

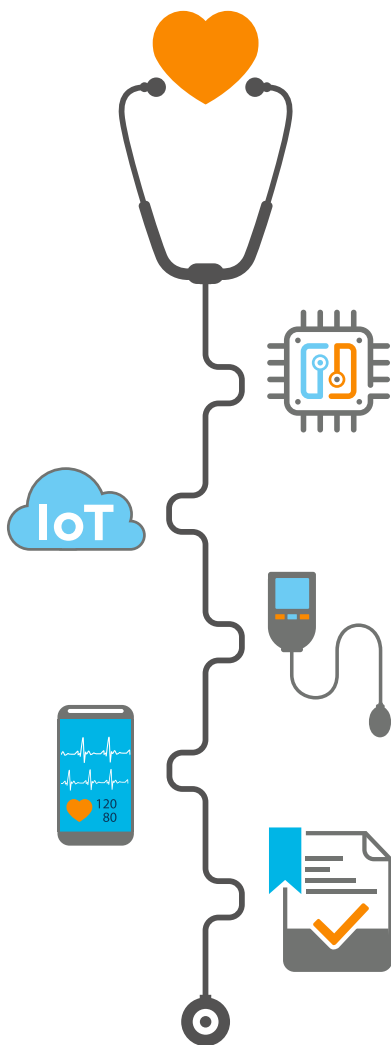
Real-time and Remote Patient Monitoring Trends

How Sensors and Devices Are Forever Changing the Face of Healthcare

Trend Paper

Imagine getting preventative care outside of a hospital setting. It is increasingly taking place today. Startups, Fortune 500 technology companies and medical providers are all looking at new products and devices that could revolutionize medical care and streamline costs by reducing hospital readmission rates, and allowing patients in remote areas to get the care they need.

Remote patient monitoring is having its day, and there is no let up in sight on this evolving trend. It could fundamentally improve patient outcomes and quality of care across the medical field. This includes onsite in hospitals and clinics, for at-home care, and for remote care in less populated areas of the country and in developing countries.



Transforming Healthcare — New Devices, New Technologies, Better Results

- Imagine cardiovascular patients having their blood pressure and heart rate measured on a regular basis at home, and the data fed back to cardiologists so they can better track patient care. Doctors could far more easily track everything from respiration rate, cardiac output, oxygen and carbon dioxide levels in the blood to body temperature.
- What if devices could track the weight of patients battling obstructive heart disease to detect fluid (**what fluid?**) retention before hospitalization is required?
- Consider sensor-based devices used to monitor a child's asthma medication usage to be sure family members are providing the right dosage, and as a way to cut down on visits to the ER.
- What if providers could wirelessly link a range of sensors that measure vitals in the emergency and intensive-care units. Sensors that create this data are a good first step. When artificial intelligence and similar tools are added to this, the devices could potentially analyze huge amounts of data to improve clinical decisions.
- Rural hospitals in dire need of more physicians could take advantage of telemedicine and other technology advancements. This might include remote consultations, in-home monitoring, outsourced diagnostic analysis, and remote specialist consultations. Telemedicine enables remote physician consultations that are faster, cheaper and more efficient than traditional healthcare appointments.
- Even within hospitals and practices, sensor networks are helping to optimize healthcare delivery and monitor patient adherence.

Industry Statistics and the Big Picture

By 2018, more than five million wearable, mobile medical sensors will be purchased and used throughout the healthcare space. And by 2020, some industry analysts expect global remote monitoring systems to reach a staggering \$46 billion in value, driven in part by the need to reduce healthcare spending. (Source: Global Industry Analysts Inc., strategy report.)

As technology continues to dramatically evolve, many believe the Internet of Things (IoT) could play a pivotal role in industry after industry — but especially in creating a more connected healthcare ecosystem. In healthcare, IoT may just redefine how apps, devices and people interact and connect with one another to deliver healthcare solutions. The benefits? It could help reduce costs, improve outcomes and disease management, and enhance patient experiences.

Here are some of the trends taking place in the patient monitoring field and the key market drivers that design engineers need to consider. Clearly, there is overlap as IoT spans two important areas: the development of smart, connected products and devices, and the proliferation of big data.



