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Purpose

Science fiction has been promising us cool new stuff on our skin for decades – but what will our wearables actually look like and what will they be able to do? The future's gaining pace thanks to advances in materials, sensors, and power sources aimed at next-gen wearables that accomplish two main objectives: Be less intrusive and more reliable.

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Our Wearable Future: What Will New Tech Look Like?

***WEBMD HEALTH NEWS** Written by Jerilyn Covert Aug. 23, 2022*

"You don't drive a car around without a dashboard. I would argue it's just as crazy to go around without a health monitor."
Michael Snyder of Stanford University, a pioneer in the field of wearables.

Today's 'Stone Age' Tech Hints at Tomorrow's Medical Miracles

Science fiction has been promising us cool new stuff on our skin for decades – but what will our wearables actually look like and what will they be able to do? The future's gaining pace thanks to advances in materials, sensors, and power sources aimed at next-gen wearables that accomplish two main objectives: Be less intrusive and more reliable.

Smartwatches measure heart rate and sleep patterns – emerging apps can use this data to spot a COVID-19 infection before you do. A snug shirt can measure your vital signs continuously in real time. And a skin patch on the back of your arm can measure your glucose levels 24 hours a day, no finger pricks needed – you can see in real time how your diet impacts your blood sugar, giving you a personalized road map for how to eat.

Still others are pushing further, striving to make wearables friendly to our day-to-day lives, making them smaller, more flexible, stretchable, and even washable.

Imagine a normal-looking shirt with invisible sensors knit into the fabric, or a device so small it can hide under your fingernail – or even inside you (this is not your grandmother's pacemaker).

Why Wearables?

"Big data" is positively gargantuan in health and medicine. As machine learning, artificial intelligence (AI), and data analytics evolve to harness the power of all this data, wearables are the ideal vehicles for collecting it.

These advancements are "symbiotic," says Michael Daniele, PhD, an associate professor of electrical and computer engineering at North Carolina State University. "If we do the wearable right, it will deliver quality data that can then be put into the machine learning-AI-big data pipeline." Likewise, that data is worthless without those tools to transform it into information, he says.

Unlike conventional methods – which you likely use only at doctor visits maybe once or twice a year – wearables can be donned anywhere, anytime, tracking data continuously and revealing health trends. That may help doctors "fill in the gaps" when making a diagnosis or prognosis, Daniele says. "It gives doctors another arrow in the quiver."

Research shows that smartwatches with EKG can diagnose atrial fibrillation (AFib) with surprising accuracy (and some major brands already have received FDA approval for AFib features), and they may one day prove useful for flagging heart attacks as well.

Snyder and his team have pioneered an app that pairs with a smartwatch to detect infection and disease.

"We can now tell if you have COVID in 80% of cases before symptoms occur," he says. "The median is 3 days prior to symptom onset."

He hopes to scale this technology within 5 years, making it available to every person. "3.8 billion people have a smartphone," he says. "All you have to do is pair that with a smartwatch, and you have a health monitor for 3.8 billion people."

Arguably the greatest success to date is the continuous glucose monitor – like Abbott's Freestyle Libre and the Dexcom G6 – which can be worn for 10 to 14 days, testing glucose every few minutes and transmitting the info wirelessly to your cellphone. Typically worn on the belly or back of the arm, these work through a tiny sensor inserted under the skin to measure the glucose level in interstitial fluid – fluid in the space between cells.

What Will Future Wearables Do?

The potential for new worldwide health applications is enormous. In some cases, wearables may make tracking your health easier. Switch out a stethoscope for a chest patch, say, or a bulky Holter monitor for a comfy shirt. Need some lab work? Skip the needle and slap on a sweat or interstitial fluid sensor instead.

Other areas being researched:

Gentle, skin-like sensors. John Rogers, PhD, a professor of materials science and engineering, biomedical engineering, and neurological surgery at Northwestern University, has already developed a "very soft, thin, flexible skin-like" wireless sensor that is very gentle. It's designed so anyone can benefit, but he suggests premature babies in intensive care "could benefit most."

These fragile patients must have vital signs monitored continuously, involving a "rat's nest" of wires and tape, he explains. But he and his team (through their startup Sibel Health) have developed wireless monitoring sensors that spare the baby's delicate flesh and help provide healthful skin-to-skin contact with the mother.

Because these sensors are reusable and can work with smartphones, they may be ideal in developing countries that can't afford a lot of expensive monitoring equipment, Rogers says. Thousands have already been deployed to Zambia, Ghana, Kenya, India, Pakistan, and Mexico.

