With costs on the rise, and a focus on delivering better outcomes, a new era of healthcare is upon us. Powered by an unwavering Mission to improve lives, Medtronic teams are uncovering the potential that today’s technology offers, both near and long term. Together — with partners spanning disease states, industries, and geographies — we combine a patient-centric mindset with the expertise and application needed to make a difference for patients, providers, and health systems around the globe.

**RON BROWN WRITES A LETTER TO MEDTRONIC EVERY YEAR**

The husband, father, and grandfather has lived with the help of Medtronic technology since his 30s, when he received his first cardiac pacemaker. His annual letter is read to employees around the holidays, and is a subtle reminder of why we do what we do. “Without your products,” he tells the crowd, “I would be a fading photograph in a family album.”

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Co-founder, Earl Bakken, etched the concept of **meaningful innovation** into everything at Medtronic. His passion to “put things together, differently” inspired Bakken to develop the first wearable, external, battery-powered, transistorized pacemaker in 1957. That passion — combined with a Mission to improve the lives of patients — remains strong at Medtronic seven decades later.

Today, our therapies help two people every second. With 84,000 employees working across 160 countries, developing patient-focused innovation — and strong partnerships — remain key to an even better, more impactful future.

**PATIENT-INSPIRED TECHNOLOGY FUELS 21ST CENTURY HEALTHCARE**

The number of people who use connected devices to monitor their health is forecasted to grow sevenfold by 2021, from 7.1 million in 2016 to more than 50 million. With the advent of remote monitoring, wearables and telemedicine, and 30 percent of today’s healthcare spend attributed to administrative costs, the potential is high to significantly impact cost — and outcomes — through monitoring and treating patients in new and different ways.

Our teams have developed technologies and solutions that help anticipate, adapt and react to patient needs beyond the hospital setting. More recently, a global study of heart failure patients indicated certain benefits of a specific Medtronic algorithm, found on the company’s cardiac resynchronization therapy (CRT) devices, compared to conventional biventricular pacing therapy. The research showed a 46 percent reduced risk of atrial fibrillation (AF) events, and a 59 percent reduction of a patient’s odds of a heart failure hospital readmission within 30 days.

“The algorithm’s personalized therapy helps keep more patients out of the hospital. On a system-level, this results in savings and less use of healthcare resources.”

59 percent reduction of a patient’s odds of a heart failure hospital readmission within 30 days

**50M:**

Individuals expected to use connected devices to monitor their health by 2021.

**59%**
“The study results are clear in showing that CRT devices with adaptive algorithms reduce the risk of AF adverse events and related costs,” said Prof. Dr. Med. Bernd Lemke, head of the Department of Cardiology at Lüdenscheid Hospital, Germany. “On an individual level, the algorithm’s personalized therapy helps keep more patients out of the hospital. On a system-level, this results in savings and less use of healthcare resources.” Like artificial intelligence (AI), great potential exists in areas such as biosensors, augmented reality, and material science. Additive manufacturing (3D printing) in the industry, alone, is expected to nearly triple by 2021. Navigating this new era of even more personalized, precision medicine, our people work with patients and clinicians every day to identify and address unmet needs across the healthcare system. “A lot of companies have mission statements, but here, it’s a very patient-centric mission that drives us,” says Mark Phelps, an electrical engineer who led an exploratory project more than 10 years ago called Deep Miniaturization. At the time, Medtronic employees recognized the potential benefits to patients if implantable devices could be 90 percent smaller. Now, the world’s smallest pacemaker, and an insertable cardiac monitor that is the size of a small battery — both built on the technology Phelps and his team developed — are helping patients around the globe. Read about Deep Miniaturization.

These advances take time and teamwork.

“We hire people from different industries and different backgrounds, and get the voice of the customer from all over the world to bring new ideas together in a meaningful way.”

“It starts with the first principles of science. You have to understand physics, biology, mathematics, and chemistry, and how materials and systems change when exposed to different environments,” says Mark Breyen, a senior R&D leader at Medtronic. “We also hire people from different industries and different backgrounds, and get the voice of the customer from all over the world to bring new ideas together in a meaningful way.” Breyen keeps a photo on his wall of a patient helped by several devices he created, as a reminder of why he works at Medtronic.

Diversity of thought, and a continuous cycle of input from patients and providers, informs the teams trying to develop solutions that will work in today’s tech-driven, connected world.

