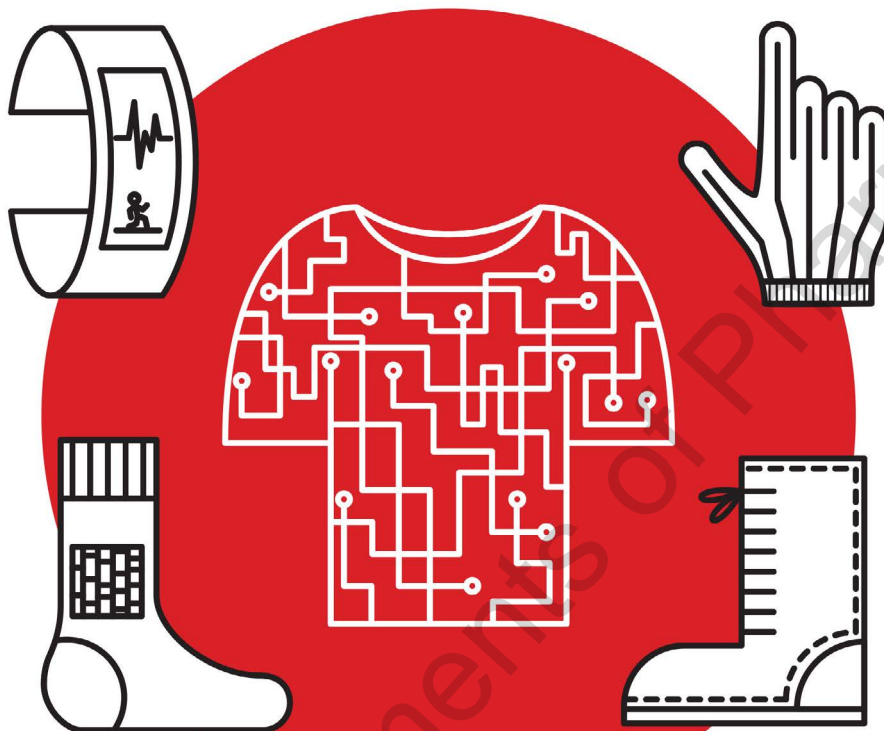


# Wearing Your health: The Case for Smart Clothing

As the wearable market continues to expand, the potential for smart clothing to monitor and manage health is breaking new ground.



**T**he market for wearables is continuing to grow as more companies enter the space and as more and more consumers acquire devices. According to IDTechEx, the market for wearables was valued at \$50 billion in 2019, more than double what it was five years ago, and covers 48 different product types.

While the adoption of wearables such as smartwatches is well underway, one area that could have huge potential for health monitoring is smart clothing, also known as connected garments, smart textiles, or “d-textiles”. Tractica has forecast the market for smart clothing to grow from 1.7 million units shipped in 2016 to 26.9 million by 2022.

Bryan Hill, VP, chief technology officer, life sciences, Cognizant, says because clothing is ubiquitous, e-textiles and smart

clothes provide an interesting broad scale opportunity for better digital integration with our daily health beyond wrist-worn tech.

“By overcoming the difficulty of device usage, and integrating into the everyday, smart clothing can be considered more convenient, washable, and reliable vs current health wearables,” says Dan Chichester, chief experience officer at Ogilvy Health.

Nagaraja Srivatsan, chief digital officer, R&D solutions, at IQVIA, wears a Fitbit to help measure his steps and sleep, an Apple watch to measure his ECG, and a Withings Scale for his weight, and several other devices that measure other areas related to health. “I am an active ‘quantify me’ individual,” he says. “In addition to the ones I use, there are several other biometrics sensors that take noninvasive measurements of our health. Wearable cloth-

## Current Applications for Smart Clothing

- ▶ Insoles for diabetes that can note a rise in temperature, alerting the patient to inflammation and reducing skin ulcers
- ▶ Biosensors in a sports bra that can collect data at the point of activity (vs. wrist trackers) for more accurate measurement of pulse and breathing
- ▶ Fitness pants with built in haptic vibrations that gently pulse at the hips and knees that can encourage holding positions related to physical therapy
- ▶ Smart socks for babies that can track heart rate and watch for interruptions in sleeping and breathing

Source: Dan Chichester, Chief Experience Officer, Ogilvy Health

ing is a mechanism to incorporate the features from each of the aforementioned sensors in a more integrated manner.”

## Improving Medical Insights with Smart Clothing

The use of wearables to monitor health has public support. According to a FierceHealthcare survey, 64% of patients would use a wearable device if it reduced the number of times they were required to visit their doctor or go to the hospital.