"The death rates of newborns in low- and middle-income countries remain extremely high," says William Macharia, MD, a pediatrician at Aga Khan University, in Nairobi, Kenya, who has tested the device on about 250 newborn patients in intensive care. "Most deaths happen within the first 2 weeks."

With this device, babies could be monitored much sooner, revealing problems earlier and hopefully saving lives, he says.

The platform – which received FDA clearance for noncritical care in adult patients – could have applications across medical departments. Rogers is also exploring uses in maternal health, stroke survivors, and Parkinson's and Alzheimer's patients. One version can screen for sleep apnea, effectively bringing the sleep lab into your home.

Mental health monitoring and diagnosis. Certain mental health conditions could become more easily treated via wearables that, for example, measure stress hormones. "There's an increased interest in trying to measure cortisol levels in humans," says Zhenan Bao, PhD, a professor of chemical engineering at Stanford University.

Doctors already test cortisol levels through blood, saliva, or urine. But a wearable could – through interstitial fluid or sweat – be used to track cortisol continuously, establishing a baseline and tracking whether a patient's stress levels are getting better or worse, she says.

Not only that, this information could be combined with other measures of body functions, like heart rate and skin conductance, to reach a more precise diagnosis and treatment, Bao says.

Drug adherence and dosing. Sweat may prove key to drug monitoring, says Jason Heikenfeld, PhD, a professor of electrical engineering at the University of Cincinnati. Not only will we be able to know if a person has taken a drug, doctors can monitor how quickly each person metabolizes it. This will allow doctors to prescribe custom dosages, reducing side effects and making drugs more effective.

"It's going to be the Stone Age," Heikenfeld says of current times. "We're going to be like, you went to a store and your 85-year-old grandmother who weighs 95 pounds, and you who are 32 and overweight, got the same bottle of X that says 'take this many every four hours up to this dose.' It doesn't make any sense."

And so much more.

Misra and her team at the ASSIST Center are developing sensors for measuring air quality, possibly letting us predict respiratory health. Other devices could measure human smell – volatiles in the breath are associated with cancer – revealing whether a cancer patient is in remission, for example, Misra says. Tracking behavior in

older adults could help detect changes in thinking skills or memory.

"Wearables will become more and more a predictor of health."

Pick up your smartphone. Yes, you've held it a thousand times, it's like an extension of your hands. But let's do an experiment: Grab it by both ends and stretch it out as far as it will go. Now twist it. Wrap it around your forearm. Cool, right? Now let it snap back.

Wait, what do you mean your phone won't bend and stretch?

That little exercise in imagination illustrates what's possible in the realm of wearables – electronic devices we wear close to or on our skin. Today, smartwatches and phones are still hard, inflexible blocks of plastic and metal. Tomorrow, all that will change.

"In wearables, flexibility, stretchability, and washability are all key requirements," says Veena Misra, PhD, a professor of electrical engineering at North Carolina State University and director of the ASSIST Center, a research institute funded by the National Science Foundation that develops wearables to aid health.

"We are seeing these kinds of developments across the board," Misra says, "and you can track that in the number of [research] papers coming out in wearables. That number is just growing exponentially."

We tend to think of wearables as fun consumer gadgets, but a growing school of thought says they will drastically improve health care – providing a vehicle for continuous, long-term monitoring to predict adverse events and closely track disease, improving treatments and health outcomes worldwide.

For that to happen, wearables must work seamlessly with our bodies. That means making conventionally hard, rigid devices and systems more like human skin – soft, bendable, and stretchable.

Why Does Form Factor Matter?

A wearable that conforms to your body is better in two crucial ways: It's less obtrusive for the user, and it allows for a more reliable measurement.

"Sensors and sensor systems a lot of times suffer from mechanical mismatch," says Alper Bozkurt, PhD, an electrical engineer, and Misra's colleague, at NC State and ASSIST. "If you have soft tissue that's moving around, but a rigid sensing device that's not moving around, your measurement may not be reliable."

That's because all that extra banging around between the device and your body shows up as "noise" – meaningless information that can distort the measurement and may lead to false conclusions.

Then there's the "human factor," Bozkurt notes – the issue of compliance.

"One of the challenges is, we design things in the lab, test everything, and bring it to our medical operators, and they raise their eyebrows and say, 'No, my patients are not going to wear this,'" Bozkurt says. "You cannot imagine a future for wearables without solving the compliance issue."

People want a device that's comfortable, doesn't stick out, and requires little interaction, Bozkurt says. "We call it wear-and-forget." You might compare this to wearing a Band-Aid – sure, you notice it occasionally, but mostly it fades into the background, without interfering with your daily tasks and without others even noticing it's there.

OK, So How Do You Make Electronics Soft and Stretchy?

