





Roscoe — Issue No.1

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Editor's Note

This is the most exciting time in the history of human civilization to be a surgeon. And that's saying a lot, because the history of surgery is intensely exciting — a series of astonishing and escalating accomplishments, devastating defeats and relentless determination and renewal. Today surgeons are at the forefront of movements from molecular biology to global public health. Surgeons in Canada and around the world run basic science labs to probe the secrets of inflammation, immunology and oncology. They bridge the chasms between the bench and bedside. They explore the limits of the systems they have created, making connections between disparate fields like industrial manufacturing, aviation, or public health and surgery to solve problems, to continuously improve clinical processes, and to optimize the experiences of their patients. Surgeons are among the first to respond to humanitarian crises, and to translate the lessons forged in these crises to everyday surgical practice and public health. In times of crisis it is often surgeons, with lifetimes and generations of preparedness and organization, who see opportunity.

General surgeons are the pioneers, innovators, and architects of modern trauma systems, oncology networks, and solid organ transplantation systems. The mindset that pushes them to understand the impact of life threatening illnesses on multi-organ systems also drives them to ensure the delivery of prompt and comprehensive care to all vulnerable patients, without regard for socioeconomic status or geography. Surgical systems, with a long tradition of objectivity, transparency and data-driven performance improvement, have provided the blueprint for many other systems of acute health care.

The complete care mindset, rooted in compassion and attention to detail, also pushes surgeons to the frontiers of technology. Surgeons have changed the landscape of health care through the invention and wide scale adoption of minimally invasive technologies and techniques. And we will do so again by harnessing the power and potential of information technology to support complex decisions and to tailor surgical treatments with greater precision.

This inaugural publication, named after one of Canada's most innovative general surgeons and surgical leaders, is a celebration of creativity, innovation and dedication in Canadian general surgery. Each article is evidence that the insight and energy that change the world can come from anywhere and take any form. Canadian surgeons have much to be proud of and much more to accomplish. We are both the products of a long history of accomplishment, and the promise of a great future of clinical and technical excellence and creativity. This is the legacy that unites our community of surgeons, regardless of clinical interest or subspecialty, in a common agenda to make the lives of our patients and populations better. It is the legacy that is passed from Roscoe R. Graham to Emily Partridge and Andrea MacNeill, and to the next generations of surgical pioneers, innovators, and idealists.

We are grateful to this surgical community, and excited to see what we will accomplish together next.



Morad Hameed



Anonymous. Roscoe R. Graham. A1982-1059, File 3, University of Toronto Archives & Records Management (Retrieved 2014)

The Origins of Surgical Innovation A Profile of Roscoe Reid Graham

Story by Alexandra Istl and Daryl Gray

“There [are] more surgical problems awaiting solution today than ever in history.”

Dr. Roscoe Graham’s comment in a 1938 lecture on surgical development at the Toronto General Hospital captured the expansive, pioneering spirit of general surgery. He understood that “surgery had reached a position where all barriers are down and no avenue is closed.” Graham saw surgical problems as great opportunities, with solutions waiting to be discovered and, with each solution opening new lines of inquiry and limitless possibilities for discovery.

Graham was born on January 2, 1890, in Lobo Township, near London, Ontario. His father, Peter Graham, was a country doctor, whose three sons all followed him into medicine. Roscoe went to medical school at the University of Toronto and did his internship at St. Michael's Hospital, finishing in 1913, at the age of 23. He was already an explorer, leaving Toronto to diversify his education at training programs in London, Edinburgh, Vienna and Berne.

He began his career at the threshold of WWI. The Royal Canadian Medical corps recruited him to serve at the No. 4 General Hospital in London, England. With his first years in practice shaped in this crisis, he returned to Toronto to join the staff at the Toronto General Hospital.

He built his surgical practice in Toronto at a time when Canada was making its mark on the world.

Frederick Banting and Charles Best had just changed the future of medicine with their discovery of insulin. In doing so, however, they inadvertently shed light on the symptoms and signs of hypoglycemia. In 1929, when a patient presented to the Toronto General Hospital with a six-year history of sporadic convulsions and coma, Dr. Graham was consulted for surgical exploration, in the hopes that he would identify an insulin-secreting lesion. Only two such procedures were previously attempted, and neither discovered a discrete mass. After careful deliberation, Graham operated on his patient and enucleated a discrete, functional beta islet cell cancer. She lived for 23 more years. At 39, Graham became the first surgeon in the world to successfully resect an insulinoma.

In 1937, Graham's thoughtful commitment to patient outcomes led him to describe the technique that now holds his eponym. At the time, perforated peptic ulcers were treated with gastroenterostomies. Graham found this to be excessively morbid. He believed in a fundamental principle of emergency surgery, "the patient

be treated solely for the lesion creating the emergency, and ...any procedure of a more extensive nature ... [is] meddlesome surgery."

His solution was the Graham patch. He reported that it could not be more simple: "Three interrupted catgut sutures are placed [across] the perforation. A piece of omentum, either free or attached, is laid over these sutures, which are then tied. The free omental graft provides the stimulus and the scaffolding for [fibrin] formation."

His revolutionary technique is still used today as originally described, and has probably saved millions of lives around the world. It has taken on new life in a minimally invasive surgical climate and found new applications in the management of traumatic solid organ injuries. The simplicity and elegance of the Graham patch reflects a deeper philosophy on the role of surgery in acute illness that has stood the test of time and shaped a profession.

Graham balanced a busy clinical practice with a wider commitment to his profession and to health care. Like many general surgeons, his curiosity and commitment to patient care was unconstrained — he was a pioneer in other areas, including the management of severe rectal prolapse. He was an educator and a writer. He became the head of the First Surgical Division at the Toronto General Hospital, and the Secretary and, ultimately the president of the Canadian Association of Clinical Surgeons. As an editor of the Annals of Surgery, his thought leadership extended beyond insulinomas and ulcers and national boundaries.

Graham embodies the pioneering, innovative and compassionate spirit of Canadian surgical care. By setting an example of thoughtfulness, creativity, discovery, and citizenship, driven by intense dedication to the outcomes of his patients and the welfare of his colleagues, he charted an inspiring roadmap for modern surgical endeavor with new avenues of exploration and opportunity at every turn. ●

Survival of

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Lambs

In April 2017, Dr. Emily Partridge published a paper in *Nature Communications* describing the successful maturation of fetal lambs in an artificial placenta. Within days, the astonishing medical breakthrough had been picked up by over 400 news outlets, and the story, along with a YouTube video of one of the lambs wriggling around in its plastic womb, had gone viral. But as her paper skyrocketed to the highest Altmetric score a *Nature* publication has ever received, Partridge was busy feverishly preparing for her Royal College exams in general surgery.

Rising Star — Emily Partridge

Story Andrea MacNeill
Illustration by Amy Wetton

The audacity of taking on a challenge that had bettered so many of her predecessors makes Partridge’s achievement all the more formidable.

With FRCSC now indelibly etched after her name, Partridge has time to reflect on the origins of what may prove to be the biggest development in neonatology in decades. The University of Toronto graduate describes the impact of participating in a preterm delivery of a 21-week gestation infant while a third year medical student on her obstetrics rotation.

“The fetus was delivered, had a few efforts at respiration and succumbed pretty quickly. It was just so obvious being in the room how frustrating it was for everyone that we couldn’t do more to save that baby.”

The encounter led her to reflect on the simplicity of the problem — the need to recapitulate the uterine environment and re-establish normal fetal physiology — and to investigate the technical challenges that had thwarted the many prior attempts to achieve the holy grail of neonatology.

Four years later, she took a leave of absence from her General Surgery residency to assume a post-doctoral position in the lab of Dr. Alan Flake, a fetal surgeon at the Children’s Hospital of Philadelphia (CHOP), to forge a path to becoming one of Canada’s most promising surgeon scientists.

As Partridge explains, the current paradigm of neonatal resuscitation imposes adult physiology on preterm infants whose organs are not yet developmentally prepared for post-natal processes like pulmonary gas exchange and enteral nutrition.

“These things are a departure from the normal experience of the fetus and their organs in the uterus at comparative stages development. The consequence of the current standard of care is that infants who are born at 22 to 24 weeks have an 80 to 90 per cent mortality and almost a 100 per cent chance of having lifelong health problems and challenges related to the lack of organ maturation at the time they were born.”

Her artificial placenta represents an alternative to current resuscitative practices by maintaining the preterm infant in a fluid environment on an extracorporeal oxygenation circuit to allow ongoing organ development under normal physiologic conditions. In her animal model, Partridge has successfully maintained lambs at the gestational equivalent of 23 to 24 weeks of human development for four weeks, bringing them to full fetal maturity. Intensive fetal monitoring has demonstrated persistently stable hemodynamics, normal blood gas and oxygenation parameters, and patency of the fetal circulation.

Post-natal studies have confirmed normal somatic growth, and normal lung and brain development.

“The artificial placenta represents an environment where even for those infants whose lungs aren’t yet capable of critical gas exchange we are able to offer them the ability to grow and develop and the organs can continue to mature in an environment that’s analogous to what

they would have been experiencing in utero ... That’s a huge lift in terms of overcoming the physiologic limitations of prematurity.”

As with all great innovations, this one was shaped by many formative people and places. Partridge credits her undergraduate experience at the University of Toronto with cultivating the intellectual curiosity and critical thought processes that laid the foundation for her recent breakthrough.