Working with patients to advance our technology, we see great promise in wearable and implanted devices. While many are already smart, connected, and controlled by patient input, we expect AI will help them to automatically adapt and anticipate patient needs in the future and provide a new approach to chronic pain management. This could significantly reduce the need for prescription painkillers among certain patient populations — reducing hospital admissions due to overdose, and helping address a rising global opioid crisis.

Advanced design continues to enhance safety, quality, and durability of products. We already see significant progress in this space, with Medtronic minimally invasive tools that help surgeons with early detection and more targeted treatment of conditions like lung cancer and Barrett’s esophagus, a leading predictor of esophageal cancer.

Innovation in the surgical space continues, and in the future we believe more surgical procedures will be facilitated by robotic, navigational or automated technologies. Research by Cambridge Medical Robotics suggests robotic surgery will grow to five times its present scale by 2025. As more procedures become facilitated by this kind of technology, we see great potential across the care continuum for patients, and intend to be a leader in advancing computer-assisted minimally invasive procedures well into the future.

REAL WORLD APPLICATION HELPS EXPAND INNOVATION

Our partners at universities, hospitals, and healthcare startups help us combine a patient-centric mindset with rigorous clinical trials required to expand our impact. In 2016, Medtronic acquired HeartWare™, a startup that developed a left ventricular assist device (LVAD) to help those with advanced heart failure awaiting a transplant. Working with researchers at Duke University and University of Michigan, Medtronic has since received FDA approval for expanded use of the device to serve as a destination — or permanent — therapy for patients who may not be eligible for a transplant.

Our growing global network of innovation centers — from Brazil to China — provides critical insight to the nuances that exist in healthcare delivery from one region to another. What patients and providers in India need, for example, may be different from what is needed in Australia. Even within a single region, needs can vary. Our newest center, in Chengdu China, is strategically located to serve the needs of Central and Western China. Compared to

U.S. opioid crisis costs $78.5 billion per year

5X

Robotic surgery will grow 5 times by 2025

3X

3D printing is expected to triple by 2021

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more developed countries, the region lacks sufficient clinical training for healthcare professionals, with less than half the number of on-the-job medical training organizations compared to the eastern parts of the country.\textsuperscript{11}

When we cannot physically be in a healthcare setting to experience what challenges exist, we rely on technology to bridge the gap. At our Applied Innovation Lab in Minnesota, a 360-degree “holodeck” video screen provides an immersive experience that helps scientists and engineers understand the needs of healthcare providers in remote regions and identify root causes of barriers to care. Such technology played a key role during a 2016 pilot program in Ghana and Kenya that addressed a high prevalence of hypertension in the region. The pilot has since led to the creation of Medtronic Labs Empower Health\textsuperscript{™}, a novel hypertension management model intended to reduce the burden and improve the efficiency of managing hypertension for both patients and clinicians in emerging geographies.\textsuperscript{12}

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DATA AND EXPERTISE UNCOVER POTENTIAL

The massive amount of data collected by today’s wearable and implanted medical devices provides insight to the healthcare realities of the future. Announced in late 2017, a new partnership between Medtronic and Mercy Health established a data sharing and analysis network that will help record clinical evidence — using anonymous patient data from implantable devices — to further medical device innovation and patient access to care. The partnership combines Medtronic knowledge of medical technology with Mercy’s expertise in integrating data analytics to care delivery.\textsuperscript{13}

Medtronic frequently collaborates with scientific experts to gain deeper understanding of the complexities behind chronic diseases. “Medtronic brings our expertise in biomedical, electrical, and mechanical engineering together with scientists from fields such as neuroscience, cardiology, and urology,” says Dwight Nelson, a chief scientist at Medtronic and expert on stimulation of the nervous system. “Diseases are not confined to a single body system, and modern therapies cross these artificial boundaries. When teams can reflect this diversity, we’re able to gather the data needed to drive new therapies.”

“Understanding the large-scale shifts taking place in healthcare today helps us identify where the greatest opportunities exist.”

Recognizing where we and our partners can have the greatest impact is also key to driving progress. “Understanding the large-scale shifts taking place in healthcare today helps us identify where the greatest opportunities exist,” says Medtronic scientist Nathalie Virag. “When we combine those opportunities with our shared areas of expertise, we can make a real difference for the patients and providers we serve.”

INNOVATION HAPPENS BEST WHEN IT HAPPENS FAST

The advent of big data and evolution of scientific discovery has caused exponential growth of human knowledge. The key to innovation is harnessing this new knowledge in ways that provide meaningful value to patients. Collaboration is essential to the effort.

