



MEDICINE GETS PROACTIVE: PREVENTION IS BETTER THAN CURE

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YOUNG REVIEWERS:



ARADHYA

AGE: 12



RIZVIAN

AGES: 9–13

If you have ever looked at a car's dashboard, you probably know that it can provide lots of important information about the car's health—information that can help the owner keep the car running well. But did you know that our bodies need the same kind of attention? For a long time, doctors have typically diagnosed and treated patients *after* they get sick. But what if doctors could catch illnesses early, before they even cause symptoms? New technologies, including wearable devices like smartwatches and health-tracking apps, can help with this. Devices that monitor our bodies constantly will know what is “normal” for each person, so they can warn us of small changes happening in our bodies that might mean we are starting to get sick—before we even have symptoms! This approach is called precision medicine, and could have many benefits for healthcare, from controlling future pandemics to possibly even helping humans live longer!

HOW IS YOUR CAR RUNNING?

Beyond the speedometer and the gas gauge, have you ever taken a good look at the dashboard of your family's car? Dashboard gauges provide lots of important information, ranging from how much air is in the tires, to the oil pressure in the engine, to the engine temperature, to the charge in the battery (in the case of an electric car) (Figure 1A). The dashboards of some newer cars can even tell us when it is time to take the car in for regular maintenance, or when the brake pads need to be replaced. The purpose of all this information is to help us to be **proactive** about keeping our cars healthy. If we notice that one of the measurements is "off," we can take the car in for service *before* it breaks down and leaves us stranded.

PROACTIVE

A healthcare approach focused on preventing health problems before they occur, rather than just treating them after they happen.

Figure 1

(A) A car's dashboard provides the driver with lots of information about the car's health, so that the driver can proactively address any problems with the car before it breaks down and leaves them stranded. (B) In the future, wearable medical devices could monitor many aspects of our health and provide a "human dashboard" that could warn us of health problems before they cause symptoms. That way, we could see the doctor for treatment before we even feel sick (Figure created by carlottacat.com).

REACTIVE

The traditional approach to healthcare that focuses on treating illnesses and other health problems after they occur.

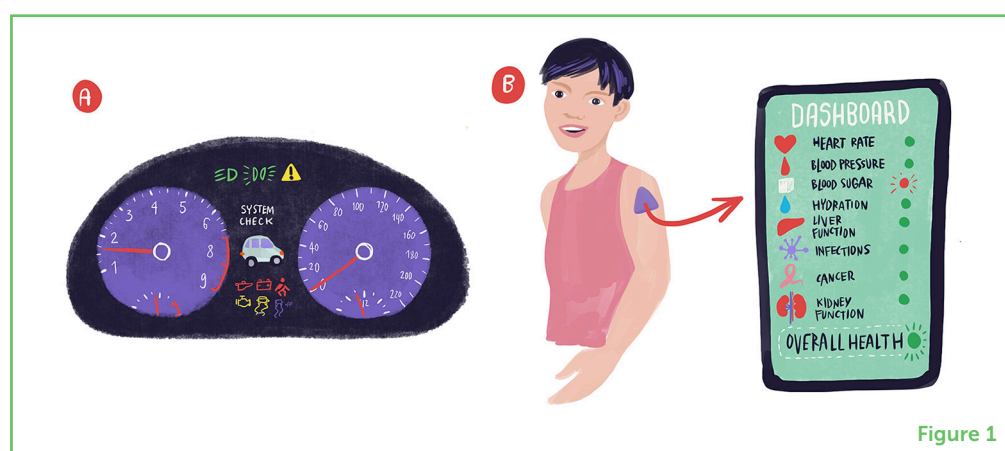


Figure 1

This is quite different from the **reactive** way that many people deal with their own health. While some people go to the doctor for a checkup once a year or so, others only go when they are already sick—when something in their bodies has broken down. At that point, the doctor generally diagnoses the problem (with some laboratory tests) and prescribes some sort of treatment, like a medicine, operation, or therapy, to get the body operating properly again. Healthcare has worked this way for a long time, and it might seem normal—but it is like waiting until the car breaks down on the side of the road! Even if people get regular checkups, a year in between visits is a long time. Imagine a car dashboard that only provides the owner with vehicle data once a year. In between, the car could easily run out of gas, or it could be leaking oil, and no one would know. During the time between visits to the doctor, a whole range of diseases could begin to develop, and some of them could be serious. Think about heart attacks, strokes, or cancer, for example.

What if we had a kind of "dashboard" for the human body that could help us to catch illnesses *early*, even before they cause any symptoms (Figure 1B)? If you have a cell phone or a smart watch with health-tracking apps, you already have the beginnings of a human dashboard on your device. These apps can help us become proactive

WEARABLE MEDICAL DEVICES

Electronic devices worn on the body to monitor health and medical information, such as heart rate, steps taken, and blood glucose levels.

DIAGNOSIS

The process of identifying a disease or condition based on its signs, symptoms, and test results.