Those early years were spent immersed in the lab, investigating the microbiology of cockroaches and acquiring a thirst for scientific inquiry that prompted her subsequent Master’s and PhD.

During her graduate studies in the laboratory of surgical oncologist Dr. Carol Swallow at Mount Sinai Hospital, she was required to collect surgical specimens for tumour profiling in Lynch Syndrome. It was this clinical exposure that inspired her to pursue a career in surgery.

Partridge points to the mentorship of Dr. Swallow as a profoundly formative influence in her journey to becoming a surgeon scientist. Similarly, she credits Dr. Jack Langer, pediatric surgeon at Sick Kids’ Hospital, with steering her in the direction of CHOP when she expressed an interest in fetal surgery, and encouraging her to take advantage of the unique funding opportunities in the U.S. to develop her idea of the artificial placenta.

To be fair, the idea of the artificial placenta did not originate with Emily Partridge, but has

The losses kept us going and kept us inspired to improve.

been the subject of repeated efforts by the scientific community since the advent of cardiopulmonary bypass technology.

The audacity of taking on a challenge that had bettered so many of her predecessors makes Partridge's achievement all the more awe-inspiring.

She describes the process of meticulously dissecting previous attempts to recreate the uterine environment and identifying the reasons for their failure in order to convince her supervisor to invest in another endeavour.

Flake's well-placed skepticism turned to admiration when Lamb No.1 survived 23 hours, far outlasting the longest survivor (four hours) of any prior published work. Together they proceeded to systematically address the failures and flaws at each step, employing a pumpless arteriovenous circuit powered by the fetal heart, developing a novel method of cannulating the umbilical vessels, and arriving at a closed system to minimize the risk of sepsis, simulating ever more closely normal fetal physiology with each iteration.

Each lamb's demise took an emotional toll, but also served as a valuable learning experience and opportunity to refine the model.

"The losses were really heart breaking on an individual level, but they were also incredibly motivating because each one posed the possibility of exploring exactly what went wrong. They kept us going and kept us inspired

to improve, and now I think we have come to a prototype that is incredibly safe because we have seen all of the various permutations of what can go wrong and have developed a 'what if' solution for everything we can conceive of."

Partridge will soon take up residence in CHOP (literally — the training program is so demanding that each pediatric surgery fellow has in-house living quarters) where she anticipates being positioned to test the artificial placenta in a clinical trial within three to five years. The pre-clinical data is currently under accelerated review by the FDA and a patent for the technology is pending.

"I'm convinced that it is going to take the next 10 to 20 years of my career to actually get a human infant through this successfully and implement it into common practice, but having said that, I'm also completely convinced that it is going to become the standard of care."

Partridge modestly acknowledges the improbability of a game changing innovation like hers and is grateful for the fulfillment of a clinical career regardless of the outcomes of the artificial placenta.

"Even if I don't succeed in being part of a discovery on the magnitude that I want, at least I can look back on my life and say that I looked after individual people, I was a surgeon, I cared for people and I made an individual difference. I saved lives." ●



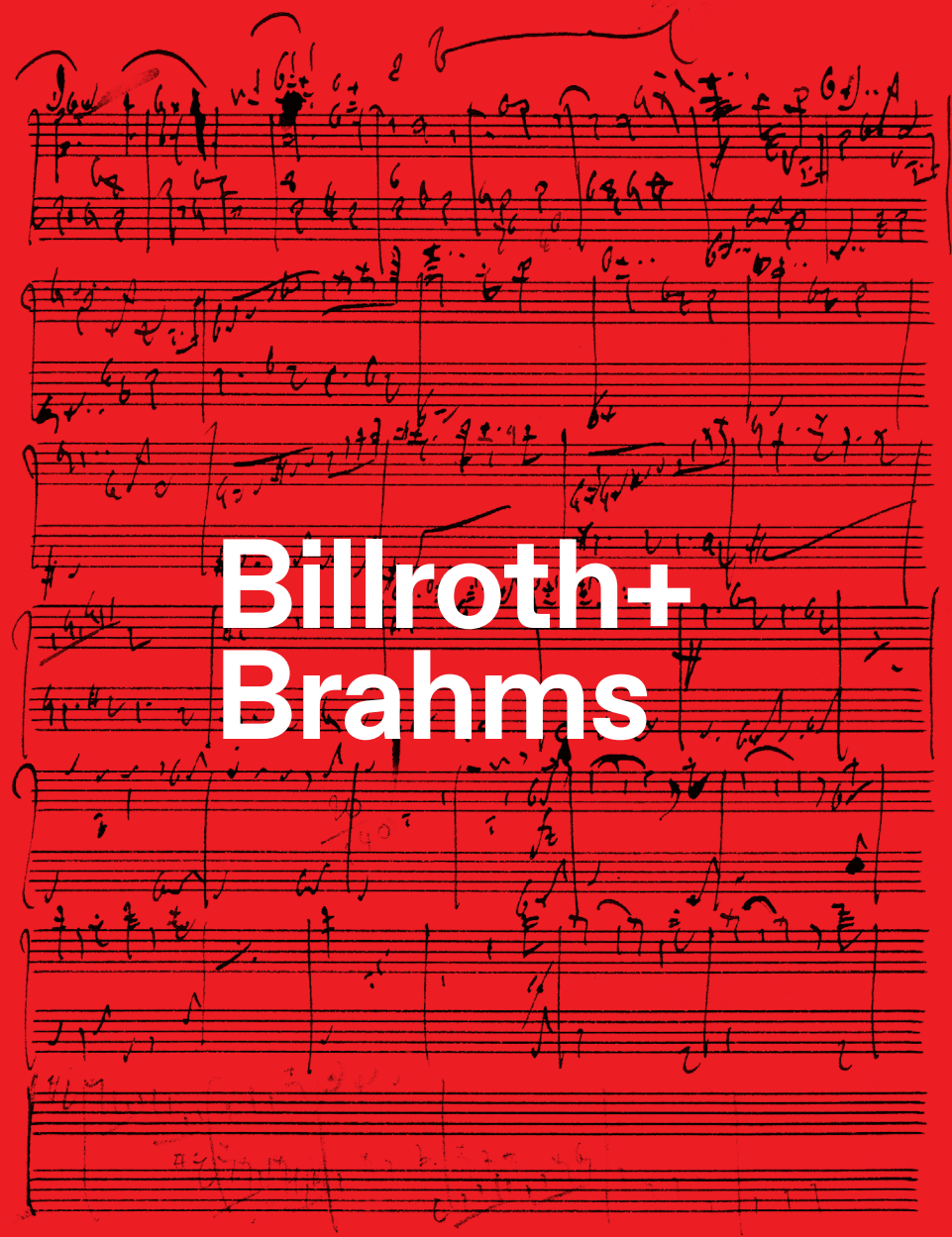
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Billroth+Brahms

De Agostini Picture Library Collection / A. Dagli Orti / Gettyimages

A Tale of Two Geniuses

Theodor Billroth was the founder of modern surgery and a close friend of composer, Johannes Brahms. Their remarkable friendship tells us much about innovation and imagination — and where they intersect.

By Savtaj Singh Brar & Ikennah Browne

Vienna.

Even whispering the name of the Hapsburg Empire's former capital evokes visions of the Ringstrasse and smoky, crowded coffee houses. From Freud and Wittgenstein to Mendel, Mozart and Beethoven, the citizens of the city gathered during one spectacular epoch, the epicentre of artistic, cultural, philosophical and scientific achievement in the second half of the 19th century.



Adalbert Franz Seligmann.
*Der Billroth'sche Hörsaal
im Wiener Allgemeinen
Krankenhaus*, 1888/1890.
Oil on canvas, 114 × 87 cm.
Österreichische Galerie
Belvedere, Vienna.

B

During my residency in general surgery, while exploring the city’s wonders, I found myself at the Josephinum, the museum of medical history. There, amongst antiquated medical texts, models and drawings, was a thing of wonder: the actual specimen from the first pyloric resection successfully performed by the pioneering surgeon, Theodor Billroth.

The inscription, written only in German, was brief — too brief to truly account for the remarkable background of Billroth’s innovation. That story unfolded later, as I delved into the history of Professor Christian Albert Theodor Billroth.

Billroth was born in Prussia on April 26, 1829 and died on February 6, 1894. Billroth lived what was amongst the most remarkable careers in the history of surgery. A man of letters, active in politics and renowned as a patron of Vienna’s vibrant musical scene, Billroth’s vast scope of interests and influence outside of medicine meant that upon his death, at age 64, a state funeral was held in his honour, with his casket carried by eight black horses, led by a thousand students carrying candles, through the Ringstrasse, by the university, and finally to the

Zentralfriedhof, the Vienna Central Cemetery.

Among the crowds that day was Johannes Brahms. As the funeral procession passed by, Brahms watched, following at a distance from the crowd. Such was the outpouring of admiration that Brahms would later say, “I wish you could witness what it means to be loved in Vienna.”

Over many years, first in Zurich and later in Vienna, the two had developed a singularly important friendship. While many of today’s surgeons know Billroth’s contribution to practice of surgery, the story of his friendship with Brahms gives us a picture of not only a unique intellect, but also how success in surgery can also mean balance, creative pursuits and thinking completely outside of the box.

