Roscoe

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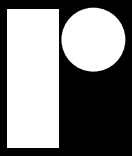

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Tessellation V, 2018
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Reflections on Human Performance

When I was on my very first clerkship rotation in surgery, my mentor would — and I'm not exaggerating — scrub for 10 or 12 minutes before every case. As the minutes ticked by, I would stand side by side at the sink with my Chief and my attending, two of us pretending to scrub, and each of us quietly lost in thought. I am sure that they were thinking through the intricacies of the case we were about to face, and running through contingencies for possible scenarios I could not even begin to imagine. But I was mainly checking to see if I had a mask on, and occasionally trying in vain to guess the thought processes of the two superheroes beside me.

That quiet moment of contemplation before we step into the centre of the room, under the lights, is a pivotal moment in the lives of both patients and surgeons. For patients, it could represent a moment of anguish, fear, relief, hope, or likely, a combination of all of these. For surgeons at every stage of training and career, it represents the culmination of a lifetime of accomplishment and preparation. Every surgeon has built that moment on a foundation of academic brilliance, inspiration, idealism, long days and nights of gruelling service, self doubt, humility, confrontation, teamwork, supreme confidence, bad judgment, experience and, ultimately, good judgment. If the moment before the next case is a peak of surgical skills, all surgeons tend to view that peak as part of a constantly rising trajectory. All of us want to get better with every case we do. All of us want our teams to perform better, our surgical systems to run more smoothly. All of us want to confront uncertainty, complexity and chaos, and shape them into order. Although every surgeon is dedicated to a lifetime of high performance, it is always worth asking how to take our individual and collective performance to greater heights.

Stephen Curry, the first unanimously selected MVP in the history of the National Basketball Association, takes to the court about 90 minutes before tip off. His scripted, but evolving, pregame routine includes graceful cross-over dribbling, two ball dribbling, left and right arcing floaters, acrobatic underhand scoops, fluid three-point shots from as far away as centre court, fadeaways, pump fakes, drives and jumpers, culminating in a high arcing shot from the deep corner. Fans come early to see the breathtaking array and accuracy of the shots, some of which barely touch the net, but maybe also to see the intense dedication to craft. In practice, Curry is known to incorporate neurocognitive strategies, such as sensory overload, sensory deprivation, and mindfulness into his training

to improve his vision and decision making. Taking him through a sensory overload shooting drill in which he has to make eight out of ten shots from seven spots, while interpreting light patterns on the wall, one of Curry's coaches, Brandon Payne, noted "That's a pretty tough drill that frustrates him. I know when I've frustrated him, I'm doing my job, because he is not gonna stop until he beats it. And trust me, frustrating that guy is getting tougher and tougher to do." According to one of his fans, Ben Sanchez, "You see him going through his craft, the attention to detail, the willingness to stay hungry. It's so crazy to observe." Curry blends these skills and this mindset seamlessly into a skilled and selfless team, the Golden State Warriors, that has won three of the past four NBA Championships, and whose culture is built around four core values: joy, mindfulness, compassion, and competition.

Issue two of *Roscoe* magazine is a reflection on human performance, taking its inspiration from surgery and other fields that have inspired surgeons to reflect on our performance. Like Steph Curry, the surgeons, scientists, athletes, and artists featured on these pages have been "intelligent, curious, and not afraid to ask questions or try new things" in the pursuit of better performances. Surgeons and the teams they lead are increasingly accumulating the insights, evidence, and technology to train more mindfully and intentionally, to constantly measure and refine their performance, to understand and account for complexity, and to rest, recharge, and draw inspiration and joy from the ideas that surround them. Surgery, and the health of society, will benefit from our attention to detail, our willingness to be frustrated, our comfort with being uncomfortable, and our dedication to staying on the steep part of our learning curves. These are traits inherent in surgeons, and ones that should always be embraced.

After all these years, it seems clear that those 12 minutes at the scrub sink were an opportunity for a great surgeon to slow down time to reflect on what we know, and to rededicate us to getting the best possible performances from ourselves and from the systems we lead.

Morad Hameed

Peak surgery/

Since 1896, elite track and field athletes have competed in the 100m dash for the coveted title of the "fastest man in the world". Considered one of the pinnacles of human athletic achievement, the event has been dominated for a generation of runners by the larger-than-life Usain Bolt. In the wake of Bolt's record-breaking gold medal sprint at the 2012 London Olympics, the *New York Times* ran an article highlighting the stunning trajectory of human athletic performance over the past century. In a head to head match up, the fastest man in the world in 1906 would have finished a full 15 meters behind Bolt.

Andrea MacNeill

The elevation of surgical performance

The physiological and psychological elements underpinning this and other astonishing advances in sports, performance arts, and industry have been extensively studied over the past few decades. There are now validated, algorithmic formulae for performance improvement and techniques for overcoming both the physical and cognitive barriers to ongoing achievement. The practice of surgery requires a complex combination of technical aptitude, non-technical skills, and emotional agility. But we as a profession have not always embraced the tools available to hone these skills in a systematic and disciplined way to continuously heighten surgical performance.

The science of expertise: deliberate practice makes perfect

Anders Ericsson is a performance psychologist whose studies of human achievement have given rise to the science of expertise. In his book, *Peak: How to Master Almost Anything*, Ericsson debunks the notion of innate talent and makes a compelling case for a prescriptive path to peak performance. Using examples

from elite athletes and musicians, chess grandmasters, and even physicians, Ericsson demonstrates that performance improvement follows a universal set of principles regardless of the skill being pursued. He is quick to point out that mindless repetition is of no value in honing one's skills, and that practice does not, in fact, make perfect. Instead there is a hierarchy to effective practice, with the gold standard deemed "deliberate practice." Deliberate practice is characterized by focused, clear goals, and immediate and directed feedback. A key feature of deliberate practice is that it pushes the participant outside of his or her comfort zone. Once a degree of proficiency has been achieved such that the activity occurs comfortably and with an element of automation, Ericsson is clear that improvement has stopped. The learner has plateaued. Very little of the current paradigm of surgical training adheres to principles of deliberate practice. Worse, the absence of almost any structures for ongoing technical refinement - other than sheer repetition - for practicing surgeons means that performance improvement slows dramatically upon completion of formal training. This is in clear contradiction to the oft-repeated mantra of lifelong learning. Technical learning, it turns out, is vastly more difficult than knowledge acquisition. Numerous studies have documented this plateau in physician performance after the early years in practice, and in fact most demonstrate a deterioration in skills over time. In reviewing this literature, Ericsson concludes: "one thing is clear: with few exceptions, neither doctors nor nurses gain expertise from experience alone."

A gradual decay of surgical skills over a decades-long career is at odds with contemporary values of patient safety and continuous quality improvement. Recent evidence ties surgeon performance directly to patient outcomes, suggesting that safety and quality are not only institutional responsibilities, but also firmly within the purview of the individual surgeon. A 2013 study published in the *New England Journal of Medicine* reviewed unedited videos of laparoscopic bariatric surgery and showed a correlation between technical errors and adverse outcomes. Earlier this year, Andras Fecso, a general surgery resident at the University of Toronto, published similar results for laparoscopic gastrectomies performed for gastric cancer in Ontario. Using validated instruments for evaluating technical performance, Fecso found that poorer technical performance was an independent predictor of major post-operative complications. A 2017 systematic review identified the same relationship between surgeon technical performance and short-term perioperative outcomes in 21 of 24 studies. These results should motivate us to elevate our performance, knowing that our patients' outcomes depend on it.

Ericsson has provided us with a formula for technical learning, allowing us to rationally supplant the trial and error approaches of our predecessors, and move from a state of arrested development to continuous learning and mastery. Deliberate practice involves identifying experts within a field and deconstructing their performance so that learners can receive targeted instruction and practice in each element. In this way, Ericsson believes that the top performers in a field can be used to improve performance across the board. The concept of coaching has been bandied about in surgery for years, since Atul Gawande first put forth the idea in a *New Yorker* article in 2011, but deliberate practice entails much more than having a colleague join you in the OR for a day. It requires a longitudinal partnership with someone who is a recognized expert in the specific technique you are attempting to master. Performances must be critically reviewed, either live or by video recording, with provision of immediate feedback and the opportunity to put recommended modifications into practice in short order. The increasing availability of simulation facilitates this repetition and is helping to shift learning curves outside of the operating room and away from real patients.

Vanessa Palter, a surgical oncologist at St. Michael's Hospital in Toronto, demonstrated these principles in surgical trainees learning laparoscopic cholecystectomies. Residents were randomized to a conventional training strategy versus one in which operating room technical performance was reviewed and scored, with directed feedback provided. The latter group was then afforded the opportunity to practice specific techniques identified as problematic in the virtual reality simulator before returning to the operating room. When both groups were compared performing laparoscopic

cholecystectomies in the operating room thereafter, the deliberate practice group demonstrated superior technical performance.

Coaches and black boxes: ingredients for improvement

The concept of coaching for practicing surgeons has been championed by Caprice Greenberg, a surgical oncologist at the University of Wisconsin. While she endorses Ericsson's model of expert coaching, she is also pragmatic about the limitations of health care systems and suggests that there is benefit in peer coaching. This framework does not involve a disparity in skill level between participants, but simply a formal structure for reviewing operative performance and providing directed feedback on an ongoing, goal-directed basis. Greenberg is willing to forego the benefit of an expert because she feels that coaches need not be the best surgeons, just as tennis coaches need not be the best players. Rather, they must possess superb communication skills and adaptability so that they can understand the learner's needs and address these effectively. The feasibility and success of these methods have been demonstrated with the Wisconsin Coaching Initiative, in which the subjective experience of participants was overwhelmingly positive and many reported bidirectional learning between coaches and learners.

The literature surrounding peer coaching is predominantly qualitative, without firm evidence of improved technical performance. This is due to the logistical challenges and labour-intensiveness of subjecting operative performance to rigorous review. Teodor Grantcharov, a minimally invasive surgeon and pioneer in surgical education at the University of Toronto, has devised a technological platform to overcome these barriers and facilitate evaluation of operative performance. Modeled after airplane black boxes, the Operating Room Black Box is a comprehensive platform that captures all activities occurring within the operating room. This includes video of the procedure and interpersonal interactions within the room, physiologic information about the patient, the ambient noise level, and even how many times the OR doors open and close during a case. These synchronized, real-time data allow critical evaluation of a surgeon's technical performance, how he or she communicates with members of the team, and how environmental conditions within the operating room affect the procedure. The OR Black Box has now been deployed in Canada, the US and the Netherlands and promises to revolutionize performance improvement and patient safety in surgery.

The OR Black Box not only allows for longitudinal evaluation of a surgeon's technical performance, but also non-technical skills and team performance. In a study of laparoscopic gastric bypasses in Ontario, surgeons were rated for their communication, situational awareness, and judgment, and a relationship was demonstrated between non-technical skills and technical adverse events.

A study reporting on the first year of OR Black Box use evaluated 132 consecutive elective laparoscopic general surgery procedures and documented a median of 138 auditory distractions per case, along with a median of 20 errors and 8 events (iatrogenic injuries) per case, revealing not only the astonishing frequency of errors, but also the importance of non-technical skills in maintaining focus and adapting to real-world conditions in the operating room.

Surgical psychology: life at the edge of the comfort zone

The uniquely catastrophic possibilities of surgery necessitate a specific skill set of performance under conditions of extreme stress and the ability to cope with devastating outcomes. These skills are encapsulated in the notion of mental toughness, a recognized construct within competitive sports and high-stakes professions which is best described as a positive variant of resilience in which one not only survives but rather thrives in the face of adversity. The validated Mental Toughness Inventory (MTI) measures traits such as self-belief, success mindset, buoyancy, and optimism. Dean Percy, a general surgery resident at the University of British Columbia, recently completed a survey of Canadian general surgery residents and staff using the MTI and found significantly higher scores for attention and emotion regulation in men compared to women, and significantly higher levels of mental toughness in staff surgeons compared to trainees. A majority of both groups expressed interest in techniques to develop mental toughness, which

have been successfully employed in other fields.

Carol-anne Moulton, an hepatobiliary surgeon from the University of Toronto, has published extensively on surgeons' perceptions of risk, experience of intra-operative events, and coping processes after adverse events. She has characterized four stages of response to adverse events and shown that, despite differences in outward displays of coping, the majority of surgeons report being equally affected. Historically, the quintessential type A alpha male surgeon bore complications and poor outcomes with the proverbial stiff upper lip, and there is a persistent misconception that emotionally blunted individuals have an advantage in the operating room. It is likely these selection biases that led to surgeons being ranked in the top five professions to attract psychopaths according to Kevin Dutton's *The Wisdom of Psychopaths*. In 2018 it should be recognized that the highs and lows of surgery require a certain emotional agility to navigate, discerning when the assertive, confident leader needs to take control of a situation and when the sensitive surgeon can provide a listening ear to a patient or family in distress. Daniel Goleman in his seminal work *Emotional Intelligence* describes a state of "detached concern" as desirable for a physician. He suggests that there is an ideal amount of empathy that allows a physician to provide conscientious and compassionate care whilst remaining sufficiently removed so as to avoid being debilitated by concern and destroyed by adverse outcomes.

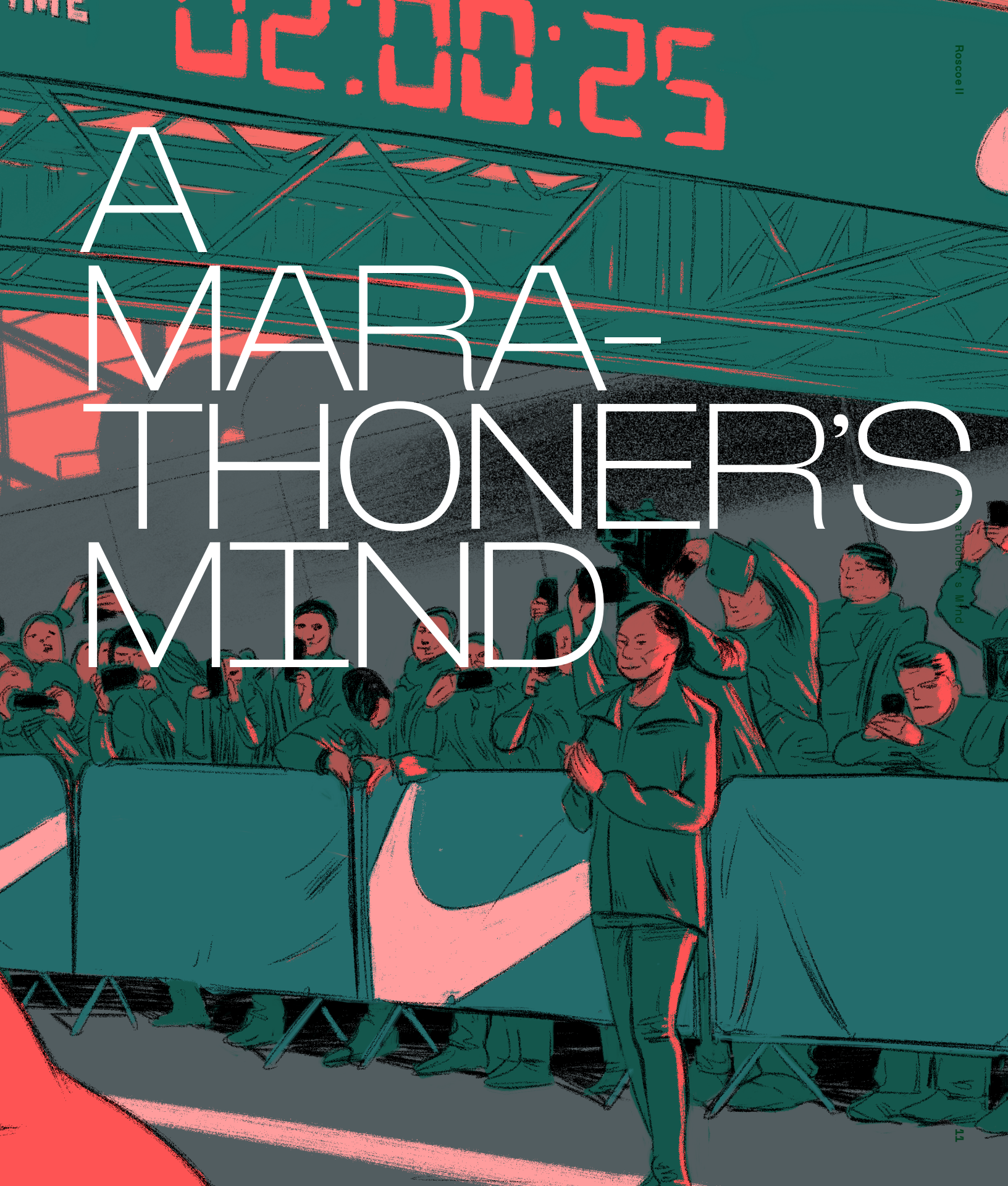
Moulton points out that athletes are coached not only in the technical aspects of their sport, but also in the cognitive components of performance. They are instructed in techniques to sharpen their focus, eliminate distractions, overcome the anxiety of competition, and recover from failure. Sports psychologists are now seen as integral to athletes' performance, with many professional teams rebranding them "mental skills coaches" in recognition of their equivalence to other members of the coaching staff. In *From Séance to Science: A History of the Profession of Psychology in America*, the value of cognitive training in sport is emphasized: "Indeed, in so many instances when physical talents seem evenly matched, it is the mental factors that will make the difference in winning and losing." Moulton describes this psychological coaching process as, "providing athletes with the tools to exist constantly at the periphery of their comfort zone;" that is, precisely where deliberate practice occurs.