BASELINE

The state of a person's normal bodily measurements (temperature, blood pressure, heart rate, etc.) when they are not sick.

PRECISION MEDICINE

A medical approach that considers individual variations in vital signs, genes, environment, and lifestyle to prevent, diagnose, and treat diseases.

about certain aspects of our fitness, like how much exercise we get and how many calories we eat vs. burn each day. Also, **wearable medical devices** that stick to the skin can collect data about things going on inside the body, using either tiny needles or electrodes. For example, wearable glucose monitors can measure blood sugar levels in people with diabetes (for more about wearables and the flood of data they collect, see [this *Frontiers for Young Minds* article](#)). Wearables eliminate the need for a blood sample, and they can also collect data as frequently as every few minutes, to notify people of small changes happening in their bodies before they get sick! A “dashboard” made from health app and wearable device data would help doctors and patients switch from a *reactive* way of managing health to one that is more *proactive*.

GETTING PERSONAL

Imagine you go to the doctor because you are feeling sick and feverish. The doctor takes your temperature and reports that it is 98.6°F/37°C, so you do not have a fever. But you *feel* feverish—what is going on? Although it is widely accepted that 98.6°F/37°C is the normal temperature of a healthy human, this is not entirely true. There is a range of normal body temperatures [1], and *your* normal healthy temperature might be a degree or two different from that of your friend or a family member. If your normal healthy temperature is 97°F, then a temperature of 98.6°F *is* a fever for you! This means that the doctor could give you an incorrect **diagnosis**.

This is true for more than just body temperature—people differ in what is “normal” for many health parameters, which means that doctors run the risk of messing up the diagnosis if they only compare a patient's values to a population “average.” Those doctors might be missing important changes in that specific patient's values over the past few months or days—changes that could indicate that the patient is in the very early stages of an illness.

This is another advantage of a health dashboard fueled by data from wearables—it could establish a healthy **baseline** for *each person*, which would allow doctors to see when something is “off” for that specific person and prescribe the right treatments proactively, maybe even before the person feels sick. This personalized approach is called **precision medicine**. There are a number of ways that precision medicine can help keep humans healthy, and we will focus on two of them. First, we will tell you about how precision medicine could help to control future pandemics, and then we will explain how a human health dashboard might help to slow down (or possibly reverse!) the aging process.

PROACTIVE DETECTION OF INFECTIONS CAN SAVE LIVES

How do you know when you are getting sick with a virus like a cold or the flu? You might start to feel feverish, or maybe your throat is sore, or your nose is stuffed up. But did you know that the virus might already be reproducing in your body several days before your symptoms show up? This means that you could spread the virus to your friends at school, your sports teammates, and maybe even your aging relatives, if you visit them—all before you even know you are sick! What if you had an early-warning system that could tell you when you were about to get sick? Maybe you would choose to stay home and get some rest or visit a doctor for some medicine—actions that would also help to keep your friends and relatives healthy.

A human dashboard that continuously watches your health parameters and knows your healthy baseline could notice very slight changes that might mean the start of an infection or other illness. A study of over 3,000 people using wearable devices like Fitbits, Apple Watches, and Oura Rings showed that slight changes in heart rate and number of steps taken predicted 80% of COVID-19 cases about 3 days before people had any symptoms [2, 3]! This is important because early detection of life-threatening viruses, especially during a pandemic, can save lives and decrease the number of people who get infected—helping health officials to get the pandemic under control.

STAYING YOUNG WITH PRECISION MEDICINE

When cars age and eventually break down, they do not all die for the same reason. Some die because their electronics fail, in others an important part of the engine might stop functioning, or in still others the frame might rust away even while their engines are still running fine. A recent study collecting personalized medical data on 43 people for 2 years has demonstrated that something similar happens in humans [4]. Like cars, people can be divided into groups depending on which of their bodily systems are aging the fastest and are likely to break down first. For example, some people's immune systems may fail first, making them more vulnerable to dangerous infections, even though their other body systems are working normally. In others, the kidneys fail first, or the liver, or the heart.

If a health dashboard could help people understand their personal aging profiles, they might be able to take simple steps *before* they get old, like changes in diet or exercise, to better support the “weakest link” in their bodily systems. For example, liver agers might pay particular attention to what they eat and drink, avoiding fatty foods and alcohol to keep their livers as healthy as possible. Early **medical interventions** might be able to slow, or even reverse, the body's aging

MEDICAL INTERVENTION

Any treatment or action taken to address a health issue or disease, such as medication, surgery, or therapy.

process—all while the person is still young and healthy. Understanding and proactively addressing the specific problems you are most likely to face as you age is like keeping an extra close eye on your car's engine temperature and coolant levels if you know that it is prone to overheating.