“Smart clothing is the next evolution for wearable technology, and it has enormous potential for health and medical applications,” says Josh Rose, VP, R&DS global strategy and head of virtual trials solutions, IQVIA. “Tak-

THE GLOBAL WEARABLE  
MEDICAL DEVICE MARKET  
IS EXPECTED TO REACH A  
MARKET VALUE OF \$27.26  
BILLION BY 2023.

Source: Industry Research





USE OF WEARABLES  
BY U.S. CONSUMERS  
ROSE FROM 9% IN  
2014 TO 33% IN 2018.

Source: Accenture

ing the concept of wearables on our wrists a step further, smart clothing that puts sensors on more parts of the body can help measure things like heart rate, blood-oxygen levels, and environmental conditions. This has a huge potential for gathering insights on overall fitness, biometrics, and environmental impacts on our health. It also offers new ways to deliver information or therapeutic benefits to athletes, patients, and others.”

Indeed, there is hope that use of smart clothing could assist with monitoring healthcare and help with treatment, for example by keeping track of people with chronic diseases or detecting disease. It has been demonstrated that remote monitoring of patients with chronic conditions can significantly reduce patient deterioration.

“Imagine if we could use wearable technologies to detect major medical problems such as cancer earlier,” says Neil Hayward, CEO of eXlthera. “Earlier diagnosis of these health issues could drive a swifter path to treatments and cures, thereby improving patient outcomes and decreasing healthcare costs.”

Today, the bedrock of healthcare remains the annual check-up, but there is only so much insight a physician can generate out of that single visit and round of labs, says Paul Balagot, chief experience officer at precision-effect.

“If our patient is clothed in wearable technology, with clinical-grade sensors proven to dependably detect meaningful changes, then that patient can be managed and monitored around the clock, and the data produced would

Imagine if we could use wearable technologies to detect major medical problems such as cancer earlier.

**NEIL HAYWARD**  
eXlthera



With greater confidence in today’s tools and technology, I think patients are more willing to embrace innovative approaches.

**AARON FLEISHMAN**  
BBK Worldwide



Developing an integrated biometric device in wearable clothing will take time and effort, and more importantly, will be expensive.

**NAGARAJA SRIVATSAN**  
IQVIA



There is already a significant amount of time, energy and money being invested in technology for clothing that monitors body parameters and various biometrics.

**LISA SUENNEN**  
Manatt, Phelps & Phillips

become much more robust and vigilant,” Mr. Balagot says. “Armed with this information, patients and their doctors would have the insight to be much more proactive in managing their health, intervening in disease, and ultimately leading to better outcomes.”

Smart clothing could overcome the problem of understanding how a patient feels, since the standard “how do you feel on a scale of 1 to 10” just isn’t enough, says Aaron Fleishman, director, market development, at BBK Worldwide.

“Any avenues for additional data that would help provide insight into a person’s condition I would support,” Mr. Fleishman says. “There would be more information to make better treatment decisions more quickly. Data and understanding the patient on an individual level leads to better treatment options and better treatment decisions.”

Smart clothing could also drive better medication adherence, Mr. Hayward says, for example by providing important information to the patient or a carer to prevent a health crisis.

“For example, the impact of high blood pressure and diabetes — two silent killers — on patients could be significantly decreased if wearable technologies were able to tell a patient when his/her blood pressure hit dangerous levels, or his/her sugars were incorrect,” he says.

Heart disease is a huge killer, claiming a life every 52 seconds in the

United States alone, says Ric Cavieres, executive VP, strategy, markets and consulting, at OZ Digital Consulting.

“AFib, an irregular heartbeat that can lead to blood clots, stroke, and heart failure, accounts for 130,000 of these heart disease deaths alone, yet 30% of people who have AFib are unaware they suffer from the condition,” he says. “The latest Apple Watch is like

The latest Apple Watch is like a doctor on your wrist and can diagnose if a wearer is suffering from AFib and alert them to seek medical treatment.

**RIC CAVIERES**  
Oz Digital  
Consulting



**What Makes a Wearable**

- ▶ **Smart watches:** Used for multiple purposes, such as monitoring UV rays and pollution
- ▶ **Fitness trackers:** Often used to track physical activity, but also to monitor heart rate and read out calories burned
- ▶ **Smart jewelry:** Connects with mobile phone to give wearers access to notifications
- ▶ **Smart clothing:** Garments with fibers that act as sensors and can monitor heart rate, stress levels, etc.
- ▶ **Head-mounted displays:** Deliver information to your eyes
- ▶ **Implantables:** Devices placed under the skin, for example to monitor heart conditions, etc.