Changing culture for boundless performance

The clinical performance of surgery requires a vast skill set of both technical and non-technical components that are not formally and systematically taught in surgical residency. Furthermore, the lifelong learning curve of the practicing surgeon beyond training has been largely neglected. We now have at our disposal the tools to elevate our performance to the next level, and a culture of patient safety telling us we can't afford not to. We have a framework of deliberate practice that has been wildly successful in other fields, a proof of concept for coaching in surgery, and a technological platform to measure our progress. But all of the experts in this field are in agreement that performance improvement in surgery is contingent upon a culture change within the profession. We must be able to exist as both an expert and a learner, inhabiting a safe environment in which we can challenge assumptions and accept discomfort. Caprice Greenberg suggests that our current model of surgeon development is focused on autonomy with the goal of achieving competence, when we should instead be collaborative in our learning with the goal of mastery. Carol-anne Moulton believes that in order for us to exist sustainably at the periphery of our comfort zones, the surgical community needs to provide a safety net. Teodor Grantcharov envisions a culture that adopts a healthy attitude toward error in which we learn from our failures rather than adopting a zero tolerance approach to error.

If we embrace these principles, Anders Ericsson assures us that we will begin to maximize our potential as surgeons:

> "we have found no limitations to the improvements that can be made with particular types of practice. As training techniques are improved and new heights of achievement are discovered, people in every area of human endeavor are constantly finding ways to get better, to raise the bar on what was thought to be possible, and there is no sign that this will stop." ●



A MARA-THONER'S MIND

Story by Alex Hutchinson
Illustration by Chris King

Just past the halfway point of the race, Eliud Kipchoge started making history. The 32-year-old Kenyan marathon whiz, already the reigning Olympic champion, was gliding smoothly around the notorious curves of a Formula One racetrack in Monza, Italy, in an exhibition race staged by Nike with the goal of breaking the two-hour marathon barrier. Other runners before him had run a half-marathon in less than an hour (though not many—the Canadian record is 1:01:28). But beyond that point, Kipchoge was in uncharted territory. With every step he took, he was the fastest human in history to cover that distance.

ON THAT EARLY MAY MORNING in 2017, I was watching from the pit lanes alongside the track, tapping frantic Tweets from my phone while covering the race for *Runner's World*. As Kipchoge pressed onward, one of the journalists alongside me nudged me in the ribs and pointed. "Look," he said. "Why's he smiling? This can't be *fun*." I shook my head: "That's not a smile. He's grimacing in agony." But as the laps wore on, Kipchoge kept flashing what looked like a broad grin.

He ended up crossing the line in 2:00:25, just short of his goal, but more than two-and-a-half minutes faster than the official world record. (His time doesn't count as a world record, because he had pacers running with him for the whole distance, which is not permitted.) And after the race, he confirmed that he had, indeed, been deliberately smiling. "I don't run with my legs. I run with my heart and my mind," he later explained. "When you smile and you're happy, you can trigger the mind to feel your legs."

WHEN WE MARVEL AT THE FEATS of amazing endurance athletes, we tend to focus on their physical gifts—the lithe limbs and cavernous lungs and turbocharged cardiovascular systems. But for years, athletes have tried to tell us that their races are won and lost in the mind. And in the last decade, scientific research has started to catch up with this idea. It's impossible to tie the limits of endurance to any single physiological variable. Instead, it's the brain that integrates signals from throughout the body and makes the final decision about when you need to slow down or stop — whether you're on a racetrack, at the gym, or in the operating room.

I was, admittedly, pretty skeptical when I first heard about Kipchoge's two-hour attempt. I got a call from my *Runner's World* editor about six months before the race. He told me that Nike had been running a secret multi-million dollar research project for several years, which they'd dubbed *Breaking2*, and were about to go public. Would I like to go behind the scenes and cover it? Two years earlier, I'd written a ten-page special report for the magazine on what it would take to lower the current world record of 2:02:57 to under two hours. I'd concluded that it was possible—and finished with a prediction that it would happen in Saskatoon in 2075. If Nike wanted to do it in 2017, I told my editor, one of us was going to come away looking pretty stupid.

Still, I accepted the assignment, and a few weeks later had my first chance to chat with Kipchoge. He had just run a half-marathon in India where he had barely managed to dip under one hour. What changes would he make in his training, I asked him, in order to run twice as far at the same pace? "The training will be the same," he said with an inscrutable smile,

Subjects are able to push their bodies harder without perceiving any greater effort. They've altered the relationship between body and mind.

"but my mind will be different." That didn't strike me as a very good plan, but over the next few months it became clear that he really meant it. It's a theme he returned to over and over in interviews. "You think it's impossible, I think it's possible," he told another journalist. "The difference only is thinking."

As the preparations for the *Breaking2* race continued, I was finishing up a book on the limits of endurance that I'd been working on for nearly a decade. I'd started out assuming that it would be all about lactate levels and cardiac stroke volume and so on, but the deeper I got into the research, the more I kept coming back to the role of the brain. And I started to see some parallels between the experiments I was encountering in labs around the world and the approach Kipchoge was taking toward his moonshot marathon goal.

One of my key epiphanies had come at an international conference on fatigue in the gold-rush town of Bathurst, in the remote Australian interior. There I heard an excitable Italian researcher named Samuele Marcora, from the University of Kent in Britain, describe his research on the influence of mental fatigue on physical performance. A mere 90 minutes of performing a simple but concentration-demanding task on a computer, he showed, resulted in a significant decrease in cycling endurance immediately afterward. The subjects had no changes in heart rate or brain glucose or any other physiological parameters—but their subjective sense of *effort* was higher right from the start, thanks to the mental fatigue induced by the task.

A later study at the Australian Institute of Sport, building on Marcora's work, found that elite cyclists were better able to resist mental fatigue and maintain their performance levels compared to very good recreational cyclists. They also had better "response inhibition," the cognitive skill that's measured in experiments like the famous Marshmallow Test. In others words, they had a greater ability to hold their finger close to the candle flame and keep it there despite mounting discomfort, a crucial skill for anyone whose profession demands sustained concentration — especially if, like marathon running and surgery, the task requires a combination of physical endurance and mental acuity. Marcora's most enticing claim? You can train this form of mental endurance.

The idea that you might be able to improve your marathon time by sitting at a computer tapping away at simple but boring cognitive tasks was bizarre enough that I convinced *Runner's World* to send to me Marcora's lab in Britain and have him design a 12-week brain training program for me to use in preparation for the Ottawa Marathon. In studies funded by the British military, Marcora has shown that repeatedly inducing mental fatigue with computerized response-inhibition tasks really

Alex Hutchinson (@sweatscience) is the author of *ENDURE: Mind, Body, and the Curiously Elastic Limits of Human Performance* (HarperCollins, 2018).

does improve performance in physical endurance tasks on a stationary bike. In practice, though, I found the brain training to be intolerably boring and way too time-consuming to be practical. It was a neat proof-of-principle, but not something I'd apply in my life.

There were other potential performance-boosters, though. Another of Marcora's studies showed that subliminal images of smiling faces, flashed in imperceptible 16-millisecond bursts, boosted endurance performance by 12 percent compared to images of frowning faces. The idea is that smiles evoke a subtle sense of ease that alter your brain's overall perception of how hard you're working, without any change in below-the-neck signals like heart rate or core temperature. There's even some fairly robust evidence that electrical brain stimulation to the motor cortex can alter perception of effort and thus increase endurance.

But the most reliable and practical way of enhancing mental (and thus physical) endurance, Marcora has found, is also the simplest. "Motivational self-talk" involves becoming aware of the internal monologue that flows through your mind during stressful situations, and identifying negative messages like "This is impossible, I can't do this." By drawing up a list of more positive alternatives ("I've trained for this. I'm ready for it."), and then spending a few weeks practicing deploying the new mantras, Marcora and other researchers have found dramatic improvements in endurance. The difference? Subjects are able to push their bodies harder without perceiving any greater effort. They've altered the relationship between body and mind.

All of this is what sticks with me when I reflect on what I learned from Kipchoge, who will undoubtedly go down as one of the greatest endurance athletes of our generation. What struck me initially as a bunch of empty platitudes was actually his systematic and deliberate attempt to prepare his mind for the challenge to come. And when the race day arrived, it was clear that he truly believed that he was ready to run 1:59:59. The two other athletes who had been chosen by Nike to make the attempt, meanwhile, looked terrified — and both fell off the pace even before the halfway mark.

A few months later, this point was driven home by a new study from Noel Brick, a psychologist at Ulster University in Northern Ireland whose research focuses on what endurance athletes think about during their races. He, too, had watched Kipchoge grinning his way through the second half of the *Breaking2* race. So he'd headed to the lab and put 24 runners through a series of tests on a treadmill. When he asked them to smile, they got two percent more efficient, burning less energy to maintain the same pace. Science, I decided, might have more to learn about peak performance from Kipchoge and his peers than the other way around. ●

PAY NO ATTENTION TO THAT MAN BEHIND THE CURTAIN

Aligning identity and experience in the pursuit of surgical excellence.

Story by Carol-anne Moulton
Illustrations by Luke Pauw

As a surgical resident I often wondered about surgeons' confidence and how much their outward projection truly aligned with their inner feelings. I wondered why surgeons seemed reluctant to call for help when they seemed obviously in need. I wondered whether surgeons were truly as unaffected by their patient's complications as they appeared. I wondered because my thoughts and feelings were different.

The first case I ever got to do skin-to-skin was an inguinal hernia repair on a young (newly married) man. What should have been a triumphant moment of my new career, became its most horrible moment when, after a smooth case, he woke up with excruciating pain in his testicle. In that moment, everything changed for me. My head swirled, my confidence shattered. I replayed the case over and over in my head, grappled with what I might have done wrong. A fresh surge of overwhelming dread came over me when I began to imagine that my young patient would never be able to have children. I went home and continued ruminating. I could not talk meaningfully about anything to my husband. My career was over before it started. I decided to go to bed but could not sleep. After several phone calls to the ward to make sure my patient was okay, I finally decided to go back to the hospital and see for myself, at three AM. I quietly walked into "Jeff's" room. He was sleeping so I gave him a little shake and, as he woke, I whispered "I just have to feel your testicle." Okay, that was a little weird ... to him, anyway. But as I walked away, reflecting on my reaction to what had turned out to not even be a complication (his testicles were both fine!), a thought became pervasive: *I was clearly not cut out to be a surgeon.*

If this was how I would react to every complication, how was I going to survive as a surgeon? Surgeons are confident and capable. I was filled with insecurity and anxiety. This was an inguinal hernia repair for goodness sake, and this was not even a complication, and I had just wasted 24 hours of my life.

Fast forward several years later and I am now a practicing HPB surgeon, with real complications. I am also a research scientist, and my lab focuses on surgical expertise and judgment. As I began my PhD I became very interested in a cognitive phenomenon that I believed to be critical to expert judgment — a phenomenon we called "slowing down when you should." My research interest became centred on the ability of the expert surgeon to transition from a relatively routine mode to a more effortful mode when she recognized a critical point of a procedure, or was feeling uncertain about an aspect of the procedure, or was faced with something unexpected. In the flow of thought and movement, I watched expert surgeons switch seamlessly and sensitively back and forth between a relatively routine mode of operating to a focused and attentive mode depending on the demands they were meeting and—fascinatingly—most were not even aware that they were doing it! In order to understand this phenomenon further, I needed to dip into other literatures, primarily cognitive psychology. I learned about attention and effort, situation awareness, automaticity and cognitive capacity. I was captivated by the complexity of our cognition, but if you asked me then, I'd have told you that surgical judgment is purely a cognitive phenomenon, that it lives in our heads. As we continued to explore the slowing down phenomenon through interviews and observations it became increasingly clear that there was more to the story. Something else of great importance also had the ability to affect the surgeon's judgment, but it was outside the cognitive domain. One of our senior surgeon participants revealed:

> *My efforts during these [slowing down] moments of crises were consumed with the anxiety I was feeling and intermixed with feelings of inadequacy, uncertainty, reputation and ego.*

A senior surgeon. A respected, accomplished, senior surgeon was "consumed" with anxiety. It started to become clear to me, not only as a researcher, but also as a practicing surgeon, that there was another aspect of judgment that needed to be acknowledged, and better understood. It required peeking behind the curtain and exposing much of what I'd come to accept as the norm as a ruse. Maybe my reaction to my first "complication" wasn't so unique?

To find out meant asking surgeons to be reflective and candid about their experiences in ways that might be uncomfortable for them. It required becoming familiar with the social cognitive and sociological literatures. As we embarked on this new exploration of the relationship between surgical identity and culture, and surgical performance, three social theories resonated with me. It is my belief that the surgical culture needs to be interrogated for the negative effects it might have on surgeon performance. It is worth exploring because surgical culture — like all cultures — is not static; through the process of socialization we can all choose to shape our culture into whatever we want it to become.

IDENTITY CONSTRUCTION

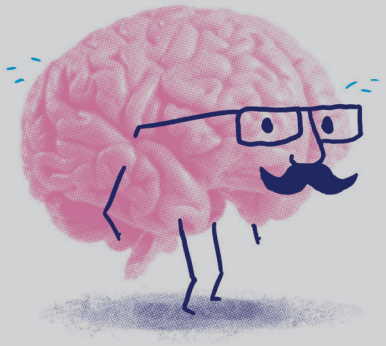
We all have some idea of what makes up a surgical identity: someone who is knowledgeable, decisive, confident, you name yours. For most of us our idea started long before we entered medicine. It is taught to us in pop culture and reinforced everywhere from the cinema to the Halloween costume.