One way is to take hard things used to monitor health – like silicon chips – and make them so thin they become flexible. Among the first to demonstrate this kind of material technology in skin-like wearable devices was John Rogers, PhD, in 2011, in a landmark Science paper titled Epidermal Electronics.

"We'd been pretty active in that field for a number of years," says Rogers, who at the time was at the University of Illinois and has since moved to Northwestern University. "But then we realized that even silicon – which most people think of as a very rigid, brittle rock-like material – can be made into forms and shapes, and at thicknesses that allow it to be bent and … even stretched."

Rogers, whose team has several applications in development, uses an etching technique to shave off the surface of a semiconductor wafer.

"It turns out all the action in those integrated circuits is happening on that very-near-surface layer," he says. "All of the silicon underneath is just serving as a mechanical support."

That critical layer is then embedded into an elastic polymer matrix, Rogers explains, allowing them to design fully functioning systems that can bend, twist, and stretch.

Still others use a different approach, building electronic parts from scratch out of materials that are inherently soft and stretchy – polymers. This is the kind of work Stanford chemical engineer Zhenan Bao, PhD, does, using a range of polymers with conducting properties.

More Wild Advances: Liquid Metals, Plasma Bonding, Chemical Sensors

Still other developments are continuing. Advancements in liquid metals allow for stretchable conductive wires. Textile-based, moisture-resistant antennas can transmit data while worn close to the skin. Methods like water vapor plasma bonding attach thin metals to soft polymers without losing flexibility or using high temperature and pressure that can damage super-thin electronics.

Sensors are improving too – that's the part that interacts with whatever you're trying to measure. Most commercial wearable sensors are mechanical (used to track physical activity) or optical (heartbeat, pulse oximetry). But chemical sensors are in development to measure internal markers in the body as well. These are critical in revealing the full picture of your health, says Joseph Wang, a doctor of science and professor of nanoengineering at the University of California, San Diego, who has published research on biosensors and wearable devices.

For example, a rise in lactate and drop in blood pressure can mean you have septic shock. Measuring potassium levels can give information about heart rate changes. And combining blood pressure and glucose measurements may reveal more about metabolic health than either one alone. "If you combine them, you get better evidence," Wang says.

This is where the new tech can get really geeky. Chemical sensors are made from some of the most exotic nano materials, including graphene, carbon nanotubes, and gold nanoparticles, Daniele says. Some (glucose sensors in particular) use enzymes that bind to target molecules. Others use aptamers, short single strands of DNA or RNA.

Chemical sensors typically work with body fluid such as sweat, saliva, tears, or – as is the case for continuous glucose monitors – interstitial fluid (the liquid between the cells in your body).

"Most of the things you want to measure in blood you'll be able to do in interstitial fluid if you have the sensor technology," says Jason Heikenfeld, PhD, a professor of electrical engineering at the University of Cincinnati. Just imagine having a full blood workup done by simply putting on a skin patch, no blood sample required.

Heikenfeld has also investigated sweat, which appears useful for measuring hormone levels (such as those that regulate stress, sex, and sleep) and prescription drug monitoring – that is, monitoring levels of a drug in the body and tracking how quickly it's metabolized, he says.

Sweat sensors may also find a place in at-home tests, Heikenfeld says. "If there was a people's choice award for bio fluids, sweat would win," he says. "We don't want to do blood, don't want to drool in a cup, don't want to mess with a urine stick. Tears, forget it. The test would be a simple patch you slap on your arm; collect some fluid, put it in an envelope, and mail it to a lab."

Wearable Power Sources: Beyond AA Batteries

This demand has prompted researchers from across the globe to develop batteries that can stretch and flex. To name just a few recent examples, Canadian researchers developed a flexible, washable battery that can stretch to double its original length and still function. In Singapore, scientists created a paper-thin biodegradable zinc battery that you can bend and twist and even cut with scissors – like any piece of paper – and it will still work. Still others are engineering batteries into long strips that can be used in smart clothing.

Misra is working on an energy generator that can convert the temperature difference between your skin and the room into energy to power a device. "You have a skin temperature of, say, 98.6 degrees," she says. "The temperature in your room is probably about 70 degrees

Fahrenheit. And that temperature difference of 28 degrees can be dropped across a device called a thermoelectric generator, which can convert that energy difference into power."

Patterns of Use and Key Predictors for the Use of Wearable Health Care Devices by US Adults: Insights from a National Survey

Published online in Journal of Medical Internet Research, 2020 Oct 16. doi: 10.2196/22443

Abstract

Background: Despite the growing popularity of wearable health care devices (from fitness trackes such as Fitbit to smartwatches such as Apple Watch and more sophisticated devices that can collect information on metrics such as blood pressure, glucose levels, and oxygen levels), we have a limited understanding about the actual use and key factors affecting the use of these devices by US adults.