After graduating from medical school, Billroth worked in Berlin as an assistant to Professor Bernhard von Langenbeck, where he was a highly productive researcher. Later, during his first academic posting as Professor of Surgery in Zurich, he explicated the relationship of benign colonic polyps in the development of malignancy, and worked on the embryology and anatomy of the spleen. His lectures and

It is one of the superficialities of our time to see in science and in art two opposites, imagination is the mother of both.

writing earned him renown as a leading thinker in academic surgery. By the age of 38, he was appointed Professor of Surgery and Head of the Second Surgical Clinic at the University of Vienna.

A pioneer in the truest sense, Billroth performed the first laryngeal resection, worked on approaches to oesophageal resection, and achieved very early success in rectal cancer excision. Following his lead, his pupils went on to perform the first abdominoperineal resection, the first curative colon resection, and the first sphincter-preserving rectal resection. The first successful resection of the stomach remains his most famous achievement. The approach to the first gastrectomy bore all the hallmarks of innovation in Billroth's career: the painstaking culmination of years of anatomic and physiologic study, attempted with great care and only after exhaustive animal and cadaveric simulation.

His innovations did not end in the laboratory or operating theatre. He proposed regular temperature assessments on patients after surgery, and was the first to perform audits on the surgical service, a forerunner to morbidity and mortality rounds and quality improvement in surgery. His approach to surgical education was famously adopted by Dr. William Halstead, who took his experiences in Vienna back to the United States.

Astonishingly, despite Billroth's success as a surgeon and innovator, medicine wasn't the career of his choosing.

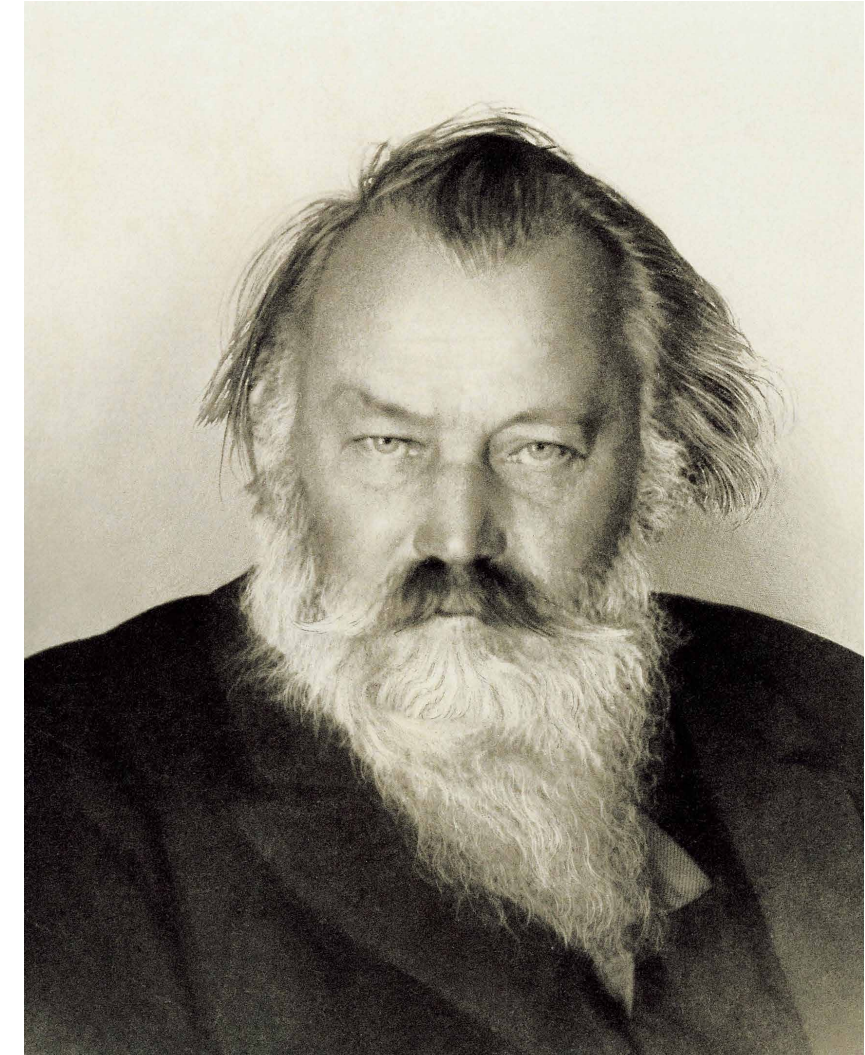
A below-average student, he preferred playing piano to studying, and had to be tutored privately to graduate from high school. An accomplished amateur on piano and viola, he was fascinated by music theory and criticism. Talented as he was, his mother insisted on a medical career. "I may have been married to medicine," Billroth later said, "but music was always my mistress." He was often seeking connections to the world of music wherever his surgical career took him. In Zurich, he immersed himself into the company of professional musicians, and parlayed that into a job as a newspaper music critic, and was even asked to be a guest composer of the Zurich Orchestra.

A meeting of minds

It was there, in Zurich, that Billroth met Brahms. Their backgrounds were quite disparate. Billroth came from an educated middle-class family, whose connections opened doors not only in his medical career, but also in the arts. Brahms, on the other hand, came from very modest means, and had used his musical talent at a very young age to support his family.

So, too, were their personalities opposite: Billroth was warm, generous and charismatic; Brahms was difficult, abrupt and obtuse. Yet it was mutual respect and a shared love of music that drew them together.

Critical of the popular music of contemporaries — he found Franz Liszt to be vulgar and



Portrait of composer, pianist and conductor Johannes Brahms. 19th century. Historisches Museum der Stadt Wien.

De Agostini Picture Library Collection / A. Dagli Orti / Gettyimages

disliked the work of Richard Wagner — Billroth became a champion to his friend Brahms, and would try in any way he could to advance his friend's career. Brahms would come to value Billroth's opinion. Billroth would read all of Brahms works, becoming a reviewer of drafts of his compositions.

Yet, it was in Vienna that Brahms' star would rise. Before Brahms debuted a new piece, he would first perform at Billroth's home before a private audience of wealthy patrons, as well as fellow musicians and artists. Billroth's home was a hub for the cultural, artistic and intellectual elite, and his musical soirees would be of unmistakable value to Brahms.

"Billroth was attracted to my music at a time when most people didn't want to hear any of it," Brahms would say. "This friendship has been a gift of fortune and his warm enthusiasm has become a necessity for me."

Performance and surgery

For Billroth, music and surgery intersected in performance. The essence of this is perhaps best captured by the seminal painting *Theodor Billroth Operating* by Adalbert Franz Seligmann. There, in the Allgemeine Krankenhaus operating theatre, Seligmann portrayed Billroth as a conductor of the surgery, with his assistants supporting in the retraction of organs, the delivery of instruments and the administration of anaesthetic. Seated around them is a gallery of fascinated spectators, medical students, visiting surgeons and members of the public. The painter himself is at the right of the painting, taking notes of Billroth's performance.

Seligmann was not alone in seeing the connection between surgery and performance. In a paper titled *Music and Surgery: A Literary Reappraisal*, Demetrios Moris and his colleagues at the Athens School of Medicine in Greece proposed that surgery, like music, is a form of art where surgeons combine intelligence, talent

and skill during even the most straightforward operations. Surgeons and musicians, they argue, should develop concentration, anticipation and improvisation. But while an overlap exists in that both the performance of music and surgery are technical exercises, music is also intrinsically creative.

And that begs the question: Was Billroth's incredible productivity as a surgeon in some part related to the outlet that music provided? Would his surgical career have been more conventional, if his life outside of medicine was more conventional, too?

In a word, yes. In her work exploring factors influencing academic productivity, sociologist Mary Frank summarized that certain cognitive traits improve productivity, such as the ability to 'play with ideas', to recombine familiar concepts in new ways, to delay closure of ideas, and to accept the abstract and ambiguous.

There is growing recognition that creative personality types may have advantages, through creative hobbies in performance. According to Dr Kevin Eschelman, an organizational psychologist who has studied the impact of creativity on human functioning, those who recover from the stress of work through creative hobbies are not only more creative in the performance of their work and more likely to help others in their workplace, they also feel in greater control of their lives.

The intersection between the "performance" of surgery and his musical interests may have helped Billroth avoid the burnout that seems endemic to life in medicine and surgery. After all, the root of burnout is thought to be emotional not physical exhaustion, and a sense of depersonalization. It has been said that "music is the medicine of the mind" and for Billroth, perhaps music was a safeguard that allowed him to continue his innovative work as a surgeon and scientist.

Later in life, Billroth suffered a bout of pneumonia, followed by what he would call

Music is the medicine of the mind.

John Alexander Logan

a 'slow and comfortable decline' in his final years. Without the vigour with which he had approached his surgical career, yet feeling a compulsion to be useful, Billroth focused on music. Sadly, this coincided with the decline of his friendship with Brahms.

For years, the two were devoted friends, writing often and even travelling together. But their differences in character and temperament increasingly became a problem — and it bled into their love of music.

When Brahms sent Billroth a copy of *A minor String Quartet Op 51*, dedicating his two string quartets to the surgeon, Billroth enthusiastically cut out and framed the first lines of the manuscript. Brahms was dismayed at what he must have felt was a disrespectful act. Billroth, in his defence, felt the dedication would be memorable long after his surgical prowess was forgotten, since he felt that "it is a human fact that love weighs more than great respect."