Many surgeons and educators consider the typical surgeon traits — confident, aggressive, infallible — to be relatively stable traits. In fact, we will try and select for these traits if we believe this to be the "right" identity of a surgeon. However the sociologists I have collaborated with suggest that these traits are constructed through a very powerful socialization process. When we tacitly accept and perpetuate these stereotypes, we teach trainees what traits are valued, and ultimately produce the same qualities in the next generation. As in most cultures, this often happens without our understanding or troubling the process. These qualities do not represent what a good surgeon "has to be", they simply represent what has historically been.

The point is surgeons want to be good surgeons, we want to be accepted by our peers as good surgeons, and we have an idea of what a good surgeon looks like. That identity of a surgeon is what we internally strive for. In a way, it can be seen as a guiding compass, or an expectation that we have set for ourselves.

Though they may seem strange to ask, questions about our identity are fundamental to our progress as a profession. Is the current goal actually what we want? Should we strive to be confident, fearless and decisive surgeons? Does this identity feel authentic?How does it impact our daily decisions? Is being a mindful, thoughtful, and inquisitive surgeon at odds with the current identity? What would be the ideal identity for a surgeon?

It is worth noting that we have multiple identities and take on and off the identities depending on our context. My identity as a mother, or as a researcher, or medical director might be, and very likely is, different from my identity as a surgeon. Often without realizing it, we are putting on and taking off these identities throughout our day, changing our behavior to align with the identity of the moment. This is part of being a social being, embedded in a social world. We are called "social actors" and this is part of living, not only as a surgeon, but as people. It is an important exercise to examine our various identities, understand what goes into their construction, and appreciate how they affect the way we behave and feel in the moment.



IMPRESSION MANAGEMENT

Erving Goffman, a Canadian sociologist, working at Berkeley and the University of Pennsylvania, was was interested in the way human beings, as social actors, behave when we interact with each other in a social setting. He described a "frontstage" to represent the performers in us, portraying an image to others we want them to see. Our "frontstage" performance is linked to the identity we strive toward. As a surgeon, we perform an identity centered on confidence, for example. But aer a junior urology resident being called into our OR when the usual methods of catheterization failed. It was July and he was a PGY1. He likely knew a lot less than my team about the tricks of a difficult cathetherization. He acted like a good surgeon — confident and able — but as his manoeuvres failed I could recognize the he was struggling. Despite his "frontstage" performance, I knew that he was not equipped to handle what was happening in the OR. At one point, I suggested he call for help, but he chose not to. It is likely that calling for help did not align with the image he had of himself, or the image he wanted his superiors to have of him. So he persisted until a false passage was created. Persisting in the face of adversity, in this case, was poor judgment; a decision made based on factors that lived outside his head. The root of his poor judgment was most likely, not a lack of anatomical or surgical knowledge. It was a social problem, a cultural problem.

I have spent many years exploring Goffman's theory among surgeons, trying to understand how this need to perform a particular surgical impression might impact patient care. I have heard accounts of trainees making up values for their superiors about blood results for fear they will portray an image of uncertainty or not knowing. I have heard fellows describe putting kidneys in upside down as their staff showed up outside the OR trying to impress upon their staff they were competent and quick. I have heard surgeons describing a reluctance to call for help when they felt they needed advice. I have heard neurosurgeons confess letting trainees operate even past the point of comfort to protect their reputation as a "cool teacher who let's trainees operate." I have heard many, many surgeons describe the impact of their complications, fearing the impact on their own reputation:

> *The truth is you're also worried about yourself. I think, really, you're worried about your reputation, how people are going to think of you, the finger pointing ... everyone in the community is going to know.*

The surgical ideal toward which so many of us strive, the all-knowing, capable, confident and fearless caricature, is tough to uphold. Portraying this image is tiresome, it takes its toll on us, and it impacts our patients. It prevents us from reaching our full potential — from reaching true expert status. And although we may internalize responsibility and blame ourselves for all of this — our "stupid" mistakes, our "unacceptable" knowledge gaps, and even our emotions—as individuals we are not really to blame. We are being the surgeon we have been trained to be. The resident lying about the blood result is being the surgeon he was trained to be — "be all-knowing." The fellow who sutured the transplanted kidney in upside down was being the fellow he was trained to be — "be quick and decisive." The surgeon who worried about calling for help is being the surgeon she was trained to be — "technically able".

I began my research career with an interest in surgical expertise. Here is an irony: in our efforts to portray to others that we are expert, we prevent ourselves from becoming expert. Do we understand this, and the subsequent implications? In our recent study exploring how surgeons would embrace coaching in the OR as a concept, we were told that although many surgeons wanted it and felt they could learn from it, they were reluctant to accept it for fear of damage to their image: "There would be a high risk of it having negative perceptions by people, so whether it's nurses, residents or fellows I think it would be perceived as either a sign of weakness or a sign of inability or a sign of lack of confidence because it's not the norm."

So, to be clear, we can't have a staff surgeon coaching program. Because we may need one, but we can't show that. To ourselves? To our colleagues? To our patients? The same people who might benefit. And we continue to train this way. Residents, too, shared that they were afraid to speak up, or to ask questions for fear of revealing that they — the learners — might need to ask questions in order to... learn. How did we get here? Why are we still here?

I truly believe that we need to change things. So let me state the irony again. In our efforts to portray an image of expertise to others, we prevent ourselves from becoming truly expert. This is a problem. Hey surgeons, judgment does not only live inside our heads! It also lives within our culture. We must make an active choice to do something about it. Lets expose the cultural inadequacies that are ingrained in our training and internalized into our very being (as was the case for the generations of surgeons before us). No longer should individuals be left to negotiate these conflicts within themselves. We need to start understanding the link between identity and impression management — the link between "managing our image" and "managing our patients" — and the link between wellness and authenticity.

SOCIALIZATION

The final theory of interest from the sociological literature is socialization. Socialization is a process that happens over time (often very quickly) where we begin to internalize the values of a certain group of people. It happens to our medical students and residents when they want to become surgeons. They see the valued attitudes and behaviours among this group and and begin to model them. They pick up values that are explicit (e.g., if you want to do this case you need to look up the details beforehand), as well as values that are implicit (e.g., when complications occur there will be chatter behind your back, in the change room and hallway, that is not always supportive). We absorb and emulate the patterns of behavior of our culture, just like everyone else does.

The best thing about socialization theory is that culture can change for the better through this very same process. As a group we can decide to value a different set of attitudes and behaviours. We can learn about the hidden curriculum and start recognizing ways we perpetuate values that lead to physician burnout and poor decisions. We can recognize the ways our attitudes and behaviors lead to a culture of "not quite expert." We can redefine what a "good surgeon" looks like. We are not simply passive vessels through which surgical culture passes, we are active agents within it. Let's reset the identity of a surgeon. Perhaps a good surgeon should be mindful, thoughtful, inquisitive, authentic, caring, feedback seeking, and vulnerable. One that works hard and is greatly skilled, but who sometimes makes mistakes. One who is human, with all that this entails. When she makes mistakes, she seeks out learning opportunities and becomes greater. A good surgeon is one that continually strives to get better, bringing peers beside him to teach him new things, and who is willing to adapt and change. It is our choice to pull back the curtain and expose the hidden areas in our culture that prevent us from being truly great.

In the 1939 film *The Wizard of Oz*, Dorothy's dog Toto, pulls back a curtain to reveal that the Wizard is only a simple man with microphones and fancy lighting equipment to portray himself as a powerful and mystical figure. Dread turns to humour when he says: "Pay no attention to the man behind the curtain!" The scene is a relief to the characters and the audiences alike, and finally a foundation from which to move forward into an exciting future. As our frontstage gets closer to our backstage, and as our identities align with our true experience, three things will change. Surgeons will feel freer and healthier. Surgeons will make better patient decisions. And surgeons will free themselves up to learn, to be coached, and to excel. It's okay if we pull the curtain back. It's okay if we expose all the microphones and lights. The future is much bolder and brighter without them. ●

Learn more at the
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THE MAJOR LEAGUE

A Lesson in Performance Metrics

SURGEON

Story by Andrea MacNeill & Zane Cohen
Illustrations by Suharu Ogawa

For anyone hoping to one day make it to the big leagues, *Baseball America* has published a helpful article entitled "What are baseball scouts looking for?" Structured as a Q-and-A with a number of veteran Major League Baseball scouts, the article outlined the selection process for MLB draft prospects. In response to the question, "How many times do you like to see a hitter before you're comfortable putting a grade on his [skills]?" One scout replied, "Just once. I mean, you either get that fuzzy feeling or you don't."

THE HISTORY OF BASEBALL SCOUTING in which players were evaluated based on their "tools" (hitting, fielding, running), not according to statistical trends but rather the visceral reaction their performances elicited in the old baseball men watching them, is comically subjective in a modern era of baseball big data. Baseball is now a game of analytics; an actuarial playground with an entire discipline of sabermetrics* dedicated to objectively capturing a player's value. The mechanics of baseball have been distilled down to their most minute components in order to rationally assemble a winning team. The lay public might be surprised to learn that despite the astronomically higher stakes, the process of selecting and developing surgeons bears more resemblance to old time baseball scouting than a modern empirical science.

In the medical equivalent of a major league draft, the CaRMS process sees residency candidates evaluated based on remote academic performance, limited research experience, brief exposure during clerkship rotations, even briefer interviews, and virtually no measure of technical aptitude. Marisa Louridas, a recent General Surgery graduate from the University of Toronto, devoted her PhD to investigating better methods of selecting residents for surgical training. She surveyed General Surgery program directors across the country who all agreed that technical competence was an area that is not uniformly achieved during residency training. According to these program directors' estimates, five to 15 percent of residents struggle to acquire the technical skills necessary to become safe and capable surgeons. This is in keeping with studies of technical learning showing that eight to 20 percent of trainees fail to reach proficiency in simulated tasks despite repetition and instruction. Louridas studied performance improvement in preclinical medical students who were given instruction in simulated laparoscopic and open tasks. Her results demonstrated differences in innate ability as well as learning curves. A subset (eight to 15 percent) of students fell into a category of low performers, who not only started at a lower skill level than their peers, but also failed to demonstrate a convincing learning curve. Yet attempts to identify these low performers at the time of resident selection have been unsuccessful, as simulated tasks of dexterity and visual spatial recognition are inadequate surrogates for technical prowess in the real world operating room. The technical execution of an operation requires a complex interaction of skills that cannot be predicted based on simplified screening of undifferentiated learners.

Whereas Major League Baseball prospects were once routinely recruited out of high school, the prevailing wisdom now suggests that performance in college is much more predictive of eventual big league play, and scouts are loath to pin their hopes (and big money) on inexperienced young talent. It may be that attempts to screen for technical aptitude in CaRMS candidates is a misguided endeavour, as the notion of accurately identifying surgical skill at the level of a medical student is akin to trying to draft major league baseball players directly from Timbit teams.

In his best-selling book *Moneyball*, Michael Lewis recounts the evolution of baseball from a storied Old Boys' Club to a rigorous science. His book, and later the movie by the same name, centres on the heart-warming underdog tale of the Oakland A's at the turn of the century. Under the leadership of general manager Billy Beane (played by Brad Pitt), the A's subscribed to an obscure analytics-based school of thought

*Named for the Society of American Baseball Research (SABR), sabermetrics is the statistical analysis of baseball in order to evaluate and compare the performance of individual players. Founder Bill James called it "the search for objective knowledge about baseball".

If we truly want to improve patient outcomes, we must be better able to account for each contributing factor, including surgeon performance.

called sabermetrics, which derived novel metrics to better reflect a player's individual contributions to winning. By selecting for undervalued skills, the A's put together a motley crew that took Oakland to the post-season four consecutive years, despite having one of the lowest payrolls in baseball. In 2002, with only $40 million, they tied the New York Yankees for the most regular season wins (the Yankees spent $125 million for the same results). Once the success of the method became known, other teams followed suit. The Boston Red Sox hired the father of sabermetrics, Bill James, to their front office and combined analytics with big money, breaking an 86-year World Series drought in 2004, with repeat performances in 2007 and 2013.

James pioneered this new approach in baseball after realizing that conventional baseball metrics reflected the conditions under which the game was played, rather than a player's individual contribution. Runs batted in, for example, required that players be on base ahead of the hitter. A long fly ball in one ballpark would be a home run in another. He and a cadre of armchair enthusiasts meticulously dissected out the components of the game in order to accurately value each one. They determined that on base percentage and slugging percentage were better reflections of a player's value to a team. An entire array of new defensive statistics were devised to separate a pitcher's performance from the fielders' behind him. A new era of evidence-based baseball had dawned.

For all of the medical profession's pontificating about being empirically driven, surgery remains woefully devoid of meaningful statistics to accurately reflect performance. The patient safety movement has given rise to big data in surgery, with thousands of hospitals participating in the American College of Surgeons' National Safety and Quality Improvement Program (NSQIP), and a multitude of cancer databases tracking oncologic outcomes. The perioperative outcome measures we are fed back (e.g. length of stay, morbidity, mortality) are a reflection of the conditions under which the surgery takes place, influenced by patient factors, members of the operative team, post-operative nursing care, and hospital ancillary services. No amount of risk adjusting can render these statistics a pure reflection of the surgeon's contribution to patient outcomes, which is why the notion of public reporting of surgeons' outcomes has been met with staunch resistance.

Surgery now stands poised on the brink of its own sabermetrics revolution. Validated scoring systems such as the Objective Structured Assessment of Technical Skills (OSATS) and the Generic Error Rating Tool (GERT) allow standardized assessment of technical performance by distilling down the process of operating into its component parts (respect for tissue, time and motion, use of assistants, etc) and assigning numerical values for each. The cognitive and interpersonal skills that underpin safe surgery can be reliably assessed with the Non-technical Skills for Surgeons (NOTSS) instrument, a behaviour rating system that evaluates situational awareness, decision-making, communication, and leadership. These tools enable the individual surgeon's performance to be evaluated at its most basic level, instead of relying on surrogate outcome measures that are messily multifactorial.

The labour intensiveness of applying such tools is a limitation to their widespread use and thus to the possibility of mandatory or routine testing. Emerging multidimensional

intraoperative surveillance technologies, such as the Operating Room Black Box developed at the University of Toronto (see Peak Surgery), harness digital technologies to capture all technical and non-technical aspects of an operation. Investigators are now integrating artificial intelligence to automate evaluation of the technical execution of an operation. One can imagine a day in which Black Box recordings of every operation provide instantaneous technical feedback to the surgeon, generating a real-time report card.

If we truly want to improve patient outcomes, we must be better able to account for each contributing factor, including surgeon performance. Bill James revolutionized baseball by asking why. Why does team batting average not correlate with wins? Why do pitchers' ratios of hits per balls in play vary wildly from year to year when their walks and strikeouts remain constant? Our current process for asking why – M&M rounds – bears more resemblance to an ad hoc post-game press conference, in which we wilfully avoid discussing technical performance and invariably conclude that patient factors were to blame, than to a rational and dispassionate critical review.

MICHAEL LEWIS RECOUNTS a pivotal moment in the sabermetrics story when two Wall Street traders and baseball enthusiasts were inspired by the derivatives market, which reduced stocks and bonds to fragments (derivatives) that had precisely quantifiable value, and applied the same algorithmic approach to baseball. They created a program to break down baseball plays into meaningful fragments that could be individually valued. Lewis lays bare the driver of this eureka moment: "Just as it never occurred to anyone on Wall Street to think about the value of pieces of a stock or bond until there was a pile of money to be made from the exercise, it never occurred to anyone in the market for baseball players to assign values to the minute components of a baseball player's performance — until baseball players became breathtakingly expensive."