Objective: The main objective of this study was to examine the use of wearable health care devices and the key predictors of wearable use by US adults.

Methods:Using a national survey of 4551 respondents, we examined the usage patterns of wearable health care devices (use of wearables, frequency of their use, and willingness to share health data from a wearable with a provider) and a set of predictors that pertain to personal demographics (age, gender, race, education, marital status, and household income), individual health (general health, presence of chronic conditions, weight perceptions, frequency of provider visits, and attitude towards exercise), and technology self-efficacy using logistic regression analysis.

Discussion

This study found wearable health care devices to be used by roughly 30% of US adults. Women, individuals with higher levels of household income, and those with higher levels of education were more likely to be wearable users. The tendency to use wearable devices seems to decline with age. US adults who consider themselves to be healthier are likely to use wearables. Other studies have also reported that healthier individuals have greater intention to adopt wearables [35]. Although individuals with chronic conditions or a higher number of provider visits have greater potential to benefit from wearables, this study did not find them to be actively using these devices. Individuals who enjoy exercise and fitness and those who are more comfortable using electronic devices exhibit a greater propensity to use wearable health care devices.

Our results indicate that only younger, healthier, wealthier, more educated, and technoliterate adults are more likely to use wearables. Younger adults are likely to be attracted to the design and aesthetic appeal of the wearable device [43], consider it “cool” [44], use it to signal their fitness intentions to peers, and also like the gamification elements such as rewards, points, and recognition of achievements awarded by the wearable devices and associated mobile apps [45-47]. Elderly adults could find wearables to be more intrusive and less comfortable [34]. Elderly adults may also not appreciate the design elements that are more geared towards younger users and would often need health professionals’ regular support and feedback to sustain the use of wearable devices [48]. Our findings imply that the design and gamification techniques in wearables that are primarily appealing to younger adults need to be customized to attract other strata of users [47]. Wearable device makers can enhance the marketability of their devices and broaden the reach of their products by coming up with devices tailored to different age groups. Our findings regarding wealthier and more educated adults to be active users of wearable technology is similar to those from other studies [37]. Educated adults are likely to be more familiar with the value they can derive from wearables. Also, given the high costs of some of the wearable devices in the market, the affordability might be better for high-income individuals [35].

Our results pertaining to the use of wearables by healthier or more health-conscious users are consistent with studies that point to the health-related motivations for using wearables such as to monitor physical activities,

improve fitness, and sustain general health [49]. Individuals who set health-related goals such as weight loss and increased physical activity are likely to find wearables to be useful to monitor their progress in achieving those goals. Studies have found individuals with wellness-oriented lifestyles to engage more in preventive health behaviors like exercising regularly, and these individuals are more likely to use wearables [43]. Among other health variables, we did not find any significant association between chronic conditions and use of wearable devices. Few studies examining the use of wearable health care devices among patients with chronic conditions have reported very limited impact of these devices on disease outcomes [4]. Perhaps, such lack of tangible value for specific health conditions might discourage adults from using these devices for chronic care management purposes.

Our findings regarding the importance of technology self-efficacy validate findings from several prior studies that have examined behavioral intentions to adopt wearables from a technology acceptance perspective [35,36,50]. Individuals' familiarity and experience with technologies such as smartphones, tablets, and other digital devices for health-related purposes would likely make them more open to using wearable health care devices. Higher technology self-efficacy can help individuals foster more positive attitudes towards smart wearables that can further augment use of these devices.

This study notes that wearable devices have not yet found widespread use among those groups that can benefit the most from them. Individuals with poor health, with chronic conditions, and who are aged can greatly benefit from tracking their physical activity and by letting their providers access the health data captured through wearables. Although our findings are consistent with other studies that have found fewer adopters of wearable devices among the senior population [51-53], they indicate a critical need to identify key barriers for low adoption of wearables among elderly US adults and work towards addressing those barriers. Factors like anxiety towards new technologies and resistance to change could impede adoption and use of wearables among elderly adults [54]. Our results have important implications for health care providers and wearable device manufacturers to educate individuals on the potential benefits of using wearables to improve health outcomes. Use cases and testimonials of wearable use by patients and elderly need to be actively publicized and promoted.

Our findings also indicate a digital divide in the US that only those with higher levels of education, household income, and technology proficiency are actively using these devices [55]. To increase patient use and engagement with digital technologies such as wearable devices, narrowing the digital divide becomes increasingly important. Making digital devices more affordable and easier to use can greatly aid in widening access to wearables and effectively using them to self-track and monitor health. This study also points to the importance of digital skills development to enable US adults to utilize wearables more effectively.