As Billroth turned his attention to music and applying his scientific approach to elucidate a physiologic understanding of the interpretation and enjoyment of music, the two men would argue. Billroth argued with Brahms on the use of the minor key in composition; Brahms would bristle over Billroth's questioning of the creative process.

Billroth theorized that composition comes from inspiration; Brahms would be angered that Billroth seemed dismissive of the talent, dedication, and intelligence required to compose great music.

Eventually, Billroth complained about

Brahms' rudeness in a letter to a mutual friend, adding that his personality was probably the product of his modest social upbringing. The letter, mistakenly sent to Brahms himself, triggered the final act of their long friendship. Hurt and angry, Brahms publicly refused to play during a soiree at Billroth's home. The two occasionally wrote after that, but their friendship was over.

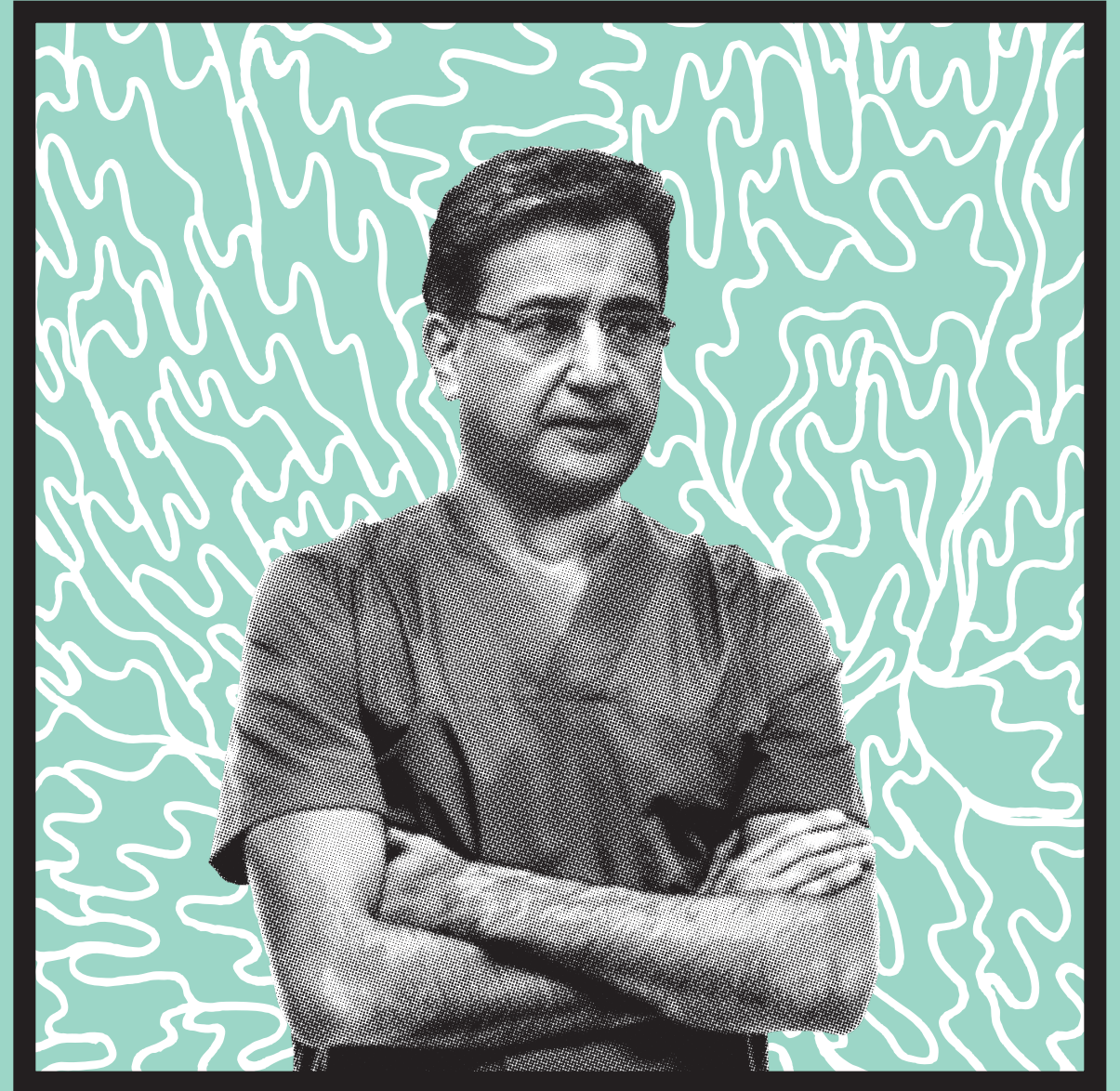
The science of music

In the end, Billroth's first love was also his last. As his health faded, he moved to the seaside resort Abbazia, in the town of Opatija, in modern-day Croatia. There, in the hotel, he cheerfully spent his days immersed in thoughts about music, theorizing about music, corresponding with others about music, and writing about music. Two days before his death, he gave a copy of a manuscript for his study of musicology to a friend, having scribbled notes in pencil about his last fleeting thoughts on his final work. Within a few years, this manuscript was published as one of the first works of scientific enquiry into music.

Billroth's death deeply affected Brahms, who was remorseful at how their friendship deteriorated. When Brahms himself passed away, his funeral procession passed through the streets of Vienna, as had Billroth's three years earlier, accompanied by throngs of Viennese citizens, performers, patrons, composers and critics, to his final place in the Zentralfriedhof, the Central Cemetary, not far from his old friend. ●

In lung transplantation, “inside the box,” or the current state, is the rapid explantation of donor lungs, ischemic time, perfusion with hypothermic preservative solution, rapid transport, rapid implantation, and the fervent hope that the newly transplanted lungs will be able to sustain life once again after a perilous and traumatic journey. “Outside the box” is the radical new concept of an “organ repair centre,” a one-stop shop where surgeons repair and pre-condition previously unsuitable organs and package them for shipment to hospitals for transplantation. *The amazing thing is such a repair center already exists.*

Thinking Inside the Box



With Shaf Keshavjee

Story by Chethan Sathya, Ikennah Browne, Indraneel Datta
Illustration by Luke Pauw

The future is only as limited as the technology used. / What we are

Lungs are notoriously fragile. The process of explanting them, locating a match, transporting them hundreds of kilometres, and implanting them successfully into patients who have nearly reached the end of life, is one of the miracles of modern medicine. Once they are in, you have to keep them dry, minimize the impact of barotrauma (from ventilators that at once sustain and damage them with every breath), suppress rejection, prevent infection, and make the frailest of patients strong again.

The complexity of this process may be reflected in the timeline of solid organ transplantation: the first successful long term lung transplant was done in 1983 at the University of Toronto, 29 years after the first kidney transplant, and 16 years after the first heart and liver transplants. Before and since then, the optimization of the lung transplant process has preoccupied surgeons and investigators at the University of Toronto, perhaps more than anywhere else.

This is where Dr. Shaf Keshavjee comes in. Keshavjee literally grew up in the legendary Toronto Lung Transplant Program, completing medical school, residency and fellowship training in general surgery, thoracic surgery, and cardiac surgery at the University of Toronto. After additional training at Harvard and the University of

London, he returned to Toronto with some fresh insights that have shifted entire paradigms of organ preservation.

Traditionally, transplant teams have focused on perfecting three phases of the transplant process: organ preservation, implantation, and the host response to the new organ. Keshavjee has focused much of his imagination and energy on the first phase: preservation. Lung transplant teams and systems recognize that when lungs are removed from the body at room temperature, they typically start to die within minutes. Hypothermic protocols have significantly prolonged lung longevity, by slowing metabolic demands, and prolonging the process of cell death. The problem with this approach is that the health of the lungs, the magnitude of trauma, and the impacts of ischemia and rejection can only be recognized at the nearly irreversible moment of implantation and reperfusion, that is, after the organ is in. The functional and mechanical properties of cooled, hibernating lungs, by definition, cannot be measured or, therefore, optimized. This makes transplant teams averse to transplanting suboptimal lungs, and greatly diminishes the donor pool.

Is there a way to preserve lungs in a way that their properties could be measured and improved prior to implantation?

Keshavjee started by developing organ preservation solutions, but quickly moved toward investigating more comprehensive strategies for ex vivo organ preservation. In Keshavjee's career, thinking outside the box to change the established paradigms of organ preservation, led him and his research teams to develop an actual box.

The xVIVO perfusion system, gently ventilates explanted lungs, while perfusing them with warming, nourishing and preserving solutions. In the ultimate counterintuitive insight, the membrane in the perfusion circuit is used to REMOVE oxygen and ADD carbon dioxide to fluid returning to the lung, so that the actual oxygenation and ventilation parameters of the explanted lungs can be measured, along with the pulmonary vascular resistance.

The xVIVO system has opened up new horizons in organ preservation. Now that the properties of lungs can be measured before implantation, they can be improved by interventional techniques such as bronchoscopy, by molecular level methods that reduce ischemia-reperfusion mediated lung damage, and even by genetic methods that use adenoviruses to change the donor lungs' immunological properties. "I know the recipient, I know the recipient HLA type and I know the immune response. Guess what, I can trick the

organ into looking like self before even exposing it to that hostile response," he says.

"We have done over 300 (xVIVO-optimized transplants) now, showing equal or better outcome to standard donor lungs," notes Keshavjee. "We can now keep a lung alive without inflicting injury for 12 to 24 hours. It is transformational."