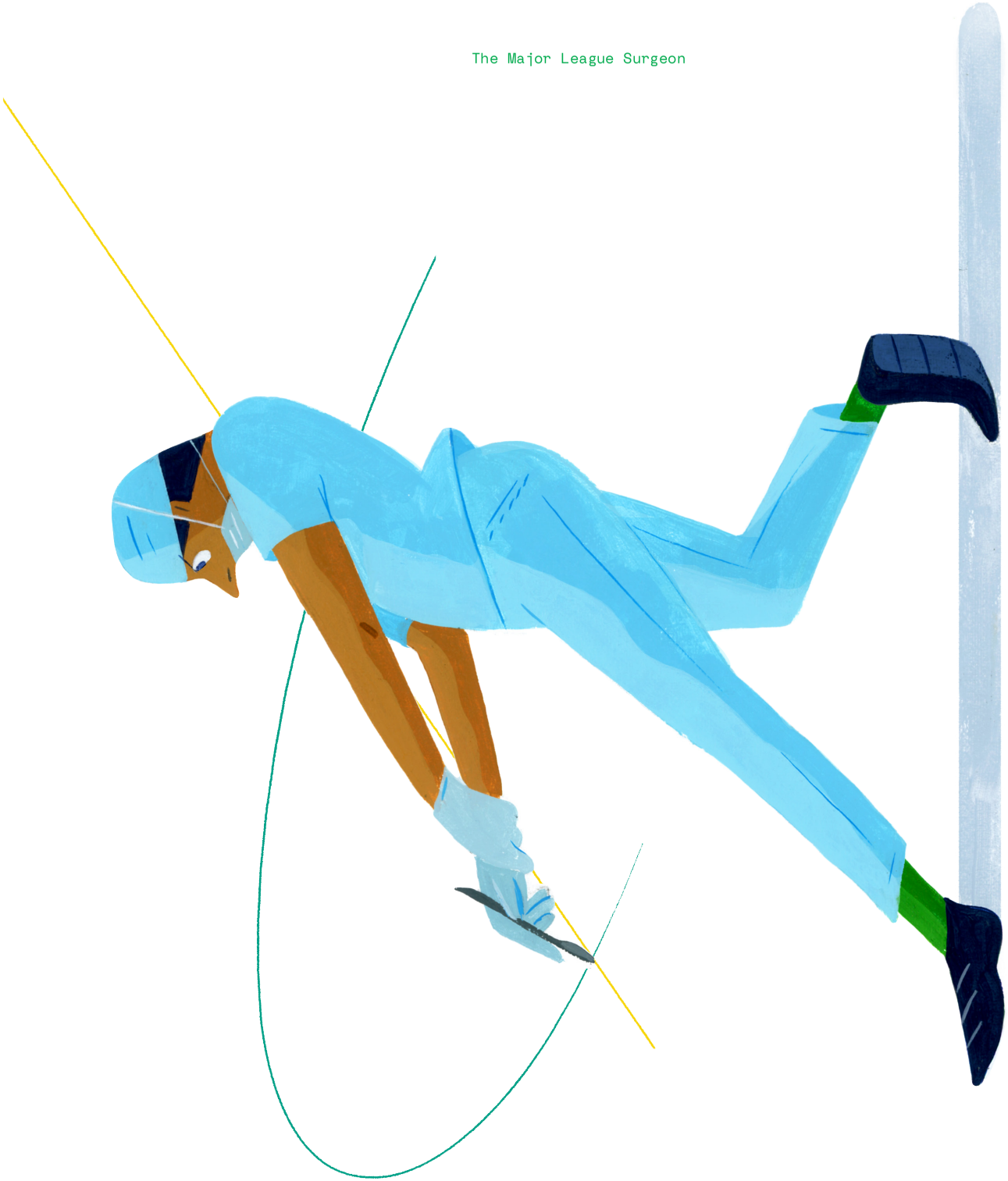
The modern era of patient safety, quality, and high value care demands that we revisit our traditionally haphazard approach to evaluating a high-stakes profession. Patients expect a guaranteed minimum standard of care, and the cost of adverse events is one of many straws breaking the back of our resource-constrained system. We cannot afford to ignore the tools at our disposal to devise a rational approach to quality surgery. We must understand the components of a good surgeon, select for these skills in our trainees, and develop and refine them over the course of our entire careers.

The majority of surgical residents are able to become safe, competent surgeons. Marisa Louridas expresses concern about focusing on selection processes to predict eventual technical performance, as the longitudinal data to validate these are lacking. Rather, "it may be more fair and accurate to evaluate technical skills acquisition early in training and identify those low performers whose learning curves predict a trajectory to substandard care." Just as MLB draft picks must ascend the minor league ranks, with some never reaching their big league goal, so surgical training should be an ongoing selection process rather than an immutable commitment to a career in surgery. Louridas suggests that having exit points early in training and a formal means of redirecting residents to alternate career paths would benefit the trainee, the residency program, and the public. Attrition should not be viewed as a failure of a resident or a program, but rather an indicator of a healthy process of cultivating proficient, mature surgeons.

The adoption of competency-based surgical training should embed the principles of systematic evaluation of technical and non-technical surgical skills into residency education. Each procedure that a resident is expected to master is deconstructed into components termed milestones, and residents are evaluated longitudinally on their autonomy in achieving these milestones. Learning does not stop once the individual steps, or milestones, of an operation are mastered, however. The refinement of technique, flow and efficiency represent an ongoing learning curve that the practicing surgeon should seek to trace, achieving new levels of mastery and technical expertise over the course of a career.

The current paradigm of surgeon recruitment and promotion places great emphasis on research productivity, teaching, and administrative roles, with little accounting for clinical skills. This valuation of surgeon performance is at odds with the core skill set and activities that define our profession. We now have robust, empiric tools to measure clinical performance and a culture that is demanding high value care. It would not only be possible, but also appropriate, to establish minimum standards for surgeons' clinical performance as well as benchmarks for ongoing improvement to lend credence to our commitment to lifelong learning.

Lest we scoff at the old baseball scouts' subjectivity in evaluating talent, we should remind ourselves that surgery still lags far behind other professions in which advancement is directly tied to performance. Surgical performance is the product of a complex and nuanced amalgam of elements, some within but many outside our control. One might argue that it can never be reduced to meaningful fragments, that the tangled web of technical aptitude, interpersonal skills, patient factors, team members, and distractions can never be unraveled to reliably reflect individual performance. It took Bill James 20 years of publishing empiric evidence to overcome this deeply entrenched thinking in baseball, and to devise the means to accurately value baseball players' performance. We need to embrace the tools of sabermetrics in surgery, to elevate our performance in order to achieve a new level of patient safety, quality, and high value care. ●



SHOULD SURGICAL SYSTEMS

Diversity and Complexity in Surgical Systems

By Morad Hameed, Chad Ball, Arianna Cruz, and Fady Balaa


OPERATE
LIKE
AIRCRAFT
CARRIERS ?

In July of 2008, a large Canadian teaching hospital launched the first iteration of its Acute Care Surgery (ACS) Service. It did not go well. Designed to free surgeons to respond more rapidly to surgical emergencies, it designated 15 surgeons to 12-hour shifts with 24/7 coverage of a busy emergency department and operating room. The hope was to create a dynamic hospital-wide surgical rescue service for outpatient and inpatient emergencies. In its first months, the service on average saw 15 new patients a day, did five operative cases, and managed an inpatient census approaching 60 patients, many of them with acute and undifferentiated conditions, and a majority with complex comorbidities. The service operated with equal frequency in the middle of the day and the middle of the night (often starting its slates at five in the afternoon, crossing paths in the change rooms with other surgical services as they were leaving for the day), and running through until morning. Although the service was roughly divided into two teams, the surgical residents frequently could not identify a most responsible surgeon because of numerous unregulated handovers and cross coverage between faculty members. It was estimated that the service required 250 handovers per day between surgeons and residents to maintain some semblance of continuity of care. Patients were lost in the shuffle, not meeting staff surgeons nor being booked for surgery or discharged for days. There were no established guidelines or standards of care, and no measures of process or outcome. There was, essentially, no formal teaching on ACS. The service ran on its novelty and on the energy and initiative of its trainees, but, with no foundation, the launch seemed to falter. A service designed to handle crisis itself seemed destined for crisis.

Industrial Engineering, Statistical Process Control and ... Surgery

Most surgeons will readily recognize the flaws in the design of a service, and might predict its inefficiencies, complications and failures. Its problems — no process or bottleneck analysis, no outcome-based performance measurements, no standard or transparent handover, no institutional or infrastructural support — have been known for over a century. In the early 1900s, a Boston surgeon, Ernest Amory Codman was a prominent member of staff at the Massachusetts General Hospital. Educated at Harvard Medical School, with surgical residency at the Brigham and Women's Hospital, Codman was, by appearances, an insider. In reality, he was an independent spirit, a fierce and passionate advocate for surgical patients and one of the world's first proponents of rigorous measurement of surgical performance and transparent reporting of outcomes. He reported his own outcomes, even starting his own "End Results Hospital" in order to report to the public, and he pushed his colleagues to do the same. He began one of the first national surgical registries in the United States to bring more data to the assessment of surgical quality. Despite a courageous career, Codman was ostracized by the surgical community. He lost his positions at MGH and in the local Surgical Society, and he eventually died in 1940, impoverished and almost forgotten.

In 1950, a 50 year old mathematician, physicist, engineer and statistician from New York University, W. Edwards Deming, stepped up to the podium at Tokyo's Hakkone Convention Center to deliver the speech of a lifetime. He was addressing the Japan Union of Scientists and Engineers, which was beginning its journey to rebuild Japan after the devastations of World War II. Deming described complex industrial processes as a collection of discrete steps, each with measurable common and special cause variation. Attention to, and minimization of, variation could ensure that processes run smoothly, and that they reliably deliver optimal outcomes. Deming's concepts of statistical process control supported Japanese excellence in manufacturing, helped to produce exponential growth of the Japanese economy in the ensuing decades, and brought industrial engineering to center stage.

A few years later, in 1966, a paper published in *Millbank Quarterly* by Avedis Donabedian, a physician and public health scientist working at the University of Michigan, made the connection between industrial engineering and health care. Donabedian noted that "the measurement of process is nearly equivalent to the measurement of quality of care because process contains all acts of health care delivery". Over an astonishingly productive career, Dr. Donabedian transformed and clarified thinking about health systems. His structure, process, outcome paradigm has formed the framework for our ideas about the optimization of health systems.

As investigators began to realize the massive scope of adverse events in health care, process control concepts gained prominence. Writing in *JAMA* in 1990, Lucian Leape (a pediatric surgeon, professor of public health at Harvard, and leading authority on medical error) noted that "one of the basic tenets of total quality management, statistical quality control, requires data regarding variation in process" and, "In a generic sense, errors are but variations in process." These ideas sparked national and global initiatives in measuring and standardizing process and outcome. Shukri Khuri, a cardiac surgeon and surgeon scientist who went on to become the Chief of Surgery at the West

Roxbury Veterans' Administration (VA) Hospital, was among the first surgeons to scale data-driven and scientific approaches to quality improvement. His work resulted in astonishing reductions of postoperative morbidity and mortality of 43 per cent and 47 per cent in the VA system, and helped to launch the National Surgical Quality Improvement Program (NSQIP), a global phenomenon, which in turn sparked many secondary quality improvement initiatives. NSQIP itself has evolved from bread and butter general surgical procedures to encompassing the most complex surgical care provided today. The finest example of this evolution would be Hepato-Pancreato-Biliary (HPB)-NSQIP. This platform has even been leveraged to perform multicenter randomized controlled trials to ensure ongoing improvements in the quality of patient care. Injury care is much the same with Trauma Quality Improvement (TQIP).

Among these evolutionary steps is the American College of Surgeons Enhanced Recovery After Surgery (ERAS) Program, a movement that emphasizes the widespread integration of best practices into standard postoperative processes. ERAS is an excellent reflection of industrial engineering principles developed over the past century, and brings the ideals of standardization and optimization of complex surgical processes to their highest level of realization yet. In some studies, ERAS has decreased morbidity and mortality rates, while shortening hospital stays, expediting return to work, and reducing health care and societal costs. One recent ERAS study in eight Ontario hospitals looked at 3,000 patients over 24 months beginning in September 2012. Through retrospective chart review, ERAS was found to eliminate one full day in recovery in hospital, which would add up to 5,000 hospital days if extrapolated across the province.

ERAS-style standardization of process, which sets up systems for compliance through protocols and checklists adopted from the airline industry, views patients from a collective and uniform perspective, and surgical systems as industrial processes that must be measured and controlled for continuous improvement. This is in distinction to modern genomics-driven movements in precision medicine that seek to tailor diagnostics and therapeutics to genotype and phenotype, or in other words, recognize nuance and complexity to identify individualized pathways for individual patients. It may be that once processes are standardized, the gains on further process refinements may begin to diminish. Furthermore, refined, industrialized processes, once entrenched in health care, may still have gaps through which unforeseen disasters could occur. Unlike rigidly standardized assembly lines, healthcare processes must be agile and resilient enough to contain and recover from adverse events. Therefore, standardization and structural improvements require a system and organization capable of accurately anticipating errors, reducing their incidence, and quickly and effectively reacting when damage occurs.

Despite some of the potential limitations of standardization, 80 years after his death Ernest Codman is vindicated and is now considered "one of the most important surgeons of the 20th century". His ideals of measurement, continuous improvement, and transparency have transformed surgical science and culture. The resulting question is: where are the next great frontiers in surgical performance improvement?

High Reliability

In the mid 1990s, the US Navy, led by Rear Admiral Tom Mercer, partnered with organization theory researchers at the University of California, Berkeley, to study safety processes aboard the aircraft carrier USS Carl Vinson. Operations aboard aircraft carriers were beautifully described by a senior Air Division officer:

> *So you want to understand an aircraft carrier? Well, just imagine that it's a busy day, and you shrink San Francisco Airport to only one short runway and one ramp and one gate. Make planes take off and land at the same time, at half the present time interval, rock the runway from side to side, and require that everyone who leaves in the morning returns that same day. Make sure the equipment is so close to the edge of the envelope that it's fragile. Then turn off the radar to avoid detection, impose strict controls on radios, fuel the aircraft in place with their engines running, put an enemy in the air, and scatter lie bombs and rockets around. Now wet the whole thing down with sea water and oil, and man it with 20 year olds, half of whom have never seen an airplane up close. Oh, and by the way, try not to kill anyone.*

Working aboard the Carl Vinson, Berkeley researchers Todd LaPorte, Gene Rochlin, and Karlene Roberts realized that although the ship was perpetually at risk of disastrous accidents, it engaged in nearly error-free operation. To them, aircraft careers, like air traffic control operations and nuclear power plants, came to exemplify high reliability organizations (HROs) — organizations that exist in complex, hazardous environments, where errors are highly consequential, but error occurrence is extremely low. Roberts later defined high reliability organizations as those in which the likelihood of success in a complex process is tens of thousands of times higher than that of failure.

LaPorte, Rochlin, and Roberts may have expected to see that this high level of performance was achieved by comprehensive, rigorous, and deeply entrenched standardization of operations, personnel, and organized hierarchy, with perhaps meticulous adherence to a standard operating manual. But they actually found very little evidence of this. Instead the working environment was comprised of a relatively flattened hierarchy, openness to communication where expertise was valued above rank, a relentless and universal commitment to learning, resilience, and an organizational culture attentive to details and preoccupied with failure.

This early work led to the more detailed characterization of HROs as those with:

01. Hypercomplexity, with extreme variety of components
02. Tight coupling — interdependence across units
03. Extreme hierarchical differentiation between units
04. Large numbers of decision makers in complex communication networks
05. High degree of accountability
06. High frequency of immediate feedback about decisions
07. Compressed time factors
08. More than one critical outcome must happen simultaneously

While some of these characteristics are present in many organizations, HROs possess all of them. If they seem familiar, it may be because ACS services, or any complex surgical service functioning in a busy multidisciplinary environment, also meet all of these criteria.