Global Wearable Medical Devices Market Report 2021-2022 & 2026 - Innovations in Medical Wearables Rushes on Full-Steam to Sustain Long-Term Growth in the Market

Dublin March 17, 2022 08:23 ET | Source: Global Newswire ***Research and Markets***

Global Wearable Medical Devices Market to Reach US$38.9 Billion by the Year 2026

The global market for Wearable Medical Devices estimated at US$18.1 Billion in the year 2021, is projected to reach a revised size of US$38.9 Billion by 2026, growing at a CAGR of 15.8% over the analysis period.

The numerous benefits of wearable electronics are contributing to their increasing use in an expanding range of applications in the areas of health & fitness, consumer, entertainment, medical and industrial sectors. Some of the most common types of electronics devices include smart watches, AR/VR glasses, head mounted computers, fitness trackers and smart clothing among others.

The medical wearables space is exploding and poised to support the healthcare system with new and compelling approaches to improve patient care while bringing down healthcare costs. These devices are enjoying extensive uptake among patients and medical professionals for catering to the patient population in real-time. Available as wearable sensors, patches, watches, footwear and devices, the medical wearable technology is exuding immense potential to change the entire healthcare landscape in a helpful manner.

Wearable sensors are significantly impacting medicine and healthcare by facilitating health monitoring in non-clinical settings and prediction of various conditions in time. Medical wearables hold critical relevance for a comprehensive spectrum of medical applications such as gastrointestinal, cardiovascular, and metabolic monitoring along with mental health, neurology, sleep and movement disorders. In addition to holding potential to transform pre- & neo-natal and maternal care, these devices are poised to support interventions related to pulmonary health and diabetes management.

The U.S. Market is Estimated at $6.6 Billion in 2021, While China is Forecast to Reach $4.1 Billion by 2026

Against the background of the concerted push towards personalized/precision medicines and healthcare, medical wearables are gaining increased attention, attracting interest from patients and healthcare professionals alike. The aspects of personalized healthcare, in terms of its participatory form and its data-centeredness, are combined in wearable sensors, self-tracking devices, and mobile apps for providing users with the ability of collecting, measuring, and displaying data related to any type of behavioral activity or bodily action.

Leading companies such as Apple and Fitbit are working aggressively on AI-powered devices that are poised to transform healthcare and improve patient experience. In addition, various players are exploiting AI and sophisticated algorithms built on deep learning for innovative use cases.

The combination of AI technology and medical wearables holds notable long-term potential to dramatically revolutionize the healthcare industry. Suunto Spartan, Polar OH1, Xiaomi Mi Band 2S, Google smart lenses,

iTBra, health patch MD, and Cloud DX vitaliti are some of the currently trending wearable medical and activity tracker devices.

Market trends & drivers

•Personalized Medicine Gets a Boost from the Rise of Medical Device Wearables

•Real-time, Personalized Medicine through Medical Wearable Becomes a Reality

•Emerging Role of Wearables in Precision Medicine

•Rising Healthcare Costs Drives Focus on Wearables for Their Ability to Reduce Cost of Healthcare

•Here's How Medical Wearables Can Reduce Healthcare Costs

•Rise in Chronic Diseases, Increase in Demand for Medical Services, the Need for Equity in Healthcare & the Ensuing Focus on Democratizing Healthcare to Benefit Medical Wearables

•COVID-19 Induced Consumer Engagement With Health & Wellbeing Technologies Drives Demand for Personal Health Monitoring & Fitness Wearables

•Global Diabetes Epidemic Provides Opportunities On a Platter for Medical Wearables

•Medical Wearables Brings the Promise of Revolutionizing the Effectiveness of Long-Term Diabetes Care & Treatment Outcomes

•Big Data Analytics Remains Vital for Shaping the Future of Wearable Technology & Realizing Complete Benefits of Medical Wearables

•Mining Healthcare Big Data Becomes Big Businesses & Wearable Medical Devices Will Add to this Data Boom

•Integrating Cloud With Medical Wearables, A Major Trend

•AI Emerges to Revolutionize Wearable Medical Devices

•Rapidly Aging World Population, COVID-19 Induced Re-Focus on Aging-In-Place & Rise in Demand for Remote Patient Monitoring to Benefit Growth of Medical Wearables

•Rapidly Aging Population & Escalation in Demand for Geriatric Healthcare Highlights the Need for Medical Emergency Wearables

•Expanding Opportunity for PERS Will Encourage Increased Use of Medical Wearables

•The Stage is Now Set for Remote Patient Monitoring

•Aging Population, Rise of PERS & Migration of Healthcare to Alternate Sites Drive the Need for Remote Patient Monitoring Wherein Wearables Play a Major Role

•Role of Wearables in Remote Patient Monitoring

•Integration of Wearables into Telemedicine Explodes Into a Major Trend

•Wearables Emerge Into the Spotlight as Telemedicine Gains Momentum

•Role of Wearables in Telemedicine

Novel Smartphone App Helps Reduce Fear of Cancer Recurrence

News > Medscape Medical News ***Roxanne Nelson, RN, BSN; November 14, 2022***

A novel "smartphone psychotherapy" application has been shown to relieve some of the anxiety and fear about cancer recurrence (FCR) that often causes distress to cancer survivors.

