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The Doctor Will Sense You Now

Medical devices are in the midst of a revolution, and designers must adapt.

(Image courtesy of Honeywell.)

Over 500,000 Americans require dialysis three or more times per week, a treatment for failing kidneys that can take upwards of five hours to filter toxins from the blood. Most dialysis in the U.S. today takes place in clinics or private treatment centers, but there's a better setting: in the home. Not only is at-home dialysis more comfortable for many patients, it's also cheaper for taxpayers—enough so that in 2019, President Trump launched the Advancing American Kidney Health initiative, one goal of which is to boost the number of at-home dialysis patients by 2025.

It's not just kidney disease patients that are shifting to in-home care. The trend toward telemedicine—healthcare at a distance—has been building for decades, and is helping drive complex new requirements for medical devices: low power, light weight and small size are just some of the constraints device designers must now consider. It's imperative to choose sensors that are up to the task.

Mini Medical Devices

There has been one major health concern on everyone's mind for the past few years, and while the COVID-19 pandemic didn't ignite the trend to telemedicine, it has accelerated it.

"There's a greater emphasis now in thinking outside the box on some of these therapies, like glucose monitoring and oxygen concentrators, that used to be done in the hospital," says Martin Murray, Global Application Engineer at Honeywell for board-mount pressure sensors, airflow sensors and force sensors.

Hospitals have germs—an obvious fact upon consideration, but one that didn't resonate with many until the threat of COVID. "If you can do these procedures at home, that not only limits the exposure to other people that might have COVID, but it also will alleviate overworked resources at these clinics and hospitals," explains Alfredo Arteta, North America Product Manager for Honeywell's medical vertical.

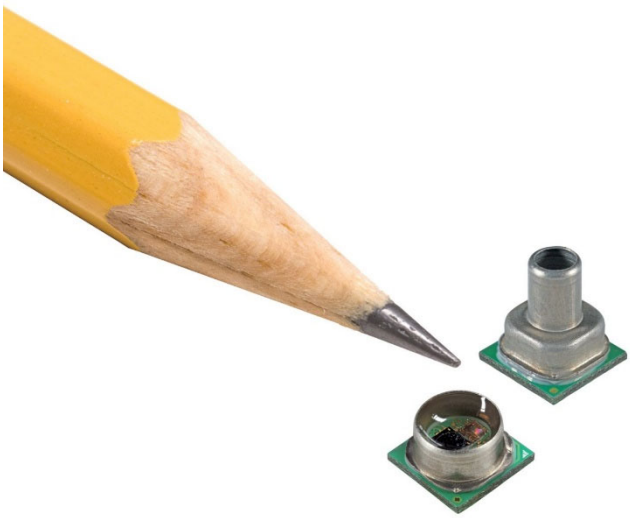
At home doesn't necessarily mean in the house, either. Rethinking therapies for mobility (ambulatory care, to use the industry jargon) ultimately means a greater quality of life for the patients. "You're allowing grandpa and grandma to go to their grandson's baseball game because they're not tied to a big tank of oxygen," Murray says.

But that kind of mobility means battery power. Medical device designers must think more carefully about their power usage, selecting sensors and other components that won't drain the battery. Mobility also means that someone must lug the device around, necessitating lighter weight and smaller size.

Miniaturization is a trend that extends beyond telemedicine. Today, small size and light weight is just as important for equipment in a crowded ICU.

"It used to be a ventilator, for example, could be as big as needed," Murray says. "Now they're trying to shrink all that down. Every little component in the system is being looked at, so small size is critical there."

For example, Honeywell's MPR Series Pressure Sensors measure just five millimeters square, and its ABP Series Pressure Sensors are just a couple millimeters bigger. Suffice it to say that both of them would be very easy to lose. Murray says these pressure sensors are used in many ambulatory applications.



The Honeywell MPR Series pressure sensors measure just five millimeters by five millimeters. (Image courtesy of Honeywell.)

Cost-Effective Care

Another trend affecting home medical devices and hospital equipment alike relates to sterilization. At home, self-care patients lack the tools and training to properly sterilize equipment. It's not as easy as breaking out the bleach—while it is an effective disinfectant, bleach eats away at glass and silicon and can easily damage electronics.

Even in a hospital setting, sterilization of medical equipment has become trickier. One common tactic is to use a hot autoclave to kill off harmful bacteria, but the temperatures required to finish the job are increasing. Twenty years ago, 120°C or so was sufficient. But today, as bacteria has gradually gained immunity, temperatures in the 130°C range are necessary. It may seem like only a slight increase, but it's enough to damage electronic components.

"It's harder to design a sensor that can withstand that increase in temperature," Murray says.

While there are other methods of sterilization, such as using ethylene oxide, not all hospitals have access to this treatment. The bottom line is that medical equipment is becoming harder to reuse, and designers must account for this fact. Low unit cost is becoming paramount both at home and in the hospital. "Any sensors or any technology you put in there, a lot of it has to be disposable," Murray says.

Acute Accuracy

The trend toward lower-cost medical equipment is countered by a trend to improve sensor accuracy. One way to do this is to move sensors as close as possible to the patient, such as putting an airflow sensor in a mask rather than in a machine separated by several feet of plastic tubing. That has ramifications for the sensors, says Murray, as they have to be "wet-capable," designed to withstand liquids and made with "biocompatible" materials.

The sensors themselves can also be designed for higher accuracy. Take pressure sensors, for instance, which are used in spirometers to measure a person's breathing and diagnose lung diseases. Spirometers must be capable of measuring a patient's full lung capacity. That encompasses a wide range of airflow, from the upper limit of lung capacity to the very low-pressure onset of breathing, a fruitful stage for finding lung problems.

"You need a sensor with what is called a high turndown ratio, which means you can measure very accurately over a wide range of flow," Murray says. "The resolution on the output, how small a pressure change can you discern, is what it really comes down to."

A decade or so ago, 12 bits of output resolution was considered a good industry standard. Today's pressure sensors offer four or more times that resolution. Honeywell's ABP Series Pressure Sensors, for example, offer a 14-bit output. The company's RSC Series goes even further with a 16-bit resolution, making it a popular choice for spirometers and ventilators.

The Honeywell RSC Series of board mount pressure sensors. (Image courtesy of Honeywell.)

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Better sensor accuracy is extremely important for medical lab automation, which has become critical for developing new devices, medicines and vaccines. For example, more accurate sensors mean more tests can be conducted on a limited blood sample.

“There’s an increasing expenditure on research and development for lab automations,” Arteta says. “Helping improve that infrastructure, especially in emerging countries, is definitely going to help present different avenues of growth.”

While the healthcare industry has been in upheaval for two years, valiantly fighting the novel coronavirus, it has also been a period of reflection and transformation. The pandemic put new pressure on trends that have been shaping up for decades: trends toward telemedicine, miniaturization and higher accuracy. For designers of medical devices, it is more important than ever to pay heed to these trends.

“Having a small, low-cost, very accurate and reliable device is critical,” Murray says.

To learn more, visit TTI’s Honeywell Medical Sensor and Switch Solutions.