Reviewing the literature in 2001, Karl Weick and Kathleen Sutcliffe, from the University of Michigan and Johns Hopkins, discovered that HROs perpetually seek to reorganize and reinvent themselves to increase people's alertness and awareness about both ongoing processes and the gathering storm clouds of potential failure. This collective mindfulness of HROs is dependent upon some critical requirements:

01. Preoccupation with failure
02. Reluctance to simplify interpretations
03. Sensitivity to operations
04. Commitment to resilience
05. Deference to expertise

This concept of developing cultures of collective mindfulness among diverse teams may represent the next wave in the evolution of surgical performance. Surprisingly, the idea of collective mindfulness is also one that is firmly grounded in mathematics.

Diversity in Complex Systems

Complex systems, according to the University of Michigan economist Scott E. Page, "consist of diverse, connected, interdependent, and adaptive actors, who collectively produce patterns that are difficult to explain or predict... they are capable of producing emergent phenomena in which the whole differs in kind from the parts that comprise it". Page also notes that complex systems "are neither ordered, nor chaotic. They lie in between". The spectrum of systems, from ordered to chaotic, have definable inputs and outputs — ordered systems are more predictable, while chaotic systems display extreme vulnerability to and variation with changes in inputs. The relationship between inputs and outputs is, of course, the subject of industrial engineering, but as systems become more complex, modeling outputs becomes increasingly challenging.

Surgical systems, and the problems they encounter, are both diverse and complex, and therefore difficult to model and difficult to predict. But their diversity, and the way they embrace their diversity may be keys to their success. In 2004, Page and his colleague Lu Hong, seeking to explain statistician Francis Galton's observation of why the collective estimate of the weight of an ox by group of villagers in Plymouth, England in 1906 could come within one percent of the ox's actual weight, developed a model of collective problem solving that compared the abilities of a relatively homogeneous group of high performing individuals with a randomly selected group of people that had a diversity of perspectives, experiences and, presumably, cognitive skills. Lu and Page showed mathematically that, in complex

problem solving, diverse groups almost always outperform groups of high performing individuals. They distilled this insight into the equation:

Crowd of Models Accuracy
=
Average Model Accuracy + Diversity

The explanation for this phenomenon is that a diverse group, with different experiences, perspectives, and skills will necessarily see the world more completely and entertain more solutions than groups of high performance individuals, regardless of what metrics were used to define high performance. According to Page, the pursuit and promotion of diversity among systems and teams is not simply a moral imperative, it is also an objective imperative if we wish to solve problems and constantly evolve.

Future — Surgery as a Sociotechnical System

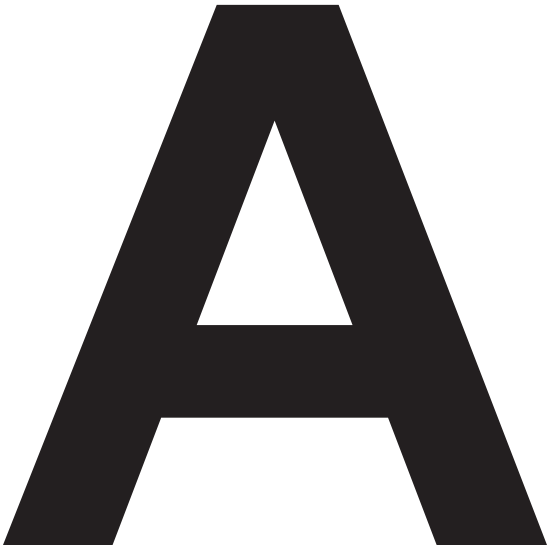
Decades of groundbreaking work have shifted surgery from a relationship between a single patient and a single surgeon to a relationship between patient populations and compassionate, high-functioning surgical teams in dynamic and often complex systems. The work of Codman, Deming, and Khuri have provided a strong technical platform based on unflinching measurement and reporting, and movements like ERAS and Safe Surgery Saves Lives are finding ways to bridge the gap between knowledge and reliably uniform, standardized best practice.

This is the platform from which to launch the next phase of surgical performance improvement — the recognition of teamwork and culture, of diversity and complexity, in the pursuit of high reliability. Acute Care Surgery Services across Canada have moved decisively in this direction; first with standardization of an inherently complex system through the collection of process and outcomes data, the identification of performance benchmarks, the establishment of standardized clinical practice guidelines and best practices, the mapping of processes, and the construction of infrastructure, such as protected urgent operative time and payment plans. Now, focus is beginning to turn toward creating ACS cultures of high reliability, with sensitivity and an uncompromising approach to complications and failures, less simplistic and more sophisticated assessments of the risks faced by our patients, deeper and more objective understanding of our clinical processes, increasing resilience and experience with rescue, and the promotion and celebration of cross-disciplinary expertise with renewed energy. Certainly it is our responsibility as patient advocates to embrace and navigate complexity in our processes and engage in cultural change to create the next wave of improvement in the performance of surgical systems. ●

Sleep is for the Strong/ Re-examining the Surgeon's Relationship with Sleep

Story by Ameer Farooq, Charles Samuels, Savtaj Singh Brar, and Indraneel Datta
Illustrations by Dalbert B. Vilarino

The invention of the light bulb upended the human sleep cycle. For millions of years prior, humans lived according to a schedule set by the sun's light, which meant 10 hours of sleep every day. Thomas Edison, the inventor of electric light, only slept four or five hours, abetted by his own invention. Edison felt sleep was incongruent with a productive, rewarding modern life — "a heritage of our cave days." *Sleep*, Edison said, was "a loss of time, vitality and opportunities" — a hindrance. In the face of a tide of scientific evidence to the contrary, how strange it is to hear these sentiments echoed by surgeons, 100 years later.



At 7:30 in the morning I was sitting in my seat at the hospital auditorium, waiting to present at grand rounds. It was my fourth year of residency, during a busy stretch of long days and nights spent at the hospital, seemingly oncall or post-call ad infinitum. Behind me were assembled surgeons and gastroenterologists, as well my fellow residents, though I was only marginally aware of their presence. My focus was inwards. I knew I was exhausted, but I felt at ease with the feeling. To admit this exhaustion to myself was difficult, to admit it to others would have been embarrassing. As my thoughts drifted, I jokingly wondering what would happen if I had a seizure during my talk. Would the Chair be upset? Would I have to do the talk again?

I did the arithmetic in my head — I had slept a total of 12 hours in seven days. This is a number I remember to this day and, though I'm loathe to admit it, I am guilty of recounting this "accomplishment" with a grin to young students and residents, dysfunctionally proud of the stress I had subjected myself to during surgical training.

Of course, even as a senior resident in general surgery, this is a deviation from normal. The story is impressive even to surgeons, but is absolutely shocking to those outside of medicine.

The history of surgeons overcoming physical discomforts and lack of sleep in the single-minded pursuit of excellence derives from the very beginning of modern surgery. The famous Scottish surgeon of the 18th century, John Hunter, was famous for his obsessive schedule and work ethic. Hunter would start his dissections at five am, and have breakfast at nine. He would see his patients and do home visits until his four pm dinner. he would then sleep a full one hour, without interruption — with the rare exception of a life threatening emergency — and then work again until midnight. This clocks Hunter in at approximately five to six hours of sleep a day. William Halsted, the great American surgeon and inaugural Chief of Surgery at Johns Hopkins, established the first modern surgical training program in the United States. Inspired by his trips to Europe, and especially his time with Theodor Bilroth, Halstead's school of surgery was a revolution. American surgical training was transformed from amorphous apprenticeships to a rigorous, regimented, and incredibly demanding program. Residents on the Halsted surgical service were expected to be oncall 24 hours a day, 365 days a year, with an average of three-to-four hours of sleep per night.

Equal to "skillfull hands" or the stereotypical "rampant ego" of surgeons, immunity to fatigue is a hallmark of the general surgeon. Our pride in our ability to persevere despite lack of sleep informs the way that we recruit new surgeons. Surgeons love the medical student who stays up all night on call and then is back working the next day. We identify this individual as a prodigious worker, one best suited for

surgery. We choose the student who sleeps less, and see this trait as a surrogate marker for work ethic. Those students, having received positive feedback for their poor sleep habits, perpetuate those habits during residency and help choose other residents just like themselves. And the cycle continues.

We thus have good reasons to believe that we don't need sleep. Our surgical ancestors did it before us, so why can't we? We need to get the work done — there is no one else to do it. While we couldn't keep our eyes open for paperwork or driving, we can raise our game when it comes to taking care of the patient in front of us — or so we tell ourselves.

IN 1984, AN 18 YEAR OLD girl named Libby Zion died of a lethal drug interaction in a New York City Hospital. A grand jury found that the death was in part the result of exhausted residents misdiagnosing her drug reaction as a viral syndrome with "hysteric symptoms." This was a watershed moment in the patient safety movement and in the approach to training and supervision of residents in our medical system, including work hours. Largely in response to the attention brought by this case, the state of New York imposed several recommendations, the most pertinent being an 80 hour work week. In 2003, the American Council for Graduate Medical Education (ACGME) went on to impose 16 hour work-hour limit for residents in the US.

Despite these work-hour restrictions present across North America, surgical residents routinely flaunt these restrictions. Furthermore, there have been growing concerns that these work-hour restrictions were put in place without much supporting data. Additionally, there has been concern about the potential increase in adverse events from increased handovers. And despite what surgical residents might say about feeling forced to stay post-call, we suspect that many residents stay because they feel the need to get enough volume during training. One day we will be expected to take care of patients by ourselves. As one surgeon memorably put it while addressing residents,

> "I think the vast majority of you [residents] will find yourselves wishing that you had seen and done more in your residency once you get out in practice, and I suspect none of you will think back at two A.M. while doing a difficult case and wish that you had had more restricted work hours."

While residents might be protected by work-hours restrictions, those same restrictions certainly don't apply to consultant surgeons, who stop working when the work is done.

Meanwhile, the rest of the world is going through a cultural revolution around sleep. Sleep is the new drug of the elite. Sleep is the secret weapon

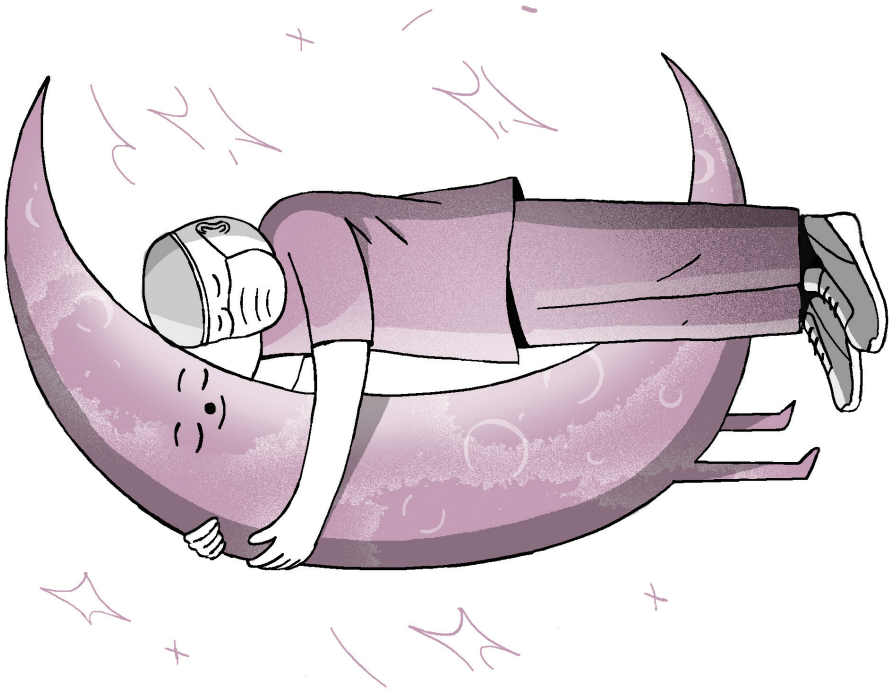
I fell asleep at the wheel of my car, careening into a driveway on a street that I wasn't meant to be driving on, and plowed full-speed into a parked vehicle.

in the Silicon Valley tech CEO's armamentarium to make her company the next unicorn. Many of the most talented performers in the world are open in the importance they place on sleep. Roger Federer, the most decorated champion in men's tennis history, reportedly sleeps 13 hours a day. Magnus Carlsen, the third youngest chess grandmaster in history, sleeps 10 hours a day. An apocryphal story of a young Bill Clinton reiterates just how this mythology regarding sleep and productivity can be convincing. Clinton, full of confidence and ambition, having heard somewhere that the great figures of history all slept judiciously, decided he would only sleep four hours a day. He embarked on his political career with considerable success. However, looking back, Clinton says that the most of the mistakes he made were because he was too tired. "You make better decisions when you're not too tired." If these high performers need their sleep, why have surgeons been so resistant to the idea that they need sleep?

One explanation could be that the body of evidence within the published literature has really failed to show any impact of lack of sleep on surgical outcomes. In a study published in the *New England Journal of Medicine*, Nancy Baxter and colleagues examined the outcomes of day procedures performed by surgeons who had been on call the night before. "There is no debate that fatigue due to sleep deprivation from any cause," the authors write, "can impair physician performance." However, using a retrospective, case-matched cohort, they found no significant differences in any of the primary outcomes after elective surgical procedures such as death, readmission, or complications between surgeons who had been on call the night before compared to those who had not been on call. Other studies seem to corroborate the findings of Baxter and her team. Despite the strong evidence that lack of sleep negatively impacts cognitive abilities and decision-making, restricting work hours of residents does not appear to improve patient safety. If we are honest with ourselves, however, none of us were waiting for this data — we were working exhausted anyways and this simply has confirmed what we believed already.

While the examination of surgeons and sleep has focused on performance as it manifests in patient safety, there remains another, much less asked question: what does the lack of sleep do to us?

It wasn't actually until after I had finished training that I fell asleep at the wheel of my car, careening into a driveway on a street that I wasn't meant to be driving on, and plowed full speed into a parked vehicle. It was four A.M. I had driven home from the hospital after finishing an emergency surgery. I was relatively well rested, given my baseline. Had it been five minutes earlier I would have been travelling at 100 kilometres per hour into a concrete barrier,



or worse yet, another car. I would have been dead, or worse, caused the death of others.

There is no question that there is a personal cost to chronic lack of sleep and substantial circadian disruption associated with being on call. Sleep deprivation clearly contributes to burnout in the long run. In one study of medical interns, there was a strong association between depression and chronic sleep deprivation. Surgical specialties have the highest rates of burnout compared to other specialties, likely in large part due to the chronic fatigue and stress associated with surgery.

