¹¹ This trend has continued.

Physician-scientists report that the most influential factors in their decision to pursue a career in science are an innate curiosity, positive role models, and exposure to research during postgraduate training.¹² When such researchers were asked what initiatives would be needed to expand the physician-scientist workforce, the number one factor was increased job security. Clinician-scientists who undertake rigorous and lengthy research training need to believe that a suitable career path is achievable. In fact, research programs develop by supporting one investigator at a time. It falls on the shoulders of residency program directors, hospital site chiefs, and department chairs along with research committees to jointly create research opportunities during and after postgraduate training to establish career paths for anesthesiologists.

Lesson learned

The lesson we can take from this second story is that anesthesiologists must engage in biomedical research to facilitate the quantum leaps needed to improve perioperative outcomes. This goal, in turn requires the development of a cadre of young investigators who are equipped with research skills and who are assured of a career path.

Story 3: Memory-blocking receptors and beyond

The third story derives from discoveries in my laboratory. The purpose of telling this story is to illustrate how basic science studies that were initially triggered by anesthesia-related questions can produce results with broad potential therapeutic applications that extend beyond our specialty.

During the 1990s, we established a neuroscience laboratory at the University of Toronto. Our aim was to understand how anesthetics depress the central nervous system. The laboratory was a collaborative effort between John MacDonald, a professor of physiology, the Department of Physiology, University of Toronto, and physicians in the Department of Anesthesia at Sunnybrook Health Sciences Centre.

Our goal was and still is to address a lack of understanding about the mechanisms of action of anesthetics. Anesthesia is administered to 234 million patients worldwide each year, but we still do not understand how these drugs work. Anesthetics produce different behavioural endpoints that allow the patient to tolerate surgery, including memory loss, unconsciousness, and immobility. They also produce life-threatening adverse effects such as respiratory depression. Increasing evidence suggests that

these desired and undesirable anesthetic endpoints are mediated by different receptors that are expressed in different regions of the central nervous system. The development of molecular biological techniques has offered us tools to disambiguate the specific receptors that mediate the desired therapeutic effects from the adverse effects. Studies evaluating the anesthetic phenotype of genetically modified mice are allowing us to identify key drug receptors. Identifying such key receptors, in turn, allows drug development to move forward.

Our specific goal was to understand the mechanism underlying the memory-blocking properties of anesthetics. These studies were motivated by a spectrum of clinical disorders, ranging from intraoperative awareness (insufficient memory loss) to postoperative cognitive function (too much memory loss). We also use anesthetics as probes for studying the molecular biology of memory.¹³

Memory blockade is one of the most potent actions of anesthetics. Recall or conscious recollection is blocked at doses that are considerably lower than the doses that cause sedation or immobilization. When I began these studies, the receptors causing memory blockade by anesthetics had not been identified.

We subsequently discovered a subtype of γ -aminobutyric acid (GABA) receptor that was highly sensitive to low concentrations of memory blocking anesthetics.¹⁴ We then elucidated a unique molecular composition of the receptor.¹⁵ Armed with this knowledge, we set out to study whether genetically modified mice lacking these particular receptors were resistant to the memory-blocking properties of anesthetics, which they were.¹⁶

Over the past several years, we have discovered similar populations of GABA_A receptors expressed in the spinal cord that are novel targets for nonopioid analgesics.¹⁷ Surprisingly, GABA_A receptors are also found outside the nervous system in organs such as the lung and pancreas. In collaboration studies, we discovered that GABA_A receptors are expressed in airway epithelial cells.¹⁸ Why are GABA_A receptors expressed in lung cells? It turns out that they regulate mucus production. Most importantly, we found that inflammation increases the expression of GABA_A receptors and thereby increases the production of mucus. Blocking these GABA_A receptors reduces the production of mucus and improves the signs of asthma in animal models. These lung receptors are now being investigated as potential targets for antiasthmatic drugs.

We recently turned our attention back to our primary focus, memory. We wondered if GABA_A receptors in the hippocampus are also involved in memory deficits associated with inflammation. Most people realize that their memory is compromised when they are sick. Clinical studies have confirmed this observation. Certainly, nobody wants to write an examination when they have the flu. Our

preliminary results show that the activity of this inhibitory receptor is increased during acute inflammation. Furthermore, drugs that inhibit the function of these GABA_A receptors restore the memory performance of mice.

On the basis of these laboratory studies, we are working with the team at the Holland Orthopaedic & Arthritic Centre in Toronto to study the association between inflammation and memory loss during the postoperative period. Thus, we are bringing the studies full circle, from the bedside to the laboratory and back to the bedside again.

Lesson learned

Anesthesia-related biomedical research can drive the major changes in perioperative care, and anesthesiologists need to participate in bench research. Our pursuit of a receptor for anesthetic drugs has identified potential new targets for the treatments for pain, asthma, and memory disorders.

Conclusions

In summary, anesthesiology is at a turning point. The profession can no longer remain focused on providing anesthesia care in the OR and responding to requests for out-of-OR services on a case-by-case basis. We must now embark on a new mandate to undertake and transform care throughout the entire perioperative period and become leaders in biomedical research. Such transformative change is not easy, but the lessons learned from Dr. Vince Hughes remind us that anesthesiologists do not shy away from difficult tasks. The investment will be worthwhile because, as shown by the Holland Orthopaedic & Arthritic Centre, this new mandate for anesthesiology can improve the lives of our patients and the professional lives of anesthesiologists for generations to come.

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