In the future, the xVIVO system may even enable the engineering of new lungs with stem cells on biological scaffolds, and allow transplant teams to choose the perfect time to implant them, based on their measured physiological properties.

Keshavjee's xVIVO system has made it possible to develop the concept of an organ repair center, or a central facility where explanted organs can be precisely optimized, ex vivo, for their waiting recipients. The repair centres have the potential to transform access to and outcomes from lung transplantation.

For the concept to work, transplant policies and practices surrounding organ sharing will have to change. According to Keshavjee, a major inefficiency with the current transplant system is that it's still "a cottage industry. We all do our own thing. When there is an organ donor at one hospital, five transplant teams will fly from five different places to descend on that one hospital. Each organ — whether it be kidneys, liver, heart,

re doing is a total paradigm shift.

or lung — is taken by one team and flown back to each respective centre in the middle of the night for transplantation.”

Organ repair centres would streamline the process through a centralized approach. “By having all organs go to one centre, we can optimize the organs, diagnose what’s wrong with them, treat them, make them safe, quality control them, and then distribute them,” says Keshavjee,

The movement toward this future is already underway. “We had an American centre that had a lung that needed repair. We brought the lung to Toronto on compassionate grounds, we repaired it in Canada over a six-hour time frame, then flew it back to Chicago where it was transplanted. This was the first example of remote organ conditioning,” he says. The world’s first organ repair centre has already been established at the Toronto General Hospital and another in Maryland. “We have started doing many things there, including ex-vivo treatment of organs and stem cell injections into hearts. We receive the organs in Maryland, repair them, and then fly them back out.”

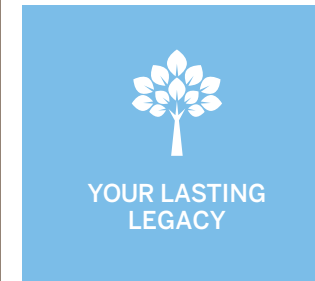
Keshavjee notes that the precedent for organ repair centers has already been established. “We used to have blood transfused in the

battle field from one soldier to another. We used to have blood banks in every hospital. But now, blood is collected in specialized collection centres where it is processed to optimize usability. Red blood cells are sent to people who need them, platelets to someone else, and so on. “We track each product, we infection control it, we monitor shelf life, and we make sure it is packed properly. As a result, blood product quality has improved drastically and the risks have gone down significantly. Organs will be managed just like that.”

For Keshavjee, the journey toward repairing organs began with a basic question: “Can one actually improve an organ compared to the state that one found it in?” This same question occupied the likes of Leonardo Da Vinci, Alexis Carrel, and Charles Lindbergh — all of whom tried and failed to answer it. It was up to a Canadian surgeon, with exceptional training and phenomenal determination to shatter and reimagine the “box”.

The xvivo system opens the future to as yet unimagined new technological applications and big blue-sky thinking. As Keshavjee and his team continue to develop and automate the process, he adds, maybe one day “you can envision organs being delivered by drones.” ●

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Chicago— **A New Roadmap**

Story by Morad Hameed, Selwyn Rogers, Matt Kaminsky, Indraneel Datta and Chad Ball
Photographs by Jon Lowenstein



● On a South Side Chicago intersection, a sudden explosion in a metal chamber launches a 9mm lead and copper projectile at 1,609 km/h down a metal barrel and out into the open night air. In flight, the bullet creates a terrifying, irreversible arc through space and time until it slams into its intended target. Nine millimetre bullets are designed with deadly precision to crash through skin and soft tissue, smash bones and carry their fragments along in their wake. They leave blast effects that shatter organs and release torrents of blood from the disrupted arteries and veins that sustain life. In a moment, life changes and families are left to live with unimaginable grief.



On the July 4, 2017 long weekend, this sequence was repeated more than one hundred times. Over one hundred people sustained gunshot wounds, a phenomenon that made headlines around the world. Within that outrageous statistic are one hundred unspeakable and avoidable tragedies, with ripple effects that are deeply felt by families, and that weaken the fabric and the resilience of entire communities and generations.

Each tragedy that weekend was met by a system of trauma care in Chicago that has been primed by unrelenting waves of gun violence. In 2016, that system responded to 4000 shooting incidents. Gunshot wounds (GSWs) are defining events in the lives of surgeons and trauma systems, testing and pushing them to higher and higher standards of performance. GSWs and other forms of severe trauma have sparked the Golden Hour concept, brought transport helicopters to the front lines of battle and to the heart of North American cities. They have refined our judgment and skills in critical moments. Since the 1960s, they have prompted the emergence trauma centres with state of the art trauma and critical care teams perpetually standing ready, and organized regional trauma systems that allow the seamless transfer of patients to higher levels of care according to their needs.

At the eye of the Chicago's storm of GSWs is the John H. Stroger Cook County Hospital. It opened in 1912 and, starting in 1966, became one of North America's earliest and most iconic trauma centres. Standing watch over Chicago's West Side, the hospital is a champion for the health care of Cook County's five million residents and has trained generations of trauma surgeons and trauma teams from all over the world.

Clinical excellence at Cook County

One of these surgeons is a young Canadian, Dr. Matt Kaminsky. Kaminsky completed medical school and surgical residency in Winnipeg. He left Canada with superb clinical training for a fellowship at one the world's best and busiest trauma surgery fellowship programs. His education has been shaped, in part, by Chicago's epidemic of gun violence. In accepting a position as a staff trauma surgeon at Cook County after he graduated, he has dedicated his career to addressing it.

Over the past four years as a trauma attending at Cook County, Kaminsky has become an expert in controlling the complex and devastating consequences of GSWs and other forms of multisystem trauma. Following him through the halls of Cook County on a cold and quiet weeknight in March, one sees a trauma centre primed and ready for any imaginable catastrophe. The 15 bright and fully equipped bays dedicated exclusively to trauma are arranged in a large square around an expansive nursing station, with equipment, imaging and operating capacity thoughtfully in reach. Although he is not on call, Kaminsky spot checks the equipment drawers, modestly shows off the balloon aortic occlusion protocols and checks in with the nurses. Even on the surface, the team looks connected, calm and professional. The arrival of a 15-year-old with multiple GSWs initiates a seamless response from the team, but barely disturbs the equilibrium of the Unit. Kaminsky, with the calmness and alertness of the place, surveys the situation and once content with the progress he sees, gently moves on.

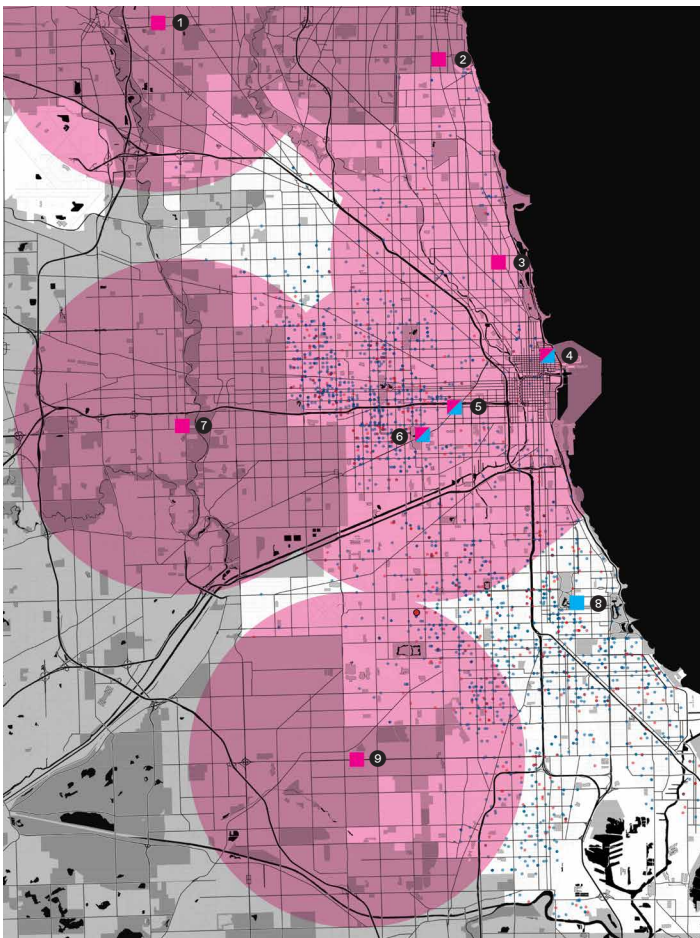
This calm effectiveness on the front lines has been hard won. The trauma centre saw almost 9,000 patients last year — an average of



We may be able to devise interventions to make a difference in people's lives.

25 patients per day. On many summer nights, Cook County trauma teams care for thirty to forty patients, an astonishing forty percent of them with penetrating injuries. Rare index trauma cases are not so rare in Chicago, with o, and Kaminsky and his teams reporting on some of the world's largest series of complex interventions for trauma. Some cases are so challenging, with simultaneous injuries and competing priorities in multiple body regions, that they cannot be referenced in any of the trauma textbooks. Many times, multiple patients like this arrive at once.

It is a striking contrast to see: amidst violence and anatomic and physiologic chaos, a poised and unaffected team backed by a system relentlessly and efficiently restoring order. It is an exhilarating place to be for anyone who is interested in trauma care, but it is also a sobering reality that patients who survive their injuries will, after receiving some of the most excellent trauma care on the planet, have no option except to return to the same streets where violence relentlessly intersected their lives.