Backed by teams of experts spanning disciplines and cultures, Medtronic creates forums intended to accelerate R&D. Internally, the company’s Knowledge Center team built a communications infrastructure for technical experts across the organization. Internal scientific conferences and symposiums facilitate critical in-person teamwork, while supplemental online platforms like MIX (Medtronic Information Exchange) fill the gaps. In one year, more than 2,000 questions were posted to the company-wide online collaboration tool, and our experts generated nearly 6,000 responses.

Externally, we’ve seen firsthand how patients benefit from accelerated innovation. In 2016, the Food and Drug Administration (FDA) approved our latest technology for type 1 diabetes — the world’s first hybrid closed loop system — with unprecedented speed. The Medtronic MiniMed 670G\textsuperscript{™} system features a highly advanced sensor, the latest in insulin pump technology, and a dynamic algorithm working together to help patients manage their disease. For patients like 16-year-old Tia Geri, who participated in clinical trials of the system, the FDA approval was exciting and rewarding. “It feels really good to know that I had a hand in helping people,” says Tia. “And I’m excited for the people who will get to use this new technology.”
LESS WORRY, MORE LIVING

After only a year on the market in Australia, the Medtronic MiniMed 670G™ is transforming diabetes management, allowing patients with type 1 diabetes to spend more time doing the things that make them happy and less time worrying about their disease.

That’s exactly what Leanne Foster has done since she began using the Medtronic MiniMed™ 670G system — a much-anticipated technological breakthrough for diabetes management in the region.

“The system has taken away some of the chores and the worries of diabetes,” said Foster, the first Australian to be fitted with the commercial device, which was locally released in February 2019. “I find the 670G just ticks along and adjusts accordingly, helping manage any fluctuations.”

The MiniMed™ 670G has been hailed a “game changer” by patients and healthcare professionals in Australia, where more than 120,000 people live with type 1 diabetes. In fact, after spending a few months on the commercial market, the system earned the Australian medtech industry’s highest honor, the Medical Technology Association of Australia (MTAA) Kerrin Rennie Award in recognition of its innovative and extraordinary contribution in improving health outcomes of Australian patients.

More than 4,000 people are currently using the MiniMed™ 670G insulin pump, signaling a major shift in how Australians are managing their disease. Prior to the MiniMed™ 670G, people with Type 1 diabetes had two primary treatment options – pumps (either standalone, or with predicted low-glucose suspend) or daily injections.

The MiniMed™ 670G system automatically adjusts to deliver precise amounts of insulin based on continuous glucose monitor (CGM) readings taken every five minutes. The system features the company’s most advanced SmartGuard™ algorithm and new Guardian™ Sensor 3, which together work to maximize the time people are within a set target glucose range.

The monitoring feature helps minimize the “highs” and “lows” patients taking daily injections often experience. Data collected by Medtronic shows that patients using the MiniMed™ 670G are now on an average Time in Range of 72% (as of December 2019), a result that exceeds the recommended TIR consensus guidelines of 70% that were published in 2019.

A PROMISING FUTURE OF BETTER HEALTH

For patients like Ron, Tia, and Leanne — and the people who care for them — Medtronic is already making a difference. But there is still tremendous opportunity ahead.

“’The opportunity to really change healthcare for patients is going to be completely evolved in the future. We intend to be leaders in that evolution.’

We envision a day in the near future when capabilities like 3D printing will allow physicians to order customized devices manufactured for specific patients; and training on the latest surgical procedures will happen using augmented reality. Longer term, with the help of our partners, we anticipate a day when chronic disease management becomes effortless for patients, cancer treatment is nothing more than a day procedure, and debilitating heart and brain conditions are not only more treatable, but entirely preventable.

For the millions of patients we serve, the future starts today. We invite you to share in the possibilities, and help us take healthcare Further, Together.

Learn more about innovation at Medtronic.

IMPORTANT SAFETY INFORMATION

Refer to technical manual and Instruction for Use (IFU) for complete list of indications, contraindications, warnings and precautions.

The patient testimonial above relates an account of an individual’s response to treatment. The account is genuine, typical and documented. However, this patient’s response does not provide any indication, guide, warranty or guarantee as to the response other people may have to the treatment. The response other individuals have to the treatment could be different. Please talk to your healthcare professional about your condition and the risks and benefits of these technologies.

This information is designed to provide you with helpful educational information but is for information purposes only, is not medical advice and should not be used as an alternative to speaking with your doctor. No representation is made that the information provided is current, complete or accurate. Medtronic does not assume any responsibility for persons relying on the information provided. Be sure to discuss questions specific to your health and treatments with a healthcare professional. For more information please speak to your healthcare professional.
REFERENCES