Source: 42 Gears

a doctor on your wrist and can diagnose if a wearer is suffering from AFib and alert them to seek medical treatment.”

Potentially, smart clothing could even enable remote treatment using electrical stimulation to trigger a central nervous system response to block pain signals, Mr. Chichester says.

**Smart Clothing in Action**

As an example of current smart clothing applications, Mr. Rose cites Project Jacquard, which lets cyclists brush their fingers on the



fabric of their jacket to check the time, answer a phone call, or play music.

“The U.S. team at the Winter Olympics in South Korea wore self-heating jackets,” Mr. Rose says. “Other sporting applications include shirts that can track heart rate or running shorts that can measure distance and speed. From a medical perspective, connected clothing can act as miniature biosensors and pressure- and temperature-sensing socks for diabetics with nerve damage. Smart clothing may one day warn of an impending heart attack or epileptic seizure.”

Mr. Hill concurs, noting that while manufacturing costs and regulatory concerns have to date seen applications of the technology focused on leisure and high-end athletics, condition-specific products such as smart socks for diabetes patients are hitting the market.

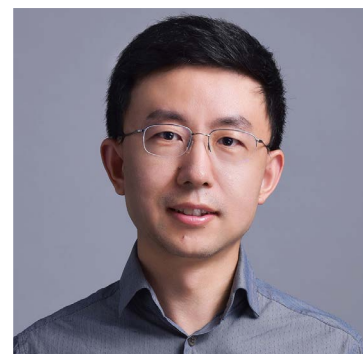
**Breaking Through the Barriers**

While smart clothing shows great promise, practical challenges remain.

“There are cost, durability, and usability challenges that must be addressed, and advances in technology will be needed before we see adoption beyond elite athletes,” Mr. Rose says. “But inevitably, connected clothing is likely to become a major force in the wearable technology sector.”

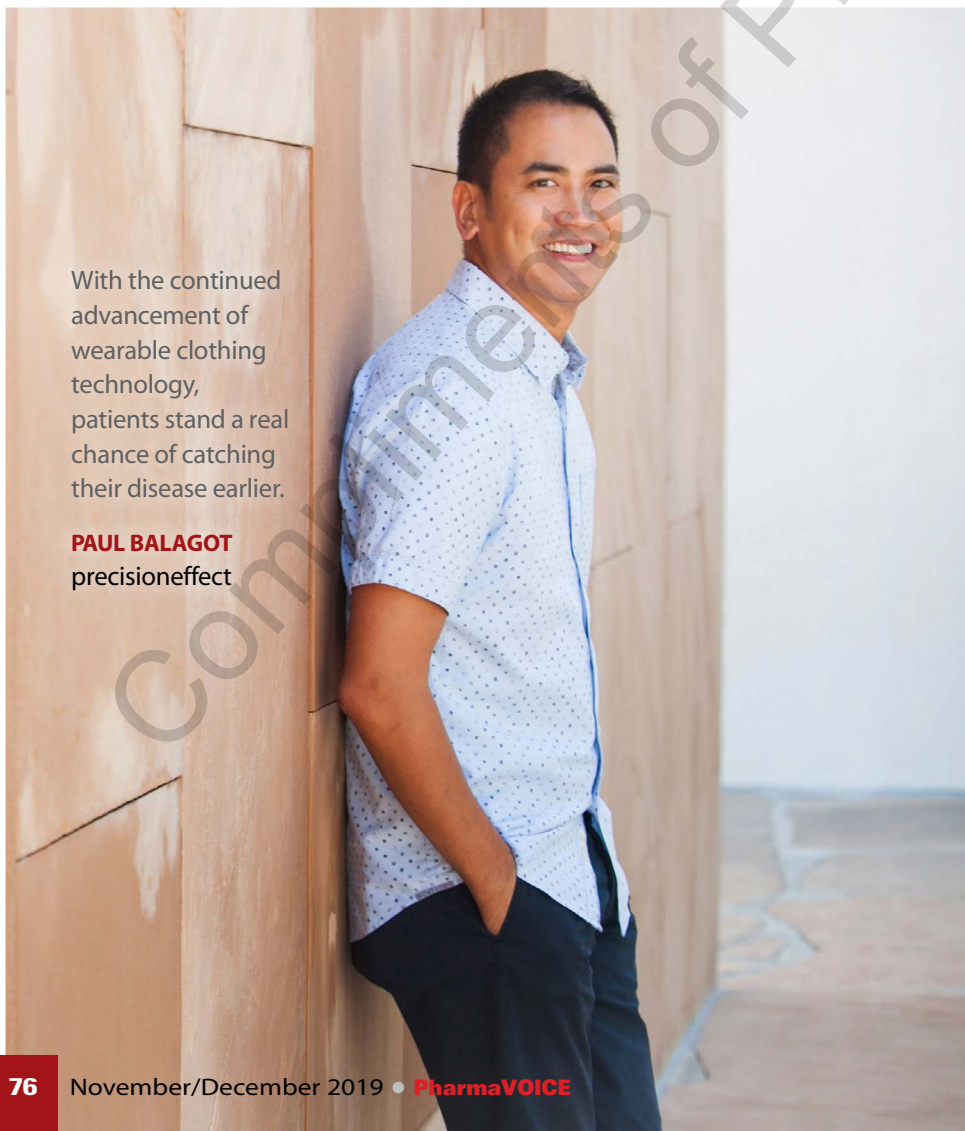
According to Lisa Suennen, leader of Manatt Digital and Technology and managing director with Manatt Health, Manatt, Phelps & Phillips, says no kind of clothing, no matter how “smart,” can manage health.