The University of Chicago's Hyde Park neighborhood is embedded in the history and geography of Chicago's Southside. The university has been at the intersection of housing segregation, urban upheaval, urban renewal and demographic change. A new trauma center there, will suddenly be at the epicenter of the Southside's gun violence epidemic.

Shooting Victims in Chicago January 1 to August 13, 2017

- Level-one Trauma Centre
 - Paediatric-only Trauma Centre
 - Area within 5 miles of a Trauma Centre
 - Fatal Shooting
 - Non-fatal Shooting
- ① Advocate Lutheran General
 - ② Presence Saint Francis
 - ③ Advocate Illinois Masonic
 - ④ Northwestern and Lurie Children's
 - ⑤ Stroger
 - ⑥ Mount Sinai
 - ⑦ Loyola University
 - ⑧ University of Chicago
 - ⑨ Advocate Christ

Trauma centre 2.0

A 15-minute drive south along the shore of Lake Michigan, deeper in the South Side at the University of Chicago, another trauma surgeon has begun to engage with this exact issue, but from a slightly different angle.

Dr. Selwyn Rogers is at the heights of an innovative and accomplished career. Born in St. Thomas in the US Virgin Islands and raised in St. Croix, he eventually moved to Boston, where he completed a degree in biology, graduating magna cum laude from Harvard College. He went on to Harvard Medical School, then general surgery and critical care training at the Brigham and Women's Hospital. His interest in disparities in health and health services research led him to graduate studies in public health at Vanderbilt University. He was an Associate Professor of Surgery at Harvard, the Chair of the Department of Surgery at Temple University in Philadelphia and a Vice President and Chief Medical Officer at the University of Texas Medical Branch.

Rogers is a skilled trauma surgeon and an experienced trauma team leader, but throughout his academic and administrative career, he's also inhabited the intersection between clinical surgery and public health. He has published widely on the social determinants of health and how they affect the risk of surgical illness and the access to surgical care.

Recently, he arrived in Chicago to take on the roles of founding director of the new University of Chicago Medicine Trauma Center and Chief of the Section of Trauma and Acute Care Surgery. After serving as a Chief Medical Officer, he is back on the front lines of trauma care, with broad and deep perspectives on health care, and on the role of surgeons as leaders.

His job is to help build a new trauma centre from the ground up, in the heart of a neighborhood that is reeling from an epidemic of trauma. For a trauma surgeon, building a state-of-the-art trauma centre that challenges preconceptions and is built with the creative freedom to apply best practices is an opportunity of a lifetime. It is

The greatest progress often occurs not from within disciplines, but at their intersections.

an open invitation to be ambitious, creative and transformative.

Rogers has entered this role as an intersectional thinker, with the knowledge that building a world-class trauma centre is only one aspect of a systematic approach to public health. This perspective has its roots in the 1948 World Health Organization definition of health, as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”

At the foundation of health is safety because it is impossible to be healthy if one does not feel safe. A holistic approach to violence and safety might benefit from knowledge of the big successes of public health of the past, including cardiovascular disease, in which careful long-term studies of risk and targeted risk modification have resulted in decreased mortality and large-scale epidemiological change.

Gun violence in Chicago, like elsewhere in the world, primarily affects geographic and demographic communities with high rates of unemployment and poverty — like those in the south and west of the city. The effects of poverty there have been compounded by societal fragmentation and redistribution that has resulted from the closure of schools and housing projects, like the Robert Taylor Homes in 2007 and the Cabrini-Green projects in four years later. Intentional violence in communities could be arguably linked to neighborhoods that are disinvested, where communities are ravaged by high unemployment and where wasted human capital is the norm. These phenomena have long-term consequences. More often than not, people who are victims of violence have been repeatedly victimized and have suffered adverse childhood exposures to trauma. Children growing up in the context of violence in their communities remain at risk for depression, aggression, delinquency and poor school performance.

Rogers believes that seeing violence as

a public health issue makes us examine the its social determinants, including poverty, structural violence, and mass incarceration.

“By studying the complex interactions of people, environment, and lived experiences, we may be able to devise interventions to make a difference in people’s lives,” he says.

The University of Chicago will be a new kind trauma centre, he adds.

“Given the proximity to intentional violence on Chicago’s South Side, we have an opportunity to challenge the narrative that violence is about bad people doing bad things to bad people. We need multi-sectoral approaches to definitely address the underlying determinants of violence in our communities,” he says.

“At the University of Chicago Medicine, we plan to include violence prevention, violence interruption and post-violence treatments to aid people in holistic recovery. We need to treat violence along a continuum and not simply as an of episode and in the same way that we address cancer care as personalized medicine with targeted therapies. For proven-risk individuals who have been traumatized by violence, we need to envelop them with personalized wrap around services that help them to cope and recover from the experiences of trauma. By partnering with communities and lifting up organizations in communities, we hope to help people beyond the trauma bay and beyond the walls of the hospital. This is hard work that starts with building relationships and engendering trust. At the core, this is the heart and soul of what drew many of us to a career in medicine.”

The intersections between trauma centres and community, health and social determinants, injury and public health, have been explored before, but have never had the opportunity to be integrated into the road map of a new system of trauma care. Rogers has been at these intersections all his life and is ready to embark on an experiment in trauma systems and public health that the global trauma community will be watching.







Intersections

It has been said that the greatest progress occurs not from within disciplines, but at their intersections. Chicago, at the confluence of the Mississippi and the Great Lakes, has always been a city of intersections, where trains, highways and flights converge, and generations of immigrants continuously build and reinvent their streets and neighbourhoods. It is a city transformed by the Great Fire, a great migration and the Great Depression. It is one of the first cities where public health determined public policy on a wide scale, when physician John H. Rausch founded the Chicago Board

of Health, and from whence the laws of the 1880s served as national templates to confront urban epidemics of cholera, smallpox and yellow fever.

Today, the epidemic is violence. In response to a storm of bullets and long-standing issues of social justice, Chicago finds itself at still uncharted intersections that hold the promise of new and possibly transformative directions of progress: excellent trauma surgeons and iconic and rising trauma centres, social awareness and community outreach, trauma surgery and public health. ●

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September 2017

EBRS is an internet-based journal club designed to teach critical appraisal skills to both residents and practicing general surgeons. EBRS consists of eight monthly modules per academic year beginning in October and continuing until May of the following year. Each module includes a clinical article relevant to the practice of general surgery, plus a methodological article that can be used to assist in the evaluation of the clinical article. The clinical and methodological reviews are completed by national and international experts in the field and the selected articles cover a spectrum of important clinical and methodological topics.

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Frontiers in Surgery

An Interview with Community
and Rural Surgeons

By Chad G. Ball and Sean Gregg



Julie Himel, *Cast II*, 2015.
12 × 12 in. Oil on Board.

Surgery's next great frontier may literally be on the frontier. Even as surgeons have relentlessly advanced knowledge, technique, and health care delivery for the majority of patients, disparities in health and in access to surgical care have remained, and in some cases, have gotten worse. In particular, access to high quality care in rural and remote communities, which has always had to face challenges related to population density and geography, has further eroded in the era of volume-outcome interactions and consolidation of health services. Today, the fabric of rural and remote communities is routinely disrupted by the need for their citizens to travel for surgical and obstetrical care. Mortality from surgical conditions is high, even up to eight times higher than urban environments for multisystem trauma. Reducing disparities like these is a defining challenge of our generation.

General surgeons are often at the front lines of these issues of access and health disparities. They are often the hubs at the center of vast hub and spoke catchment networks, or, through outreach, the representatives of surgical excellence in the most rural communities. Every minute somewhere in Canada, one of these surgeons answers a call, or picks up a scalpel to save a life, or to change a life in complex and dire circumstances.

The Frontiers section of this magazine is dedicated to sharing the thoughts and vision of surgeons who are front line champions for their patients and for our specialty, and leaders of health care systems in smaller communities across the country.

For this article, we met three surgeons in small, medium and rural practices whose passion is to be hands-on and deeply involved in ebb and flow of the lives around them. They work tirelessly, not only to care for individual patients, but also for the health and health care access of entire communities.

Dr. A* works in an area of approximately 100,000 people, where the practice is a broad mix of both elective and emergency general surgery. Although Dr. B operates in a smaller town of just 9,000 — the geographic catchment area is as large as any in the country. Dr. C practices in a city of approximately 80,000 people and mixes general with subspecialty surgery.

*Our subjects asked to remain anonymous to protect the integrity of their practices.

What led you to pursue a career in community surgery?

Dr. A — It was dominated by my overwhelming desire to have direct contact and responsibility for my patients — no middle-man. Equally important was doing my own surgery, rather than delegating or observing residents. And I loved the idea of a traditionally broad practice with the ability to treat a variety of conditions.

Dr. B — To completely honest, I had no desire to emulate the careers of the academic surgeons who trained me. I have nothing but respect and gratitude for those who deliver teaching, research and leadership, but I had no interest in being dropped into the academic meat grinder. I wanted a practice where the individual patient was my primary focus.

Dr. C — I had planned to pursue a technically demanding fellowship immediately upon completion of my residency, but was offered a job with a superb surgical group in a moderate sized city. In addition to job certainty that a super-subspecialty fellowship lacked, a community practice promised me something that made me want to pursue surgery in the first place...the ability to operate! I love it!! I saw it as the core reason to become a surgeon in the first place.