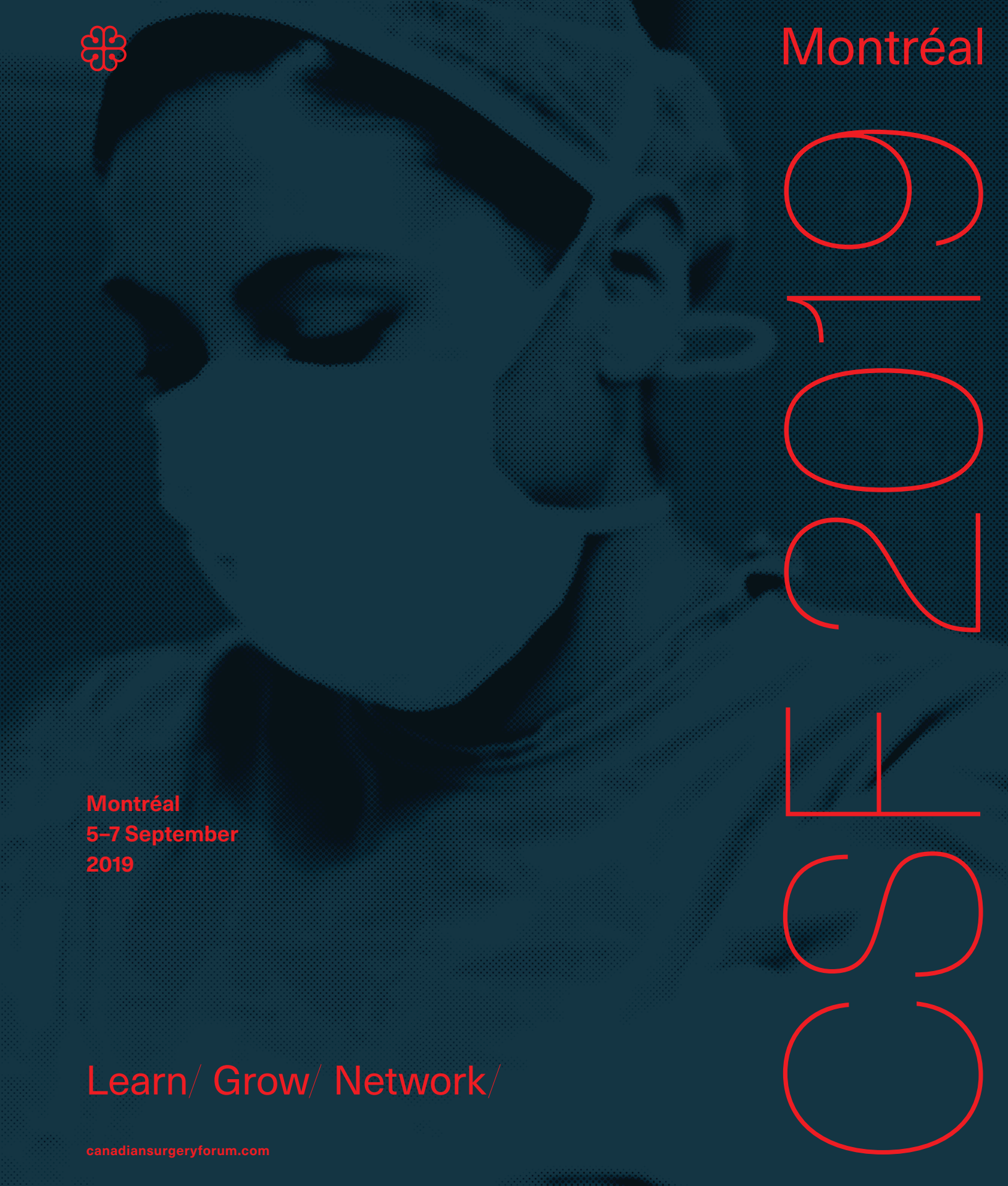
Maybe we've been looking at this problem backwards. The studies haven't shown harm to patients from tired surgeons — but are we really looking to just make sure that we have average results? We need to change our paradigm from one of being operating machines to "performers," just like any other high-level performer. If we want to be the most creative and the most innovative surgeons we can be, than we have to pay attention to our own well-being, and particularly, our sleep. Sleep is a key element of recovery and forms the foundation of our ability to manage our physical health and mental well-being. The Seattle Seahawks are well-known for equipping their players with Readibands. These wearable devices, produced by Canadian company Fatigue Science, monitor an individual's sleep and give the wearer a score that indicates not only how much, but the quality of their sleep. Richard Sherman, Seattle Seahawk quarterback, publicly credited sleep science with helping them win the Super Bowl in 2014. As surgeons, if we want to be at our best, we have to pay attention to our sleep.

To be clear, we are not advocating for mandating maximum working hours or legislating sleep. A number of large, well conducted studies have now been published showing that restricting interns to a set number of hours does not improve outcomes. The reality is that we will not be able to change our clinics, our call schedules, our length of residency training quickly, nor do we have good evidence to. We are not saying that we should all just "sleep more." What we are advocating for is a change to our culture around sleep. Instead of considering sleep being only for the weak, we have to value our sleep, our nutrition and our physical fitness just as much as operating or doing research.

There are also a number of concrete ways that we can improve the quality of our sleep, if not the length of it. The first step may just be to more aware of the quality of our own sleep, and to understand what drives our sleep cycle. There has been an explosion in the understanding of our own sleep patterns and "fatigue science". According to Matthew Walker, author of *Why We Sleep* there are two factors that affect sleep. One is our natural circadian rhythm and the second is sleep pressure. In surgeons, our natural circadian rhythm (or optimal sleep pattern) is what suffers due to the "shift work" nature of our call. Creating that perfect sleep schedule is a challenging goal to achieve. The second, sleep pressure, is secondary to the release of neuropeptide adenosine which gives you that strong "sleepy feeling" we have all experienced late at night on call. That brief period of alertness that you often feel in the morning on rounds after a night of call is a function of circadian alerting factors. These factors, however, are not sustainable without adequate sleep and do not mean we are performing at our best. Rather, that brief feeling of alertness is an indicator of the significant variation from norm we have in our sleep cycle. Being aware of circadian rhythms and sleep pressure can help us to prepare for when we do have to work post-call and plan our recovery.

Matthew Walker has a number of tips on how one can improve sleep quality. The most important point is to try to maintain a good sleep routine and use naps to catch-up on sleep loss. Regular exercise, good nutrition and hydration also can help with implementing a more regular sleep schedule. Of course, one should try to sleep in a cool, gadget-free bedroom and not lie in bed awake.

All of us have gone through the frustrating experience of being told, tired and busy as we are, that "we should try to sleep more". There are simply not enough hours in the day to accomplish all that we want and also have a normal, healthy amount of sleep. We need to focus on the straightforward ways surgeons and residents can improve the quality of sleep. Surgeons strive for excellence. To perform at our best, and not just meet a minimum standard of safety, we need to improve how we sleep. But, perhaps just as importantly, to be able to drive home safely to our families, to be able to mitigate against the pervasive effects of burnout in our careers, to feel better, then we need to change our culture, to readdress our relationship with sleep — to realize that sleep is not for the weak, but a habit of the strong. ●



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Surgical Response to **Humanitarian Crisis**

How do surgical teams deliver complex care in times of crisis?

Emilie Joos, Christian Heck, and Naisan Garraway

On the afternoon of Tuesday, January 12, 2010, a magnitude seven earthquake leveled 300,000 buildings in Haiti, claiming 160,000 lives and leaving over one million people homeless. Local and international responses to the sudden loss of infrastructure, the disruption of security and order, and the overwhelming casualties were swift and diverse. Medecins Sans Frontieres, with a 19 year presence in Haiti, mobilized to fill in emergency medical care infrastructure on the front lines of the response. The neighbouring Dominican Republic mobilized water, food and heavy lifting machinery, and made its hospitals and airports available to assist in response efforts. The Dominican Red Cross, in cooperation with the International Red Cross, coordinated international efforts, as response teams from Iceland, China, Qatar, Israel, and Korea began to arrive. Technology gave the world intimate awareness of the catastrophe, through satellite mapping, crowd mapping, web-based journalism, and social media posts. With the ability to make mobile donations, individuals from around the world could engage in a global response of unprecedented scale.

Previous: Logan Abassi/United Nations Development Programme

Emily Joos MD CM
Trauma and Acute Care Surgeon, Vancouver General Hospital.
Dr. Joos has participated in multiple deployments with Medecins Sans Frontieres and the International Committee of the Red Cross, including in the Central African Republic. Her graduate studies at the London School of Hygiene and Tropical Medicine are focused on the sustainability of global surgery initiatives. She is the new Associate Director of the University of British Columbia Branch for International Surgery.

Christian Heck MD
Trauma and Acute Care Surgery Fellow, University of British Columbia.
Staff Surgeon, Berlin Germany.
Dr. Heck is a general surgeon in Berlin, Germany, and a Fellow in Trauma and Acute Care Surgery at the University of British Columbia. He worked as a physician and surgeon for MSF in the Congo (DRC) and Chad before being appointed as surgical adviser for MSFs Operational Centre in Geneva. In this function he was involved in multiple humanitarian operations — both at headquarter level and as a surgeon in the field — among others in South Sudan, Yemen, Syria and Iraq.

Naisan Garraway MD
Trauma Surgeon and Intensivist, Vancouver General Hospital.
Commander Garraway is the Medical Director of the Trauma Program at the Vancouver General Hospital, and the Associate Director of the Canadian Forces Trauma Training Centre (West). Over the course of his career as a military surgeon, he has participated in at least five domestic and international deployments, and has led the pre-deployment training of hundreds of physicians and medics.

STILL, AN UNEXPECTED CATASTROPHE, of almost incomprehensible acuity and scale, and with a massive global response, was a perfect storm of both uncertainty and unregulated action. Reports about the Canadian DART response from that time suggested that, in some instances, the desperate pace of the response resulted in personnel arriving without adequate training and equipment, and that recommendations from advance teams in the field sometimes went unheeded. An early internal report concluded: "The push to deploy rapidly may have satisfied the strategic objective of appearance that Canada was doing something. However, it adversely affected the operational objective of providing rapid and effective humanitarian aid". Although these comments refer to the DART deployment, they could have easily referred to many medical teams arriving in Haiti without sufficient preparation or logistical support.

Access to surgical care in times of crisis is, in some ways, a measure of the scientific, organizational, and humanitarian achievement of our civilization. Watching a sudden epidemic of trauma and the collapse of an entire health infrastructure, many surgeons in Canada and around the world would have felt a pull to help with the surgical response to the Haiti earthquake. In this article, three trauma surgeons, experienced in complex surgical deployments, reflect on the state of the art and the increasingly sophisticated future of surgical care in times of humanitarian crisis:

SURGICAL DEPLOYMENTS in times of humanitarian crises have many origins and can take many forms. These responses can be small and organic, by individual surgeons, or by surgical teams with little experience in global or war surgery. They can be from established non-governmental organizations (NGOs) like Medecins Sans Frontieres (MSF) or large institutions such as the worldwide Red Cross Movement. They can also come from military organizations (Canadian Forces (CF), Israeli Defense Force). The scope and scale of response depends on the fundamental values of the organization, its resources, and its logistical and operational capacity. These approaches are discussed along the continuum of response:

01. Organizational values & vision
02. Readiness
03. Pre-deployment reconnaissance
04. Deployment
05. Debriefing
06. Interagency coordination.

Values

It seems intuitive that surgical responses to humanitarian crises are values driven, and that difficult, complex, and time dependent decisions are guided by core organizational philosophies and identities. MSF, for instance, seeks to deliver "medical care where it is needed most". Simply, the needs of vulnerable populations guide decisions to deploy, rather than political, religious or other considerations. This goal is supported by MSF's core identity: "a commitment to independence, neutrality, and impartiality", which frees the organization from many external constraints in the pursuit of its objectives. Preserving independence influences all aspects of the organization's activity — from fundraising to hiring, selecting its missions, achieving local acceptance, and holding itself and the global humanitarian community to high humanitarian standards. This also explains MSFs reluctance to become fully integrated in international humanitarian frameworks overseen by the UN or the WHO and its insistence on a strict separation of humanitarian action and military operations. To MSF, independence is not simply an ideal — the discipline with which MSF has engrained concepts of independence and impartiality into its day to day operations has allowed it to enter areas of active conflict, virtually unarmed, to deliver on its core commitments.

The Red Cross is not by definition an NGO. It is a not for profit organization that is funded by governments, and aims to assist populations in need, be it by a natural disaster or armed conflict. In general, the International Federation (IFRC) leads the Disaster Response while the International Committee (ICRC) leads responses to armed conflicts. They are two very different organizations (leadership, management, roster) working under a larger umbrella called "the movement." Over its 150 years of existence, the movement has been based on similar principles (humanity, impartiality, neutrality, and independence) that guide decisions both in times of crisis, and in routine work. These values have built, over time, an increasingly experienced and sophisticated network of personnel trained in war surgery methods, which stands ready to respond in times of disaster and provide "assistance for victims of armed conflict and other situations of violence".

Military surgical units, with experience forged in the fast paced and austere conditions of war, are often key members of the humanitarian response. But unlike MSF or Red Cross deployments, military humanitarian deployments are initiated and overseen by national governments. "The deployment of the Canadian Forces surgical unit and the scope and duration of the mission are 100 per cent decisions of the Prime Minister and the Canadian Government" according to Dr. Garraway, "although, the planning and logistics of the deployments are led by the military." The deployments then, are political decisions, and in a broad sense, should reflect the values and priorities of the Canadian electorate, including global citizenship and humanitarian aid. Prioritization of humanitarian response could, of course, be subject to changes in the economic or social climate, and could change over time.

Readiness

Like hospital-based trauma teams, surgical teams responding to humanitarian crises maintain a perpetually heightened state of readiness. Where possible, the experience of generations of surgical responses to war and other disasters are codified

in algorithms and standard approaches, but it is understood that each disaster will test existing foundations of knowledge, strategy and logistics, and will require new forms of flexibility and improvisation.

The ICRC runs 10 to 12 War Surgery courses every year, preparing surgeons to manage a spectrum of problems and contingencies, using a public health approach that considers the health of populations and a holistic approach to the care of individual patients. MSF trains medical and logistical teams together in a yearly exercise for its Rapid Deployment Surgical Unit (RDSU) and prepares MSF surgeons in a one-week cadaver workshop for interventions that are usually outside the scope of a general surgeon, from craniotomies to hand surgery. Dr. Heck admits that the demand for training surpasses the available places for the latter course. MSF, ICRC and IFRC have very strict criteria for selection of general surgeons to their rosters. Some technical skills are mandatory, such as C-sections, while others are strongly recommended, such as the application of external fixators and skin grafts. Ensuring a key set of competencies maximizes the efficiency of the team on the ground, and reduces the number of surgeons needed to be deployed for the crisis.

The Canadian Forces ensures that its personnel receive multifaceted pre deployment training that includes annual physical fitness, military and defense training. The CF expects its teams to participate in a five day multidisciplinary, simulation-based Advanced Military Trauma Resuscitation Program (AMTRP) at least every five years, and all CF surgeons are expected to take a war surgery course, such as the one provided by the ICRC. Military trauma surgeons are embedded within civilian trauma services such as Vancouver, Toronto and Montreal, and these services are often the sites of just in time pre-deployment training for military physicians, nurses and physician assistants. Ongoing military-civilian partnerships ensure the constant accrual of experience and active exchange of ideas and cutting edge practices.

Elaborate systems have evolved to keep surgical teams ready for deployment, and keeping complete teams at the ready is not only expensive but also requires a large pool of experienced and available staff. Many NGOs struggle to build up adequate surge capacity. While large organizations like MSF can rely on a larger number of staff with extensive experience, it is still hard to mobilize enough key personnel immediately. Currently MSF is keeping experienced staff with various backgrounds employed in a dedicated emergency pool.

Reconnaissance and Planning

Surgical crisis deployments are often informed by the work of advance teams, such as the Field Assessment and Coordination Team (FACT) of the Red Cross. These teams of administrators, logistics experts and clinicians are sent ahead to assess conditions, determine needs, and ensure coordination with local communities, leaders, and other responding organizations. Not surprisingly, they often find that local needs are different from what might have been expected. CF teams responding to the Haiti earthquake found that the need for trauma care peaked early, and was replaced by crises of infectious diseases and malnutrition. Crisis — be it man made or natural — will often severely disrupt existing medical services and the need for mother and child care, treatment of non-communicable diseases, or advanced medical procedures like hemodialysis can easily surpass the need for acute trauma care — even in an active war zone. If trauma is found to be the main cause of excess morbidity — then the need for reconstructive and rehabilitation programs is often underestimated. Data from advance teams can shape an organization's response, including determining whether an organization has the expertise, equipment or capacity to respond.