Trend #1

An aging population vulnerable to chronic disease is driving the market.

The world population is aging. People are living longer with good health, but many are also living longer with chronic disease — putting a strain on healthcare systems and resources. According to the World Health Organization¹, the number of people aged 65 or older is projected to grow from an estimated 524 million in 2010 to nearly 1.5 billion in 2050, with most of the increase in developing countries.

“The disease burden associated with a growing elderly population will require a large and diverse health care workforce that can effectively and efficiently diagnose and treat patients with complex medical conditions,” according to one study².

According to another study in the Journal of the American Medical Informatics Association (JAMIA), *“Remote home monitoring continues to boost patient engagement with their overall health and adherence to provider recommendations for managing their chronic medical conditions.”*



Trend #2

The focus in the healthcare industry is shifting to value-based, patient-centric care and outcomes.

Are healthcare companies and providers moving to value-based care? Industry analysts say yes. The increased focus on value-based care is shifting financial incentives to a healthcare model where providers are compensated based on how their patients fare, rather than by the number of tests, visits, or procedures performed. It’s about the quality of care not the quantity.

But here’s where new devices and technology could make a big impact, and in some cases already is. As one example, data sensors could help a health care provider detect potential issues in a prosthetic knee joint, helping them summarize the bilateral force distribution and pressure patterns across the lower extremity. In addition to offering huge value to the patient — alerting them to the first hint of strain — the provider benefits by using 24/7 monitoring that allows for adjusting treatment, and the payer avoids the additional costs of prolonged recovery or remedial treatment.

This is just another example where advances in sensor technology are making this possible — in part by making gathering new data much easier.



¹http://www.who.int/ageing/publications/global_health.pdf

²<http://content.healthaffairs.org/content/32/11/2013.full>



Trend #3

Healthcare Big Data is having a huge impact on the medical field in all ways.

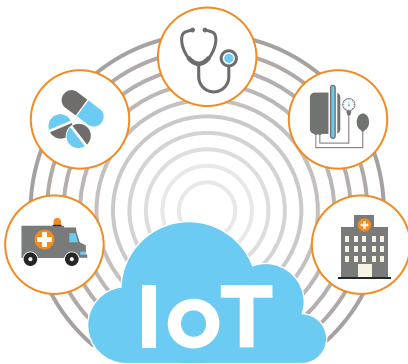
Some industry analysts believe that ‘big data’ is fueling the healthcare industry’s biggest trends — such as precision medicine, predictive analytics, and machine learning, according to an article in HealthIT Analytics.

Big data is already having a profound impact on the healthcare field in areas from oncology to neurology, cardiology, genomics, and other specialties with more personalized therapies and diagnostic tools. And patient-specific data is increasingly available through a new generation of devices and applications that collect information through wearables, home monitors, and smartphones.

According to a paper by Stanford Medicine on “Harnessing the power of data in healthcare,” Stanford believes that data is permeating every component of the healthcare ecosystem — medical research, daily life, the patient experience, ongoing care, prediction and prevention. Says the report:

“A focus on data in the coming years has the potential to make healthcare more preventive, predictive and personalized, and meaningfully reduce health care costs and lead to better patient care.”

Big data allows medical providers and healthcare professionals to accumulate and analyze on a much larger population base and assess huge volumes of new data — opening up new areas for research and treatment opportunities. Again, remote monitoring systems can help collect this information and play a role in boosting analysis of this healthcare-related Big Data.



Trend #4

The increasing role of Internet of Things (IoT) for remote monitoring and healthcare applications in general.

Most would agree, the Internet has changed everything. Now many believe that the Internet of Things (IoT) will change everything yet again. IoT will eventually allow patients and providers to work together for more effective chronic disease management, deeper engagement, and more open communication.

By integrating IoT features into medical devices, it promises to greatly improve the quality and effectiveness of healthcare, bringing especially high value care for the elderly, patients with chronic conditions, and those requiring constant supervision. There is a growing interest in IoT-driven healthcare services and wearable medical devices that feature sensors, actuators and other mobile communications methods that allow patient data to be continuously monitored and transmitted via cloud-based platforms. These devices can alert doctors and nurses of important changes in vital signs.