What are the best things about your practice?

Dr. A — The variety of clinical content. The relative increase in the importance and focus on emergency general surgery has aligned well as I advance in my career. Now as a senior surgeon, making a difference to patients and their families at a critical, often life-threatening time is much more important to me than doing the ‘big elective case’. From my viewpoint, it’s where we make the biggest difference.

Dr. B Autonomy. My partners and I are able to run our collective practice on every level — the business, the clinical side and through local leadership. We are also privileged to play a significant role in local town leadership on a multitude of issues. I love being part of this community and a health care system where everyone knows each other. Mutual respect and a working relationship become essential when compared to some of the behaviour I have witnessed in larger cities.

Dr. C — It has been the evolution in my clinical practice. I started out doing all ‘bread and butter’ general surgery, including breast, neck and colorectal. After a few years in practice, I returned to my academic roots for subspecialty training. My driver was both personal interest and for my community, where there was a clear need for this expertise. I have now surrendered this broader practice in favour of a narrower, but deeper clinical experience. This flexibility, supported by my partners and community, has been incredible.

What are the biggest challenges you face in your practice?

Dr. A — Resource constraints always represent my greatest frustration. The most defeating experience is having a patient see me as the face of the system that fails to meet their needs due to inadequate resources.

Dr. B — Without question, the struggle to get patients into the operating room. I’ve stopped defending the ‘system’ and encouraged my patients to engage with their MLAs directly. We need a national push for surgical care, and capacity in particular. The second major challenge remains the need for difficult travel/transfer decisions, as well as cost considerations in a rural environment such as ours. However, this also represents an incredible positive when you get it right.

Dr. C — Not enough resources. A lack of access to the operating theatre in a timely and reasonable manner is a constant stress. The second issue would be trying to change the perception that community hospitals don’t provide superb emergency care compared to the tertiary care centers. Having said that, the new generation of surgeons in the first half of their practice appear to be much more active in community hospital outreach and relationships. A number of these academic surgeons spend at least some time clinically in smaller community hospitals at their own volition.

If you could share one thing about you and your practice in a community environment, what would it be?

Dr. A — Surgeons in the community feel valued by our patients, families and local hospital staff. The deeply meaningful work we do makes a difference, one patient at a time. Being up to one’s elbows in an emergency surgical disaster may seem unappealing to many, but saving a life gets us out of bed at night with a grin.

Dr. B — I can honestly say that I feel fulfilled in a small rural surgical practice. I don’t feel like a small cog in a large wheel. I know my colleagues. I know my patients, and I know my community. I love it!

Dr. C — For the most part, we all embark on medical training with open minds, but we inherit the biases of specialists who teach us. Similarly, general surgery residencies are offered predominantly in large academic centres. We may be shortchanging our trainees if they don’t get to spend enough time in a community practice. For the right person, community surgery can be an unencumbered pathway to clinical excellence. By choosing a community practice, I was not giving up teaching, leadership opportunities, or the ability to do research. Those opportunities abound in any setting. ●

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— B. J. Hancock, MD, FACS, FRCSC, Regent, American College of Surgeons, and Associate Professor, Departments of Surgery and Pediatrics and Child Health, University of Manitoba

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Jirō Ono (Age 85)

THE ART OF THE CRAFT

a case study in technical mastery

Text by Indraneel Datta, Amit Dey and David Gelb
Watercolours by Amy Wetton



**“YOU HAVE TO FALL IN LOVE WITH YOUR WORK ...
THAT IS THE SECRET TO SUCCESS”**

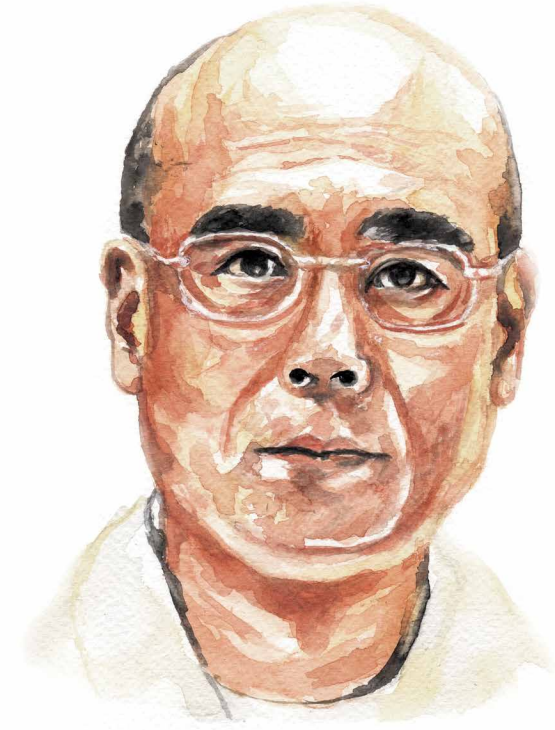
(Jiro Ono)

The metropolitan prefecture of Tokyo is mind blowing. The spectacular skyscrapers, the fashion trends, the bright lights and the subways. In amidst the organized chaos the day begins early and follows a precise and identical sequence; Wake up at 5am, dress simply, take the same route to work, and even enter the same train car, saving precious attention and concentration for the work that lies ahead. Consider the unique variations in the challenges of the day, but assemble and greet your team in the same way as you did yesterday and every other day. Expect the same high standards from your colleagues and your trainees as you do for yourself.

For a sushi chef working in a ten seat restaurant in a Tokyo subway station, the journey started with childhood dreams, and has continued exactly in this way, everyday,

for 84 years in a row. From the moment of his first restaurant job, 84 years ago, legendary sushi master, the three-Michelin starred Japanese chef, Jiro Ono, 91 has excelled in the “art of sushi.”

Lauded worldwide, he could have been the face of multiple franchises and television shows, yet Ono stands apart from his contemporaries by helming his tiny restaurant in the subway every day of the week. With a humble approach to his craft — and a relentless pursuit of perfection — Jiro has willed himself to the top of his profession, and has remained there for six decades. In the landmark 2012 documentary *Jiro Dreams of Sushi* by filmmaker and this article’s co-author, David Gelb illuminates the thoughtful process that shaped a remarkable career. From his perch behind the counter of his



Yoshikazu (Age 50)

restaurant, Sukiyabashi Jiro, in a Tokyo subway station, Ono is in a constant state of deep attention to detail and repetition. Every ingredient, every tool, the temperature of every bite is painstakingly assessed and held up to the highest standards. And, in the process, he has established a perpetually rising international benchmark for sushi preparation.

Tako, or octopus nigiri, is a case in point. Traditionally an unpopular item because “too often, octopus tastes like rubber and it has no flavour,” he notes, Ono set about improving the dish’s profile. “[I used to] massage the octopus for 30 minutes — now it is massaged for 40 to 50 minutes,” he says. To improve the taste, he worked on the smell, “to bring out the fragrance of the octopus, we serve it warm.” As he told René Redzepi,

chef of Noma, a two-Michelin-starred restaurant in Copenhagen, “I found a way to modify it and make it my own ... people started to like it and order more.” Tako is now found on every sushi menu in the world.

The food writer Yamamoto notes that the three star Michelin rating reflects the highest standards of both quality and consistency. “Out of hundreds of restaurants I have been to, Jiro’s was the best by far.” Yamamoto never had a disappointing experience there, a phenomenon that he describes as “nothing short of a miracle.”

A Tokyo subway stop is an unexpectedly great place to study a miracle.

The secret may be in Jiro’s eldest son Yoshikazu’s description of the world’s greatest artisans: “The way of the shokunin is to repeat the same thing every day.” Yamamoto



“AS SURGEONS, WE MUST APPLY ONO’S PHILOSOPHY TO *OUR* TRADE.”

notes that Jiro also “sets the standard of self-discipline. He is always looking ahead. He is never satisfied with his work. He is always trying to find ways to make the sushi better or to improve himself ... I’ve seen many chefs who are self-critical but I have never seen another chef who is so hard on himself.” Jiro himself notes: “Once you decide on your occupation, you must immerse yourself in your work. Never complain about your job. You must dedicate your life to mastering your skill ... You have to be tough. Failure is not an option That’s the secret of success and it is the key to being regarded honorably.”

In sushi preparation, as perhaps in surgery, the miracle is technical mastery. It comes from the relentless repetition, attention to detail, and thoughtful and incremental

process improvement. This mastery is a foundation for creativity and exploration. One may wonder, how do you reach this level of dedication? Particularly at the expense of comfort and the pleasures of variety and spontaneity? Jiro elaborates on this as well: “You have to fall in love with your work.”

Until the documentary, *Jiro Dreams of Sushi*, one might never have thought of a subway station as a place for technical mastery, creativity and big ideas. But Jiro says “My mind was bursting with ideas. In my dreams I would have visions of sushi.” It is something to think about on your own journey towards technical mastery and the pursuit of everyday miracles. It is something to remind yourself at 5am when your alarm goes off and your own dreams become reality. ●

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April 2017

Dear Friends:

I am pleased to extend my congratulations on the occasion of the 40th anniversary of the Canadian Association of General Surgeons (CAGS).



This milestone offers a wonderful opportunity to reflect upon the important role CAGS has played in communities across Canada. For four decades, this organization has dedicated itself to empowering general surgeons to improve patients' lives through advocacy, education, and research.

I would like to commend the members of CAGS for their commitment to excellence in general surgical care for all patients. You may take pride in knowing that your hard work and dedication have enhanced many lives over the years.