According to Dr. Heck, this early phase of fact-finding often includes a fair amount of guesswork due to the dynamic nature of a crisis, and decisions need to be made based on incomplete or inaccurate data. Programs usually have to be adapted in later stages. While MSF has the logistical capacity to deploy a pre-packed surgical unit including stabilization beds and supplies within 72 hours, the reconnaissance, planning and negotiations on the spot can easily take longer.

Deployment

The scope and duration of an individual organization's response depends on its objectives and its resources. One of the criticisms of the Haiti response was the influx of a large number of unprepared medical teams, which contributed to the depletion of already scarce resources. Emergency Medical Teams need to be self-sufficient for the first few weeks, and the truth is, only very few organization such as the military, MSF, IFRC and ICRC have the capacity to do this. Like MSF, IFRC has specialized teams trained to respond quickly to natural disasters.These are called Emergency Response Units (ERUs), and the Canadian Red Cross is one of the four national societies that host a Rapid Deployment Hospital ERU. Able to start performing surgical procedures within 48 hours of deployment, this ERU is fully self contained for 30 days and deployable for four months. These rapid deployments can be informed, not only by reconnaissance at the time of a disaster (such as FACT), but, even more significantly, by a humanitarian agency's presence in a region before the onset of a disaster. For example, an IFRC ERU deployment can benefit from work on the ground performed by the host national society (i.e. the Red Cross society of the affected country). Their knowledge of the terrain, local situation, local needs, and existing resources are key in planning an efficient response on the ground.

MSF deployments are often longitudinal, and can be comprehensive if they are meant to fully replace lost health care infrastructure. In the Central African Republic, the MSF has been running a surgical unit with general surgical and obstetrical services in the midst of the instability of armed conflict for the past 10 years. The ICRC had a 19-year presence in Haiti before the earthquake, and continues to have one today, while the Canadian Forces deployed a surgical hospital there after an 18-day delay, and withdrew two months later. This CF deployment, however, has been in the context of longstanding Canadian humanitarian investment in Haiti.

In general, non-military deployments rely on hard won, universal reputations of impartiality and neutrality, and local good will, to enter dangerous areas and engage with the public. Military responses tend to be well protected, self-contained, and primarily focused on strategic objectives. They rely less on good will, and trade deep, longitudinal partnerships for security and focus on defined objectives. In Afghanistan, where Dr. Garraway served four tours, the Canadian military ran and served in a fully functioning surgical hospital, with its own health care infrastructure. As with other deployments, its primary objective was to provide surgical and medical support for allied troops, but secondarily, the CF has worked to treat combatants, local police forces, and civilians, and has functioned in advisory roles to build health care capacity, so as not to leave a vacuum as military presence is withdrawn.

Debriefing

Personnel returning from MSF deployments have an opportunity to debrief at MSF headquarters. Reflections from these debriefings enable the organization to learn from mistakes and to optimize missions in progress. They also provide a forum for front line providers to reflect on their accomplishments and to express their frustrations. The CF has found that up to 20—25 per cent of personnel returning from deployments are affected by acute stress reaction or posttraumatic stress disorder, often with adverse consequences for their careers and personal lives. Returning personnel undergo a four- to five-day debriefing and decompression session, often in a third country, and all of them fill out a debriefing questionnaire and have access to social worker and psychiatric support with workers experienced with military personnel. Dr. Garraway notes that, while comprehensive, the system is not perfect, and that more sensitive surveillance and follow up of mental health issues would help to ensure that no one struggling with these problems is missed. Military personnel are individually screened again before being deployed on any subsequent operations.

Coordination

At the UN level, coordination of disasters and conflict response does exist in the form of the Office for the Coordination of Humanitarian Affairs (OCHA). However, operationally this response is too slow to provide immediate healthcare in the

first hours and weeks of conflict (it takes about six weeks for OCHA to release the funds to finance the humanitarian response). As a result, humanitarian crises initially attract a diverse and uncoordinated global response, including the experienced actors mentioned above as well as smaller, less experienced organizations and unaffiliated but highly motivated individuals. Together, these emergency responders can be called Emergency Medical Teams (EMTs). Coordination of efforts across organizations, especially when communication infrastructure is compromised, can be extremely difficult. After the Haiti earthquake, the Canadian Forces learned that the initial deployment should have been faster and better coordinated with other military and NGO responses. In fact, more seamless coordination of complex responses among organizations with differing values and motivations — impartial and partial, military and non-military, private and public, short and long-term — in situations with shifting needs and evolving safety and security issues, is a defining priority of modern surgical response to humanitarian crisis.

The WHO Emergency Medical Teams (EMT) Initiative intends to set binding standards for medical and surgical teams who respond to a humanitarian crisis and to provide a framework for centralised coordination. For example, EMTs responding to future humanitarian crises can be classified ("1" for resuscitation, "2" for emergency surgery capability, "3" for reconstructive and definitive surgery) and asked to meet minimal, standard criteria even prior to deployment. Compliance with international standards could even be linked to landing permits for teams arriving in a crisis zone. This is an exciting first step in integrating multifaceted responses. According to Dr. Heck, defining expectations more clearly would help to ensure that global humanitarian actors are held more responsible to comply with and uphold both international and local norms and standards, in more seamlessly integrated and systematic responses.

While the need for standardisation and minimum requirements is generally accepted and supported by the ICRC and MSF, there is a considerable debate within the humanitarian community about the implications and risks of central coordination, especially in the context of war and political instability, which was recently fueled by the international response to the 2016–2017 Battle of Mosul in Northern Iraq, a predicted mass casualty situation that affected and displaced thousands of people. UN-funded NGOs and one private for-profit company worked in an unprecedented way alongside and embedded within combatant forces under the coordination of the WHO, while ICRC and MSF choose to remain independent to protect their principles of neutrality. Both organizations set up their own response but were also seriously hampered by the challenging security situation and the unpredictable nature of the conflict. MSF for example was fast in setting up a surgical field hospital for emergency and resuscitative surgery in the North of Mosul and later found that the northern frontline remained virtually closed and the expected casualties were directed towards other routes. The hospital was taken down again and resources moved to East Mosul at a later stage.

Finding ways to reconcile philosophical differences and divide and coordinate responsibilities ahead of time may allow responding organizations to more fully realize their mandates. The development and application of geographic software and social media in disaster response will add an important dimension to future coordination efforts.

Sustainability

Ultimately, surgical responses to humanitarian crisis, and capacity building in global surgery in general, should be judged by objective measures and, ultimately, by their sustainability. Global responses to humanitarian crises must, to be successful, integrate with local expertise and capacity on the front lines to address acute and long-standing vulnerabilities. Like the military and MSF, the Red Cross can stay longer in the field (an ERU is usually operational for up to four months) but an important advantage of the Red Cross ERU is the handover of all of its structure, material and resources to the national Red Cross society. As well, the ERU delegates have the mandate to train the local Red Cross delegates to ensure sustainability of operations after the handover. MSF is now testing and rolling out

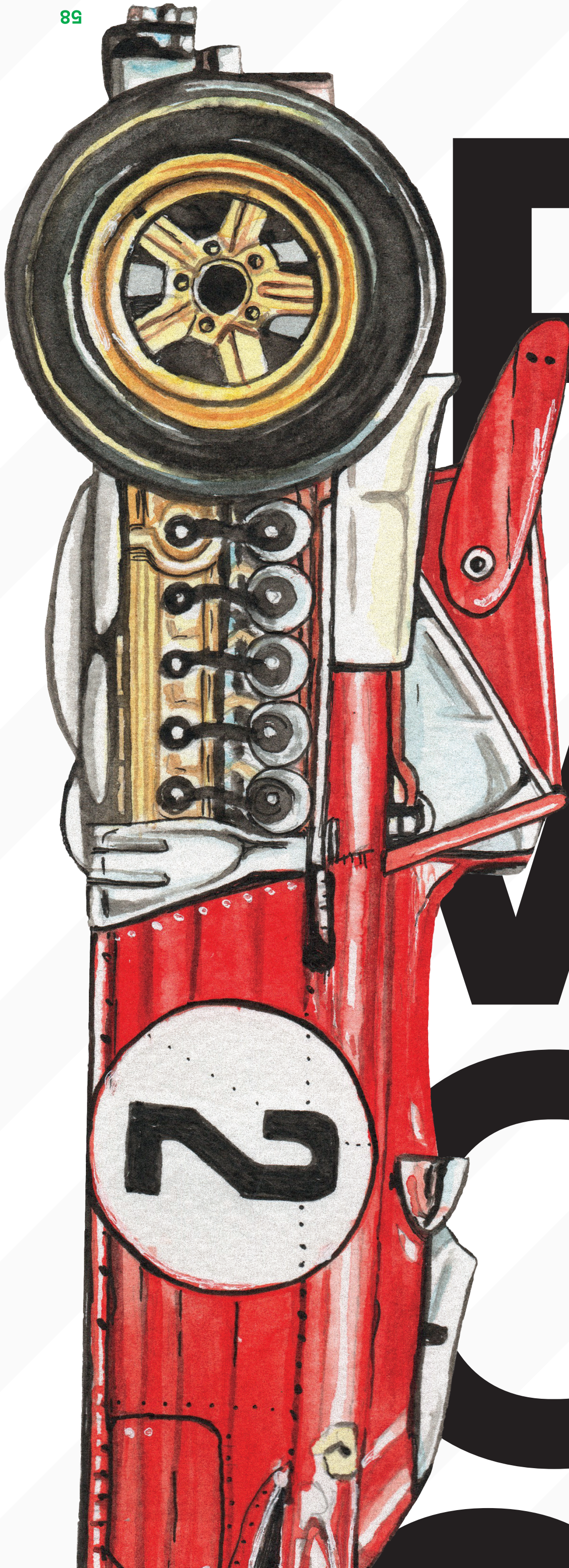
various initiatives to facilitate knowledge transfer and formalize field based training for emergency care and trauma surgery.

Still, even with this thoughtful model of coordination and sustainability, at times humanitarian deployments have been criticized for not being expert, agile, or resilient enough to create sustainable benefits. A recent report from the US National Public Radio and ProPublica suggested that the American Red Cross, which raised close to 500 million dollars for earthquake relief in Haiti, managed to build only six permanent houses, and had few other tangible accomplishments from this massive investment. Reports of financial mismanagement and insensitivity to local conditions by foreign organizations have rightly raised skepticism about current models of humanitarian relief and highlight the need for even more seamless coordination between external agencies and local experts.

Surgical Team Performance in Humanitarian Crisis

Humanitarian crises often reveal and amplify pre-existing vulnerabilities in the social determinants of health, and, by definition, always exceed local capacity for response. These crises always need a response from the global community. Most agencies responding to humanitarian crises recognize that efforts to address vulnerability should be active, in different forms, before, during, and after the acute crisis, and that they must be carefully coordinated with local priorities and expertise. Surgeons, with clinical, decision making, and leadership skills forged in crisis, and lifelong experiences as architects of complex systems of care, are uniquely positioned to contribute to relief efforts in this context. But the complexity of recent crises and the increasing sophistication of surgical responses, have made it clear that participation in this critical work requires careful reflection, specialized preparation, and alignment with agencies with shared values and with the capacity to support coordinated, sustained, locally relevant, and sustainable response. This is an important and exciting frontier of surgical team performance, whose continued exploration will shape the way the world confronts the biggest challenges that lie ahead. ●

FOR-MULA ONE



SUR-GERY

A surgeon's life-long obssession with Formula One.

Story by Manoj Raval
Illustrations by Amy Wetton

AS THE SON OF IMMIGRANTS, my life's trajectory could not have been more different than my father's. About the only thing we have in common is a passion for cars. As a young child, my dad took me on weekends to the local auto dealerships to check out the new models. After getting friendly with several managers, we'd take them for test drives, and I'd be sent home with a stack of new car brochures. Naturally, our fervour extended into auto racing. As a result of the British influence of his upbringing in Asia and Africa, he (and therefore I) gravitated toward the European racing series, especially Formula 1.

Back in the 70s and 80s, there was little TV coverage of F1, so it wasn't easy to be a fan. In the pre-Internet era, we obtained our F1 news from the foreign newspapers at the library or leafing through British racing magazines at the bookstores. Being a family of meagre income, it was out of the question to consider *buying* books on the subject, even if they could be found. We could only share our excitement and disappointments in race results with each other — no other family or friends had any interest in racing.

Once I got into university in 1990, my interest only grew, because now I had access to massive libraries with old and new racing magazines (mostly on microfiche) and traditional books on F1. I spent hours reading about the history of F1, the race teams, the lives of the legendary drivers, and the giants of racing car design. Thank goodness the Internet wasn't around much yet, or I probably would have flunked out. Nevertheless, I amassed a fairly comprehensive, but utterly useless, body of knowledge about Formula 1 racing.

In the 90s and 00s, the Internet and explosion of TV channels meant I could indulge my pastime even more and I delved deeper

into the F1 culture. I just could not believe what it took to put one person into a race car on a Sunday for under two hours, much less win that race, much less win a championship. And because I read about F1 voraciously at the same time as I went through medical school and surgery training, I started to see some unexpected parallels between surgery and professional race car driving.

In an F1 race, the driver gets all the glory. The "money shots" in press are almost always the driver on the podium getting the trophy and spraying Moët and Chandon in victory, or the driver crossing the start-finish line with his* hand raised in triumph. The pre and post-race interviews are with the driver, and the promotional appearances and materials all feature the driver. Even in the tragedies it's all about the driver, whether he holds his helmeted head in anguish after a mechanical failure forces his car to retire or he crashes his car. And by a wide margin, the driver is the highest paid person on the team, often well into eight figures.

When it comes to surgery, it's common that a patient or a family's only experience comes from watching TV or movies, where it's up to the surgeon to single-handedly save the day in superheroic fashion, or be self-loathing in dramatic despair after a patient's death. So, after an emergency operation for a patient in life-threatening sepsis from perforated bowel or a 12-hour cancer resection, the patient and family infer that their life saved is due to one person, the surgeon, who will get all the gratitude, thanks and admiration. Thankfully, most (though not all) patients realize that not all complications are due to surgeon ineptitude.

It is true that in both arenas, a unifying theme is that both must keep calm and level-headed in order to reach a high-level goal while not uncommonly in the midst of absolute, and sometimes life-threatening, chaos. I've met, learned from and worked with a great many surgeons in my career, and the best ones have an air of serenity (almost boredom) at the most difficult moments. I recall an operation when I was a colorectal surgery fellow doing a complex pelvic exenteration, and we got into internal iliac and presacral venous bleeding. Even after six years of general surgery, I had never seen such vigorous bleeding, traumas notwithstanding. The surgeon worked carefully, methodically, and decisively over 20 minutes to get things under control, so we could continue. She conveyed enough of a sense of urgency to let the anesthetists and nurses know that this was serious, and their full attention should be on the matter at hand, yet the cadence and volume of her voice hadn't changed from 30-minutes prior, when we were doing the more mundane and routine parts of the operation. It was one of those moments of clarity when I said to myself, "This is what I need to be." Since we had another five hours of operating to do, it wasn't until I reflected on the case a few days later that I realized how much more was going on (stay tuned).

In a different city with a different surgeon, we did a stat case involving a young woman bleeding out from a massive splenic artery aneurysm. When it became obvious that we couldn't control it through the abdomen, the surgeon decided to do a thoracotomy and cross-clamp the aorta for proximal control. It takes considerable wherewithal to make this critical decision, with all its potential complications and possibility of harm to the patient, in order to save her life. Even apart from these dramatic moments, it's up to the surgeon to avoid errors which could have significant downstream consequences.