It is even becoming big business. Spending on healthcare IoT could top \$120 billion in just four years, by some estimates.

Devices today monitor all sorts of patient behavior – from glucose monitors to fetal monitors to electrocardiograms to blood pressure. And while patients have to often follow-up with a physician, the smarter monitoring devices of tomorrow may change that.

For instance, some smart devices today can detect if medicines are being taken regularly at home from smart dispensers. If not, they can initiate a call or other contact from providers to get patients properly medicated. The possibilities offered by the healthcare IoT to lower costs and improve patient care are almost limitless.



Trend #5

Wearable medical technology innovations are driving growth, allowing healthcare to reach new frontiers.

“Soon, medical centers, rather than tech and fitness companies, will become the de facto providers of wearables,” Stanford University Medicine predicts. “In fact, a majority of people [participating in a 2016 PWC survey] already agree that they would be excited to experience wearable technology from a doctor (65 percent), from a hospital (62 percent) or a health insurance company (62 percent).”

The clinical application of wearable medical technology is evolving fast as technology companies are partnering with healthcare organizations to help patients and clinicians make better decisions. Consider some of these applications:

- Remote monitoring of sleep and vital statistics for bedridden patients.
- Gloves with Bluetooth sensors that help stroke patients with neurological and musculoskeletal injuries regain mobility in their hands.
- Painless and accurate glucose monitoring.

- Continuous temperature monitoring devices (such as chest straps) that can be used for babies and young children, post-operative patients, cancer patients, and seniors.
- Headband and/or ear buds that measure discomfort in the user's electroencephalography (EEG) system for better pain management.
- Personalized, AI-based wearable technologies that learn about the user. Think smart watches that recognize and normalize sleep apnea, a dangerous health condition.
- Smart glasses that help the blind see what they can't see and talk them through situations.

Though many new devices are being developed, there is still a challenge to ensure that the devices can aggregate and share data, and communicate reliably and securely.



TE Connectivity's Solution for Blood Oxygen Level Detection

As many of these trends point out, demand is increasing for solutions for home healthcare with remote and self-monitoring technology. And sensor technology plays a vital role in many of these healthcare applications.

TE Connectivity (TE) is now one of the largest sensor companies in the world, with innovative sensor solutions that help customers transform concepts into smart, connected creations. Electronic systems in medical equipment, devices and probes rely on sensor signals as a basis for control activities, accurate diagnosis and treatment.

In particular, TE Connectivity offers cardiovascular monitoring and diagnosis sensors —including photo optic sensors that measure blood oxygen saturation (SpO₂) and pulse.

TE Connectivity satisfies this need with its Model SpO₂ components. Specifically, these optical components comprise a key part for non-invasively measuring blood oxygenation levels. It's an important capability. Low oxygen level can put a strain on cell functioning including the heart and brain. This is critical in acute medical situations like post-op recovery.

Benefits of TE's solution include:

- **Best-in-class accuracy** — TE's SpO₂ optical components improve accuracy with tighter red LED wavelength tolerance up to 660 nm ± 2 nm. Proprietary emitters spectrally matched to function with a detector drive this precision. More precision in acute medical conditions can mean the difference between life and death.

- **Higher reliability with proven design and a track record in the marketplace** — With more than 27 years in the business and more than 25 million components produced, TE Connectivity has a proven track record in quality and reliability.
- **Flexibility to meet customer requirements** — TE's SpO₂ optical components have proprietary emitters with three different IR LED wavelength choices: 880 nm, 905 nm and 940 nm. Without compromise to size and lower power consumption, our dual drive emitters accommodate two different LED wavelengths (both Red and IR).
- **Scalable, value-added manufacturing** — With scalable, automated manufacturing, TE can meet large component volume requirements. TE also has capability to provide complete pulse oximetry sensors (reusable and disposable sensors).

TE Connectivity provides both components and complete sensor packages. This capability makes us the leading choice for pulse oximetry applications that require high degrees of precision, durability and performance.

Be Part of Health Technology Innovations

Key healthcare trends will continue to strengthen remote patient monitoring and open up new opportunities for growth. And that translates into new challenges to design and create solutions based on advanced sensor technology. TE Connectivity can help.

Learn more today at www.te.com.