Please accept my best wishes for a memorable anniversary celebration.

Sincerely,

The Rt. Hon. Justin P.J. Trudeau, P.C., M.P.
Prime Minister of Canada



Canadian Association of General Surgeons
Celebrating 40 years of excellence.

The Sustainable Scalpel



**APPLYING COLD HARD STEEL
TO A LOW CARBON FUTURE**

Story by Andrea MacNeill



Previous: Earth from Apollo 11. NASA. Opposite: Sagarmatha National Park, Nepal. Stocksy.

Former Program Director's Note

In the fall of 2010, when I was a new general surgery residency program director, a superstar second year resident came to my office to discuss her plans for her research year. In every way — knowledge, skill, professionalism — Andrea MacNeill was already on her way to becoming an excellent surgeon, and I thought I could predict the path she might follow, based on the examples I had seen in the past. Except, she came to me with an idea that I could never have imagined on my own. With her usual poise and conviction, she outlined a plan to go to Oxford University to study Environmental Change and Management. I remember that moment well. Sitting across from her near a window with a view of English Bay, the glass skyscrapers of downtown Vancouver, and the Coast Mountains and blue sky beyond, I somehow couldn't think of a single connection between surgery and the environment, and I tried desperately in those long seconds to find ways to redirect her talent. But her passion for both surgery and the environment were clear and urgent, and we ultimately decided to support her plan. That was the moment when she embarked on a journey that would take her to operating rooms around the world, to laundry chutes, garbage bins, electrical meters and ventilation ducts, and ultimately to the development of a powerful method to quantify greenhouse gas emissions from operating rooms. It was a journey that taught us to see sustainability as both a personal and a global issue. It showed us beyond a doubt that creativity and idealism have a place in surgery, and that these things in fact sustain us and shape the future of surgery. Andrea MacNeill's story is about the intersection of disciplines and about passion that leads to creativity, and her work and writing are both a reminder of our responsibility and influence, and an inspiring call to action.

— Morad Hameed

In 2009, the Lancet Commission on Climate and Health identified climate change as the greatest health threat of the 21st century. In contrast to other established health hazards such as smoking, climate change is not a singular risk but rather a force multiplier by which existing threats to health and wellbeing are exacerbated by a shifting environment. Within this ever-shrinking global village we can expect food insecurity to increase, infectious disease epidemics to expand, and waves of human migration to intensify. In developed economies, escalating rates of cancer, cardiovascular and respiratory disease are shortening life expectancies for the first time in generations and straining health systems to the point of collapse. The World Health Organization (WHO) estimates that 22 percent of global burden of disease is attributable to modifiable environmental factors, and that climate change will be responsible for approximately 250,000 excess deaths annually by 2030.¹ Yet “while climate change may kill millions, it will be on the death certificate of no one.”²

As health professionals, we cannot turn a blind eye to this insidious force shaping the landscape of global health and disease. For one thing, we are not merely spectators to a rising tide of environmentally-mediated disease, but rather active participants in the defining issue of our time.

Stratospheric Sequelae of Surgery

In 2016, a US study estimated the carbon footprint of the health care system at 10 percent of national greenhouse gas emissions.³ Put in perspective, this is more than the carbon footprint of the entire UK. If the American health care system were an independent country, it would rank 13th in the world for greenhouse gas emissions. The study went on to estimate the health damages attributable to what it termed “health care pollution” and found that in 2013 health care activities were responsible for 470,000 disability-adjusted life years (DALYs) lost. Not only is climate change a pervasive public health issue, but the health sector itself is a significant driver. Homing in further, we find that surgery is one of the most resource-intensive areas within health care, consuming more energy and generating proportionately more waste than other clinical activities. This is our opportunity as surgeons, public health advocates, and concerned global citizens to lead by example and protect the health of the populations we serve and the natural systems that sustain them.

With this in mind, I undertook a study to determine the carbon footprint of surgery with the hope of lessening our impact on the natural world. Three countries and 10,000 kg of surgical waste later, I had compiled a detailed greenhouse gas inventory of operating rooms. Through this carbon accounting exercise, we were able to identify key contributors to the operating room footprint and formulate strategies to improve our environmental performance. The “convenient truth” of these measures is that they feed back into the system, increasing efficiency, improving health, and reducing costs.

The most striking discovery with respect to operating room emissions was the role of anesthetic gases. While CO₂ may be the face of climate villainy, volatile anesthetic agents are in fact far more potent greenhouse gases with global warming potentials ranging from 130 (isoflurane) to 2,450 (desflurane) times that

of CO₂. These gases are largely unmetabolized but instead are expelled unchanged into the atmosphere. Desflurane allows patients to emerge more quickly from anesthesia, making it the preferred volatile agent at many North American hospitals, whereas in the UK its use is restricted due to its higher price tag. Preferential use of desflurane translated into a 10-fold difference in anesthetic footprints across the hospitals we studied. A practical shift in defaulting to sevoflurane, or alternative anesthetic techniques such as regional or total intravenous anesthesia, can decrease a hospital’s anesthetic footprint by an order of magnitude, without adversely affecting patient care. Going one step further, waste anesthetic gas capture technology can convert the single greatest source of operating room carbon emissions to zero.

In 2016, a Yale/Northeastern University study estimated the carbon footprint of the US health care system at 10 percent of national greenhouse gas emissions.

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One of the easiest wins for improved OR environmental performance revolves around energy management. Hospitals are known to be among the most energy-intensive commercial buildings due to their complex demands and 24/7 operations. The majority of these energy demands relate to heating, ventilation and air conditioning (HVAC) required to maintain clean, and in some cases sterile, clinical areas. The HVAC standards for operating rooms are the most rigorous of any buildings. While HVAC demands are generally thought to be responsible for 50% of a hospital's energy requirements, we found that they comprise 90–97% of OR energy use. Matching OR ventilation to use by minimizing air flow after hours can reduce energy consumption by up to 45%, generating significant cost and carbon savings.

Widely described as a force multiplier, climate change exacerbates public health problems in every corner of the planet, from sprawling urban centres to remote communities with minimal access to fresh water.

For surgeons and other inhabitants of the operating room, the most visible environmental impact is the mountain of waste generated with even the simplest procedure. While careful waste management can ensure its optimal disposal, even the most ambitious recycling program pales in comparison to the impact of avoided waste as the resources required to manufacture a product far outweigh those required to dispose of it. By merely purchasing a single-use item, one has already accounted for the majority of its environmental impacts, regardless of the means of disposal. On an individual or hospital level, improved environmental performance can be achieved by streamlining pick lists and custom packs, and working with the supply chain to select environmentally preferable products. On a larger scale, we as surgeons can leverage the purchasing power of our profession to counter the seemingly inexorable industry shift toward single-use consumables.

All told, we estimated the carbon footprint of surgery in Canada, the US, and the UK combined to be equivalent to two million cars on the road every year, a number that could be drastically reduced with a few simple interventions. Fortuitously for the health sector, environmental sustainability initiatives entail convenient synergies as improved public health will help ensure the economic sustainability of the system and build resilience for future generations.

Do No Harm

While health care may not be the biggest polluter — that dubious distinction belongs to the energy and transport sectors — we have a moral obligation to protect and promote human health. In 1980, a group of concerned physicians mobilized around the defining political and public health issue of that era and five years later International Physicians for the Prevention of Nuclear War was awarded a Nobel peace prize, for “spreading authoritative information and...creating an awareness of the catastrophic consequences of atomic warfare.”⁴ We as a health sector must lead

by example, not because our actions alone can prove decisive in the war against climate change, but because the public continues to invest us with a moral authority that is becoming increasingly scarce. In an era of alternative facts and manufactured reality, the demand for authoritative information is even more acute than it was 40 years ago.

Acknowledging the failure of international climate negotiations and the absence of effective top-down governance, it is increasingly clear that decisive climate change mitigation will fall to non-political actors. Attempts for global agreement have proven incompatible with short political time horizons and vested interests, as demonstrated most glaringly by the recent withdrawal of the US from the landmark Paris Agreement. Amidst calls for more agile agents of change, subnational efforts have emerged with cities, states, and corporations engaging in crucial bottom-up action. The health sector is strategically poised to take a leadership role in this realm. Characterized by a high degree of uniformity and transcendent of political boundaries, health systems around the world can collectively mainstream environmental sustainability and serve as a prototype for a low carbon future.

From Hippocratic to Apocalyptic

In the 4th century BC, Hippocrates provided the first recorded depiction of the physical climate as a shaper of human health and fortunes in his treatise *On Airs, Waters and Places*. The inextricability of human, environmental, and economic sustainability now presents both an unparalleled threat but also unprecedented opportunity to shape the health and wellbeing of current and future generations. It is time to muster all of our moral authority and practical solutions to catapult our profession to the forefront of climate action. Within this movement, surgeons are uniquely positioned, both due to our disproportionate footprint as well as the opportunity to complement our daily eradication of environmentally-mediated disease with primary prevention on the grandest scale. “This century, climate change — a fifth horseman, a new threat of a magnitude unknown to human experience — will ride across our promising landscape of public health,” said Margaret Chan, former Director General of the WHO. “Together we can take a stand against this newest evil that has been cast our way. We are obliged to do so, in a spirit of solidarity, motivated by the pursuit of fairness in our out-of-balance world, but above all for the sake of our common humanity.” ●

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