*When referring to an F1 driver, I use "he" or "him" because, apart from a couple of races in history, all F1 drivers have been men. There is an "old boys club" temperament still pervasive in F1 but, happily, this seems to be changing. Two of the 10 team principals are women, Claire Williams and Monisha Kaltenborn, and I expect to see women drivers in the next few years. I'm hoping that my three-year-old daughter has some F1 role models as she grows up.

Being less than 100 per cent meticulous could result in an unnecessary enterotomy, resulting in multiple postoperative abscesses and a weeks-long hospital stay. A slight lapse in concentration could mean a transected ureter, which even if successfully repaired, could lead to stricture and chronic renal damage, not to mention the possible cancellation of the case to follow with that patient being denied timely care. One of my mentors told me that no one is surprised when complications happen during emergency surgery; it is during mundane and routine surgery that inexcusable things happen, and that complete vigilance is required skin to skin. No wonder surgery can be so exhausting.

The professional racing driver must make minute adjustments corner-by-corner, drive the best line, be aware of track hazards and weather to modify his line, communicate with the team to give feedback about the car and develop strategy for pit stops, all while going 300 km/h and avoiding crashing into 19 other cars on a narrow race track for two hours, all to gain only tenths or hundredths of seconds per lap. If you've never seen it, watch an onboard video of a driver during a race lap and see how many adjustments he makes during a lap on a steering wheel with about 70 different controls. Seemingly, everyone else's job is done and it's entirely up to him to bring the car home and win the race. Like at the 2018 Monaco Grand Prix, when Daniel Ricciardo of the Red Bull team drove to victory despite losing seventh and eighth gears, by driving the best possible race line while altering it in key corners to hold off the Ferrari of Sebastien Vettel who was mere tenths of a second behind. Or when Lewis Hamilton won this year's rain-soaked German Grand Prix after a hydraulic failure in qualifying left him starting from 14th place on the grid. Or when Michael Schumacher drove his Benetton to second place at the 1994 Barcelona race even though his car was stuck in fifth gear almost the whole race. Or perhaps the greatest lap of all, my personal favourite Ayrton Senna's 1988 Monaco Grand Prix qualifying lap, after which he said, "Suddenly I realised that I was no longer driving the car consciously. I was driving it by a kind of instinct, only I was in a different dimension." Being a race car driver seems easy because everyone drives. The parallel is thinking that surgery would be easy because everyone knows how to use scissors and a knife.

The truth is, any race car driver or surgeon who thinks he is a one-man band is completely self-deluded. In a race, the goal is to win. In surgery, the goal is patient well-being. There is a massive army of people behind the driver and behind the surgeon to achieve these goals.

In Formula 1, achieving a race win is the result of years or decades of tireless work by hundreds or thousands of people. The driver has a race engineer (their go-to person for the race itself), but there are around 50–75 trackside personnel for each team — mechanics, pit crew, engineers, tire specialists, strategists, management, and support staff. Then there are up to 500 people working back at the factory and development centre. These men and women have spent years in training and in a factory engineering a car. During a race, several gigabytes of data are fed from the car to the pit wall engineers to monitor car performance, and from this come recommendations to the driver to modify car settings or driving style. Beyond that, up to two terabytes of data are transferred between the engineers at the track and the strategists at the factory in any given race. Actively during the race, then, hundreds of people are working feverishly to try to win. All of their livelihoods depend on it — doing well in a race means getting points, points translate into the share of the F1 revenue pool the team gets at the end of a season, and the funds are put into development for the next year's car in the hopes of doing even better. This is the long game — even teams with no hope of winning a race aim to scrounge a

few points so that over the course of years, they may end up with a race-winning car. It's the race car driver's job to carry the final baton in the relay by doing his best and getting the most out of the car that so many people are counting on. Don't believe me? Just watch the pit crew's reaction when a driver is overtaken by a rival or crashes out — their anguish and disappointment are as acute as the driver's. Perhaps even moreso, because if a team doesn't do well in a given year, people get laid off. These days, TV F1 coverage plays a lot of radio communication between drivers and the pit wall, and modern drivers understand this concept of team, saying "Sorry guys" when they make an error that ends a race. I'm still trying to convince my non-racing fan friends that F1 racing is the ultimate team sport.

In surgery, it is now almost universally acknowledged that the surgeon is just one member of the multidisciplinary team that sees the patient through a continuum of surgical care. Inquisitive patients are fascinated when I describe the many steps in their journey from referral to recovery, along with all of the personnel, resources, and expertise that coalesce into a complex process that is repeated thousands of times each year. The success of enhanced recovery after surgery (ERAS) programs demonstrates what can be achieved by integrating diverse team members into streamlined care pathways.

In the case of pelvic exsanguination I described earlier, the surgeon had temporary digital control of the bleeding, and quickly made a plan, rallying the team to implement it. She called everyone back into the room, communicated the plan, summoned another resident to help with retraction, ensured that all required equipment was available, strategized with the anesthetists, and only proceeded once everything was in place. Everyone played their part as professionals, and the patient did well. As surgeons we have to be team leaders, but every time we get accolades we should be quick to point out that a patient's success is a team effort. It only takes a second, but that small acknowledgement can make a nurse's or student's day and will pay huge dividends down the road.

The training of surgeons and F1 drivers are prolonged reflections on teamwork and leadership. The lifelong training starts off at prerequisites (undergrad university vs. go-karts), progresses through formal schooling (medical school vs. racing school), to apprenticeship (residency vs. test or reserve driver, or competing in lower series), to mastery (staff surgeon vs. professional race car driver). Along the way both have to develop skills on-the-fly in domains they didn't expect — manager, motivator, teacher, collaborator, role model, ambassador. Perhaps the CanMEDS framework was developed by a surgeon who liked racing. Both are also highly critical of themselves and the best of each try to learn objectively from their mistakes to improve their performance.

The best drivers will also be active in briefings with the team, look at race car telemetry data, be fully involved in development, and set the emotional tone of the team. In contradistinction, drivers in years past would show up, drive a few laps, then retire to their yachts and parties. Both must also move on from bad outcomes, because so many people are relying on them to give their best no matter what has just transpired.

As a lifelong motorsport enthusiast and now a career surgeon who loves his job, I never expected that two of my greatest passions would share so much common ground. Both are ways of life, not just jobs. I feel I'm still only scratching the surface. Now that I have taken up racing as a hobby, I look forward to discovering how much more the two worlds intertwine. I wish I could show my race car driver friends how much surgery and racing are alike, but I don't think that taking up surgery would be a good hobby for them. ●

A Conversation on Art & Surgery

By Mary Brindle, Andrew Seal, and Chad Ball

SURGERY, ANATOMY AND ART are inextricably linked in their traditions, passions, and aspirations. Great anatomists and artists through the centuries have explored the power, the weakness, the suffering and the variability of the human form, in art. For the modern surgeon, despite the availability of exact digital photographic reproductions, the role of illustrated anatomy texts and surgical atlases remains unique. The ability of these surgical text illustrations to capture key elements, tissue handling, technique and even, to some extent, the emotion of surgery underlines the importance of art and illustration in our field.

Art influences and helps to train surgeons, but, in many ways, surgeons become artists. With the advent of general anesthetic, surgical hemostatic techniques and antibiotics, the practice of surgery moved beyond brutal, short and painful procedures to becoming a highly technical and skilled craft. The performance of the surgeon mirrors in some ways that of the artist. At the same time, surgery departs from traditional visual arts as it requires technical skills under pressure, honed for an unforgiving and fast-paced environment.

It is not a surprise that many surgeons are musicians and artists. This relationship can reflect the love of developing skills involved in technical performance. It can also be an escape from the restrictions of surgical performance and can develop and nurture the creative and humanistic side of the surgeon.

Earlier this year, Dr. Andrew Seal and Dr. Mary Brindle, two surgeons and painters, sat down to discuss the importance of art in their lives and reflect on the influence of art in the profession and performance of surgery.

MB: When did you start painting?

AS: I have painted all my life. I painted at school, with my first introduction to the French Impressionists on a school visit to the Courtauld Institute at age 14. After medical school graduation in '69 and after house jobs, ships doctoring and a teaching position as an Anatomy demonstrator at Guy's Hospital, I enrolled as a student at the Brighton College of Art during the week paying my way as an emerge doc at the Royal East Sussex Hospital in Hastings on weekends. I decided to return to medicine and was given the opportunity of joining the General Surgery Residency program at UBC in 1975. Royal College Fellowship followed in 1979, and in 1981 I joined UBC Department of Surgery. I then enrolled as an extension student at the Emily Carr College of Art (now University), in their painting program. Every Thursday night I changed from being a surgeon to an art student, jumping on my bike and pedaling down to Granville Island for four hours of painting. I converted my double garage into a studio, raised the roof, put in a skylight, heating and plumbing and have painted there ever since, more so now that I have retired from practice.

MB: Similar to you, I painted since I was very young. I have photos of me as a child drawing from National Geographic magazines. It was a huge part of my life growing up. In fact, my undergraduate degree at Yale was in art, specializing in painting. I was conflicted as to whether to continue it as a career or go into medicine.

AS: What made you make the switch?

MB: Partly thinking what a love about painting and art would be like as a career in which it is difficult to support yourself. My goal at the time was to be painting and not advertising or teaching. At the same time, I loved the idea of medicine; aspects of which come into my paintings; for example, the use of taxidermy specimens and the depiction of anatomy. I have continued to paint until today with no one pushing me in any direction. I went to Dalhousie for medicine where there was an artist in residence program; I was fascinated by that program. I have continued to do work in medical illustration for different publications and projects, which has been rewarding, but painting remains my own thing.

On Making Time for Art in a Surgical Career

AS: We are both very lucky to be our own patrons as it's tough to make a living in the world of art. I recognize that it's a privilege that we have. It's nice to have the freedom of doing what you want.

MB: I absolutely agree with that.

AS: The main thing is to be doing it so that your passions are not lost which can so often happen in our profession.

MB: I agree. For me that's the battle I have; making that a priority. The professional work is the necessary part and carving out the time for the art is a challenge.

AS: I have always encouraged our students to ensure their artistic sides are nurtured and encouraged and not allowed to fall by the wayside. I started a gala concert here at UBC when I was Associate Dean of Student Affairs in '95 so that students could have an opportunity to share their amazing musical and other talents and it has continued annually ever since. Shortly afterwards I initiated the first Student and Faculty Art exhibitions, recognizing that not everyone is a Julliard musician or a dancer.

Previous
Mary Brindle
Detail of *Actaeon* (unfinished), 2018
96 × 48 cm
oil on canvas

Opposite
Andrew Seal
Abstract I, 1985
162 × 198 cm
acrylic on canvas


Sinl '85

On Art and the Performance of Surgery

MB: The fact that you love painting and the fact you became a surgeon; I'm sure they're linked in some respect to doing things and creating things.

AS: I couldn't imagine a professional life without doing something practical. We end up doing the things we want to do. The students often talk about this; that they want to do something with their hands.

MB: Do you find the process of painting is at all similar to surgery? I think about this a lot when I'm teaching (in surgery) but I'm not certain how much it relates to the approach I take to painting.

AS: You're talking about the process now are you?

MB: Yes, the process.

AS: I think like any art form you have to learn your scales. It's hard to play the piano without practicing your scales and I think to paint you have to understand colour, media and how different media behave and how to use them. But I've got to the point where I don't think about that anymore because I know how to use the media and what will happen. The process now when I'm mixing my acrylics or using my watercolors, pen and ink, I just do it without thinking in any detail about the technique itself ... but to get to that point you have to go through courses and training. Two summers ago, I did a painting course going through all the exercises in a book on watercolour painting. I learnt so much from just doing the exercises over that month. I believe we are all life-long students. Always learning. In that respect, I think it's like medicine; you can't assume at any time that you know it all.

I'm not sure, however, that I connect my art with my surgery. I am very much aware that you can't be an impressionistic surgeon. You can't be an abstract surgeon. The skill of surgery is very precise. You can't just say "Oh I'm going to experiment and see what happens." That's why I feel the art is a release in a way from the discipline of surgery where you have to perform within boundaries. If you stray outside those boundaries things go wrong, whereas in art it doesn't matter if you make mistakes. In fact, art is about making mistakes and learning from them, because after all nobody's life is dependant on how you wield your brushes.

MB: It's true. I think however there is a certain kind of discipline in art but not in the same way. It's not discipline with constraint. I found when I was in that period where I was painting all the time, stretching canvases in the middle of the night and working in the studio at every available hour there was a discipline to the creativity of it. But once you have that platform you have to release yourself from the constraints I suppose.

AS: I'll never forget the big abstract paintings I did in 1986 and 87, the time I spent stretching the canvases, gessoing them all and then finding I had these three big canvases ready to paint. It was a bit nerve wracking thinking "oh my goodness, now I've got to paint on these." There's a massive painting about 20 feet long by Robert Motherwell in Washington and there's a description of him preparing this painting and finally the canvas on the floor of his studio was ready for him to start. He took his pulse before beginning and it was racing at around 160 beats per minute. He was so psyched about starting to paint but once he started the anxiety was forgotten.

AS: And, of course, preparing for an operation is even more momentous too. It's a whole different level of stress.

MB: It's interesting thinking about the craft in surgery itself. I think we are in an era now where we might be at the peak of the human craft in surgery because I suspect that the next evolution will move away from human involvement. I'm not saying that laparoscopic surgery is moving away from it but there is now a distance. Whereas I think that as soon as general anaesthetic became safe and prolonged then the

surgeon could really have the opportunity to develop the human skill or craft. I think now we are at the stage where there might be opportunities for people to move away from that and probably for the good of the patients. We might be in that hay day period of maximal craft in surgery.

AS: Well, look at robotic surgery for example where the surgeon may not be anywhere near the patient.

And, look at things like staplers in our lifetime, which haven't completely replaced the hand sewing element but I think it's inevitable that some of this craft will be lost.

One of the first things you wrote to me preparing for this interview I thought was interesting:

> The skills of performance artists require a similar dedication to those of a surgeon and the lessons from those achieving mastery within the arts can be applied to those aiming for mastery in surgery: Pride in performance, coaching, deliberate practice, constructive critical feedback.

It's all part of communication education and performance and coaching, which of course is what we all do. I often think that an operation is like a performance; something in three acts: the opening act, the middle act and then the closing. It's a journey we go on every time we operate.

MB: It may be similar to a pianist or performance artist, where the final product is what you are doing while you are there and you can't really re-do it. So, there is that concentration in getting that technical skill right at the time, which I do think involves a considerable amount of dedication: the planning beforehand, the working through things, the going through the steps of it, so that when you get up there to do your case or performance you have physically and mentally gone through this so many times it allows you to concentrate on the challenging parts and not on the basic elements.

Andrew Seal
The OR Team, 2010
28 × 38 cm
watercolour

AS: But it's also an awareness that it's a team and that you're not a prima donna; it isn't about you, it's about everybody around you in the same way that any performance isn't just about the performer. Of course, if you're Lang Lang you're a solo performer but a surgeon is not a solo performer. A surgeon is a leader of a team or part of a team and everybody in that team has their part to play. I've always believed that it's important to recognize and acknowledge that. We can't do it on our own.

MB: Even in the most solo part of an operation or the most technically challenging very rarely is there not someone else who is a partner in that part of the operation. I think that is one of the unique things about surgery is that even the areas that we think are where it is purely our own skill there's always someone else there. ●

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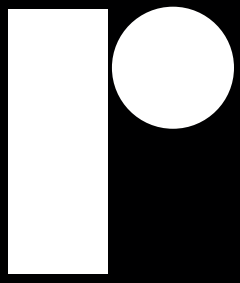

Contributors Welcome

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