The intervention is comprised of smartphone problem-solving therapy and behavioral activation apps, and was tested in a study that involved 447 survivors of breast cancer. The results showed that the group of survivors who used the app had statistically greater improvements on a scale measuring fear of cancer recurrence as well as several measures of anxiety and depression at week 8 when compared with controls.

"To our knowledge, the present study is the first to demonstrate the efficacy of smartphone-based psychological therapies in reducing FCR among breast cancer survivors," the authors comment.

It also "demonstrated that the intervention had potential efficacy on depression and psychological needs among breast cancer survivors," they write.

"Given the large number of cancer survivors and the limited number of therapists to competently conduct appropriate psychotherapy, novel smartphone psychotherapy may be a promising way to reduce fear of cancer recurrence," they suggested.

The study was published online November 2 in the Journal of Clinical Oncology.

Commenting on the study, Erica L. Mayer, MD, MPH, director of clinical research at the Dana-Farber Cancer Institute, Boston, Massachusetts, noted that "the use of a novel 8-week cognitive behavioral therapy smartphone app significantly reduced measures of psychological distress, especially in those who expressed anxiety at baseline."

"These findings suggest expanded use of smartphone-based mental health support is feasible and effective and may be an efficient platform to provide mental health support to young breast cancer survivors," Mayer said in a statement.

So, the team developed a problem-solving therapy (PST) program as a smartphone app. Its acceptability and efficacy was demonstrated in a single-arm pilot study with breast cancer survivors (Jpn J Clin Oncol 2019; 49:537-544).

Building on those results, they now conducted a randomized trial to further examine the efficacy of smartphone-based PST and behavioral activation (BA) interventions in reducing fears of recurrence among breast cancer survivors.

For this trial, they randomly assigned disease-free breast cancer survivors between the ages of 20-49 years to the smartphone-based intervention (n = 223) or waitlist control (n = 224). Both groups received treatment as usual, and the control group could access the smartphone apps during weeks 8-24.

Primary outcome data at 8 weeks were obtained for 444 randomly assigned participants (99.7% of the total 447 participants). Among the 223 participants who received the intervention, 213 (95.5%) completed the follow-up assessment at week 24.

The top medical monitoring and healthcare wearable device trends of 2022

INSIDER INTELLIGENCE -Alexandra Samet, February 03, 2022

Powerful data and analysis on nearly every digital topic

- Wearable technology incentivizes behavior that reduces hospital visits and readmissions due to poorly managed personal health—75% of users agree that wearables help them keep track of their health.
- Healthier corporate culture is shown to reduce employee turnover—employers who

offer five or more well-being 'best practices' had an average turnover of 18%, compared to 29% for those that offer two or fewer.

When consumers started spending more time at home during the pandemic, many started using wearable devices as a means to monitor their health and seek medical treatment.

According to Insider Intelligence, US consumers' use of wearables increased from 9% to 33% in just four years.

Here are some key digital health stats to know:

Wearable Fitness Trackers

The first forms of wearable fitness trackers were wristbands equipped with sensors to track a user's physical activity and heart rate. Some of the earliest models, such as the FitBit Flex, were favored for their sleek look, their ability to track steps with five indicator lights, and their capacity to sync with a number of smartphone apps.

Fast forward a few years and more wearable fitness trackers have entered the market, thanks in large part to big tech players entering the space. According to IDC, Apple shipped 34.1% of wearables worldwide in 2020, far ahead of Samsung (9%) and Fitbit (2.9%).