“All it can do is inform us of when things happening in our body are straying from



The advantage of clothing-based health wearables is that they can become part of one's everyday routine and thus are user friendly — literally like putting on a pair of pants.

**JIANG LI**  
VivaLNK



With the continued advancement of wearable clothing technology, patients stand a real chance of catching their disease earlier.

**PAUL BALAGOT**  
precisioneffect

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norms and perhaps trigger messages to us to suggest actions and confirm when actions create results," she says. "The effort to manage the response is done by people alone. We have to remember the difference between technology and health. Tech is merely a tool to help advance health; without the acts of people in response, it is meaningless."

Mr. Srivatsan agrees that health cannot be fully managed just by wearable clothing.

"Wearable clothing measures our body's health using external sensors," he says. "To fully monitor our health, we need to know what is going on inside the body. For example, we need to measure blood sugar to manage chronic conditions, such as diabetes. Until we can incorporate sensors that can measure what is going on inside our bodies as well as outside, it will be difficult to create a comprehensive health device. The other issue is integrating features of each individual devices with the right fidelity. Developing such an integrated biometric device in wearable clothing will take time and effort, and more importantly, will be expensive."

Wearable clothing is the way of the future but will take time to be adopted by one and all.

While clothing-based health wearables have an advantage because they can become part of a person's everyday routine, the amount of clothing movement and loose adherence to the human body means its application for medical use will be limited, primarily due to signal noise issues, says Jiang Li, CEO of VivaLNK.

"For example, daily movement or fall detection might be accurately captured using an accelerometer embedded in the clothing, but obtaining an accurate heart rate or ECG signal is not likely feasible even with an embedded ECG or PPG sensor," Mr. Jiang says.

However, Mr. Hill notes that because smart clothing covers a larger part of the body, it makes

it possible to monitor a greater number of biometrics with improved accuracy.

"Digital fabrics enable people to also better interrogate their surroundings with sensors that may detect a range of environmental factors such as air quality, UV, and sound that may impact health or a related care plan," he says. "Haptic feedback allows for real-time unobtrusive coaching as risks are detected, while visual indicators could be integrated to raise awareness of a health event to a nearby caregiver."

According to Geoffrey Gill, president, Shimmer Americas, while monitoring someone's vital signs through wearable clothing will likely become standard in the future, the

industry is a long way from this nirvana. "Clinicians need to understand the implications of wearable data much better and then be able to prove that their clinical protocol will improve both quality of life and cost," he continues. "Furthermore, it may take a fundamental change in how the healthcare system is managed from an economic perspective, particularly in the United States, for these changes to be viable."

To get the most out of wearables, including smart clothing, Mr. Jiang says it's best to identify the application, user profile, and data quality expectations upfront, and then match the appropriate wearable — patch, wrist, clothes, etc. — to the use case. **PV**

Clothes are for everyone, and don't carry the stigma associated with wearing a traditional medical device.

**DAN CHICHESTER**  
Ogilvy Health



Smart clothing will someday become standard, driving down re-admission rates, greatly reducing costs and improving patients' quality of life.

**GEOFFREY GILL**  
Shimmer Americas



For those living with chronic conditions, clothing can serve as a frictionless digital Sherpa leveraging biometrics, environmental data, and feedback mechanisms to guide the wearer toward better managing their disease and medication.

**BRYAN HILL**  
Cognizant

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