HEALTHIER INDIVIDUALS, HEALTHIER SOCIETIES

The switch from traditional, reactive healthcare to a more proactive version is one of the most exciting changes that precision medicine will bring about (Figure 2). Instead of waiting for people to get sick and then treating them, more and more doctors will be able to use wearable medical devices and other new technologies to predict which of their healthy patients are likely to develop certain diseases. In addition to the uses discussed in this article, a personalized, proactive approach could also help to identify people who are at high risk for conditions like cancer, heart disease, or stroke. Doctors could then take steps to prevent or treat at-risk people long before their diseases become a problem. These diseases can be very expensive to treat, so being proactive can save money and help to keep healthcare costs down. In the long run, by being proactive and providing the right treatments to the right people at the right time, the “human dashboard” powered by precision medicine could improve and prolong many human lives.

Figure 2

In a proactive approach to healthcare, doctors could monitor data from advanced wearable medical devices to understand the healthy baseline for each of their patients. Then they would be able to spot small changes in a patient's health data that might mean a patient is about to get sick—and treat them before the patient even feels symptoms. This proactive approach aims to keep people healthy, in contrast to the traditional, reactive approach to healthcare in which patients wait until they are already sick to go to the doctor and get treatment (Figure created by carlottacat.com).

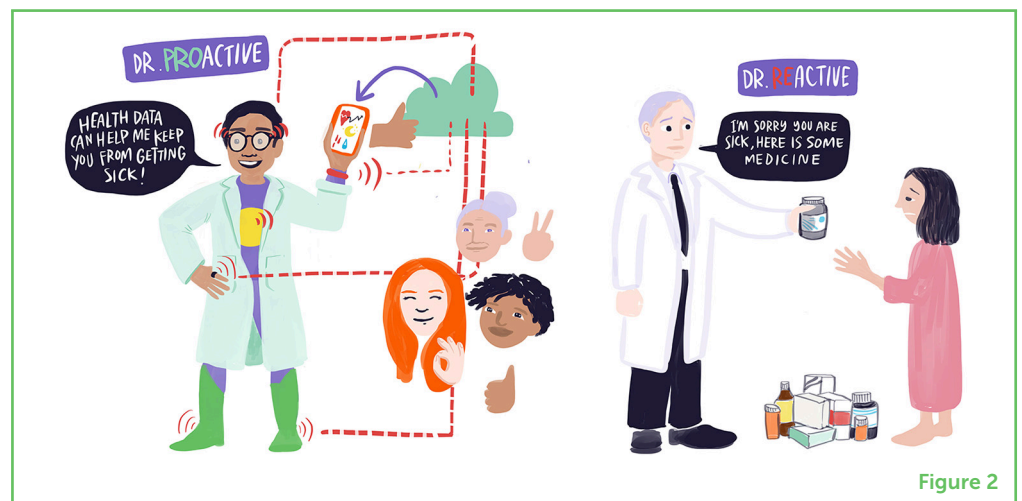


Figure 2

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Articled inspired by the [Sparks! Serendipity Forum at CERN](#). For more info on this particular topic, see talks by [Ariel Ganz](#) and [Mark Kendall](#).

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YOUNG REVIEWERS



ARADHYA, AGE: 12

I like playing, reading, and dancing. I like to travel to new places and know about their history. I love to paint natural life forms. I like to play volleyball and badminton. I like to perform classical dance as it represents my culture.



RIZVIAN, AGES: 9–13

We are young science enthusiasts. We love learning about how the world works, and we are always up for a new experiment. In our free time, you can find us reading science books, watching documentaries, or building things with our Dad. Our dream is to one day become a scientist and make new discoveries that help people.

AUTHORS



SUSAN J. DEBAD

Susan has been the main editor for FYM since 2015, making all our science clear and interesting—so that nobody feels it is “boring” or “too hard.” She has a Ph.D. in viral immunology (how the immune system protects us against viruses). Susan lives outside Washington, DC, and has a teenage son, two birds, and four dogs. She fosters beagles and helps them to get adopted, which means that sometimes she has more than four dogs! In her spare time she enjoys reading, crossword puzzles, and being outdoors. *susan@sjdconsultingllc.com



MICHAEL SNYDER

Dr. Snyder is a professor and Chair of Genetics at Stanford University. He is a pioneer in personalized and precision medicine and was the first to use watches like the Fitbit and Apple watch to monitor health and detect disease. Mike tracked his own health and found a risk factor for diabetes. After he then got diabetes, he tracked his health while he took medications and did lifestyle interventions to reverse his diabetes. He also detected his own Lyme disease with a smartwatch. In his free time, he enjoys working out and spending time with his family and two dogs. *mpsnyder@stanford.edu



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Dr. Ganz is a postdoctoral scientist in Dr. Michael Snyder’s lab at Stanford University researching Mental Health and Precision Medicine, especially focusing on wellness practices that improve wellbeing. She also started a venture fund, Arben Ventures, to invest in the next generation of innovators. In her free time, Ariel enjoys yoga, horseback riding, tennis, and playing with her cat and dog. *abganz@stanford.edu