Fitness trackers and smartwatches are the most popular among US wearable device owners

Wearable Device Shipments Worldwide, by Brand, 2019 & 2020

millions, % of total, and % change

	2019		2020		
	Shipments	% of total	Shipments	% of total	% change
Apple	111.5	32.2%	151.4	34.1%	35.9%
Xiaomi	41.7	12.0%	50.7	11.4%	21.7%
Huawei	28.9	8.3%	43.5	9.8%	50.7%
Samsung	31.4	9.1%	40.0	9.0%	27.3%
Fitbit	15.9	4.6%	12.9	2.9%	-18.8%
Other	117.1	33.8%	146.1	32.9%	24.7%
Total	**346.4**	**100.0%**	**444.7**	**100.0%**	**28.4%**

Note: numbers may not add up to total due to rounding
Source: International Data Corporation (IDC), "Worldwide Quarterly Wearable Device Tracker" as cited in press release, March 15, 2021

Smart Health Watches

While smart health watches were first known for more simple fitness uses like counting daily steps, recent advancements have made them more viable healthcare tools. The Apple Heart Study app gained popularity in 2017 for its capacity to monitor heart rhythm and alert users if they experience atrial fibrillation.

Apple's Series 7 model released in 2021 came packed with a blood oxygen saturation monitor, native sleep-tracking capabilities, a faster FDA-approved electrocardiogram (ECG) sensor, upgraded heart health monitoring, and fall detection that will automatically call 911 if it detects the wearer is not moving.

According to Insider Intelligence's Smartwatch Users forecast shown below, the number of US smartwatch users grew from 42 million to 45.2 million users from 2020 to 2021, and this is expected to continue to grow to 51.9 million smartwatch users by 2024.

"There will be 51.9 million smartwatch users in the US by 2024."

Wearable Blood Pressure Monitors

According to a February 2021 poll conducted by the COVID-19 Healthcare Coalition, the highest percentage of telehealth users are interested in monitoring chronic conditions, including high blood pressure. As wearables become more widely used for healthcare, blood pressure monitoring will become an even more sought after feature.

It's estimated that one in four men and one in five women around the world have high blood pressure, or hypertension, which can put them at a higher risk of a heart attack or stroke. Hypertension is usually detected through the use of a blood pressure cuff with pressure sensors that measure the strength it takes the blood to push on one's arteries as it is pumped around the body.

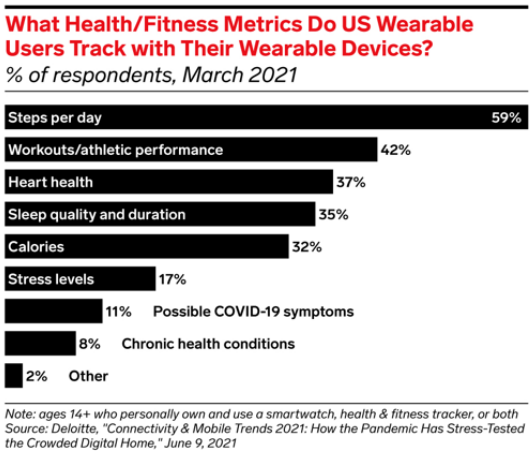
However, medical personnel don't always have the time or ability to monitor blood pressure over multiple readings. There are also a number of conditions that cause a person's blood pressure to elevate and produce inaccurate readings. New wearable blood pressure monitors help to fill this gap, by allowing users to measure their blood pressure over longer periods and in different conditions, and to share this data with their physician.

Omron healthcare launched Heart Guide in 2019—the first wearable oscillometric blood pressure monitor. What makes this particular monitor stand out is that it can measure blood pressure as it tracks daily activities like steps, distance, and calories burned. This allows users to determine how their habits are impacting their blood sugar.

Wearable ECG Monitors

Wearable ECG monitors use flashing LEDs to penetrate the skin, capture the flow of blood through sensors, and produce heart rate data. ECG monitoring first became popular through the Apple Watch, and is now used on other smartwatches such as the Samsung Galaxy Watch 3 and the Fitbit Sense health watch.

What's more, the Withings Move ECG smartwatch launched in 2019, making it simple for users to keep up with heart health and send data from ECG readings directly to their doctor. As insurers and companies start to see the positive impact of this technology on the health of consumers and the profitability of brands, the future of these types of wearables looks promising.



RESOURCES

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Personal Information

Registration Number	
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SAPC Profile Login Details

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ID number	
Password	

Please remember to complete your "Annual Declaration" on your SAPC profile before sending in this template.

Your username and password will not be shared with anyone other than the Focus on Health personnel. If you do not want to provide us with your login details, we will not be able to submit your CPD activities online on your behalf.

STEP 1: REFLECTION

Title of the article or activity **G1(23) Wearable tech in Healthcare Part 3**

A. Domain and domain competency

Please tick only ONE domain and only ONE domain competency listed underneath.

☒	Public health	☐	Promotion of health and wellness
		☐	Medicines information
		☐	Professional and health advocacy
		☐	Health economics
		☐	Epidemic and disaster management
		☐	Primary healthcare
☐	Safe and rational use of medicines and medical devices	☐	Patient consultation
		☐	Patient counselling
		☐	Patient medicine review and management
		☐	Medicines and medical devices safety
		☐	Therapeutic outcome monitoring
		☐	Pharmacist initiated therapy
		☐	Pharmacovigilance
		☐	Clinical trials
☐	Supply of medicines and medical devices	☐	Medicine production according to GxP
		☐	Supply chain management
		☐	Formulary development
		☐	Medicine dispensing
		☐	Medicine compounding
		☐	Medicine disposal/destruction
☐	Organisation and management skills	☐	Human resources management
		☐	Financial management
		☐	Pharmaceutical infrastructure management
		☐	Quality assurance
		☐	Change management
		☐	Policy development
☐	Professional and personal practice	☐	Patient-centred care
		☐	Professional practice
		☐	Ethical and legal practice
		☐	Continuing professional development
		☐	Leadership
		☐	Decision-making
		☐	Collaborative practice
		☐	Self-management
		☐	Communications
☐	Education, research and critical analysis	☐	Education and training policy
		☐	Provision of education and training
		☐	Practice embedded education or workplace education
		☐	Gap analysis
		☐	Critical analysis
		☐	Research
		☐	Supervision of other researchers
		☐	Collaborative research

Learning trigger

Please tick only one box

- ☐ Appraisals
- ☐ Audit
- ☐ Competencies
- ☐ Critical incidents
- ☐ Feedback from colleagues
- ☐ Feedback from service users
- ☐ Personal interest
- ☐ Reading journals
- ☐ Talking to colleagues
- ☐ Other – Please specify:

Learning is related to

Please tick only one box

- ☐ Current role
- ☐ New role
- ☐ Both

Learning initiated by

Please tick only one box

- ☐ Top down (employer or contracting information)
- ☐ Bottom down (users of my products and services)
- ☐ Lateral (colleagues / peers)
- ☐ Myself

*In the next part you will need to describe what you need to learn about, in this case **The Future of wearables.** This section specifically addresses the ethical challenges with smartwatch-based screening for atrial fibrillation. You may hope to learn more about this topic so that you can advise your patients when they have questions.*

For example:

With the ever-growing market of wearables, pharmacists should develop the skills to evaluate different devices and applications.

I want to learn how wearables are compatibility with existing healthcare systems.

Describe the learning need that you have identified to improve your knowledge and skill, and what you hope to achieve after addressing this learning need?

Max 1000 characters

STEP 2: LEARNING PLAN

Start Date (The date on which you started your learning activity): ____ /____ /_____

End Date (The date you intend completing your learning): ____ /____ /_____

Mode of learning and primary activity

If you are completing the Focus on Health activities, you may tick Non-measurable and Self-study.

☐	Non-Measurable	☐	Self-study
		☐	Casual reading of professional journal or magazine
		☐	Events presented by an accredited organisation or individual, whereby a certificate of attendance was issued
		☐	Breakfast meetings, presentations or journal club
		☐	Case study discussion
		☐	On-the-job learning
		☐	Conferences, symposia, refresher courses, short courses without a measurable outcome
		☐	Other – Please specify:

In the next part you will need to briefly describe what you are going to do to achieve your learning need. ***How you are going to do it*** *(in this case you plan to read through the article and make notes on the important points) and* ***why you are going to do things this way*** *(perhaps you prefer self-study because your schedule allows it or you like reading through journals due to their factuality).*

For example:

I will conduct research to gather information about the different types of wearable devices, their functionalities, and their applications in healthcare. This research will involve studying reputable online sources.

I will connect with other healthcare professionals who have knowledge and experience in the field of wearable devices. Whenever possible, I will seek practical experiences with wearable devices to gain first-hand knowledge.

Briefly describe the reasoning behind your planning selections.
Max 1000 characters

STEP 3: IMPLEMENT

In the next part you will need to describe what actions you have taken to achieve your learning outcome, i.e., what, when, where and how did you implement your plan to learn more.

If you have completed the multiple-choice questionnaire you may also mention this here, as it is part of the actions you have taken to learn more.

Duration of the activity
Please tick only one box

- ☐ < 30mins
- ☐ 30 to 60 mins
- ☐ 60 to 90 mins
- ☐ 90 to 120 mins
- ☐ > 120 mins

Achievement date
The date on which you completed your learning/reading

____ /____ /_____

If you want, you can also complete our multiple-choice questionnaire. This will add as part of the actions you have taken to achieve your learning outcomes. Your answers can be written down in the table provide below.

Describe what you have done, that is, the action taken to achieve the specific outcome.
Max 1000 characters

Answer sheet for multiple choice questionnaire

G1(23) Wearable tech in Healthcare Part 3

(The questionnaire is on last page of this document)

PART 3											
	A	B	C	D	E		A	B	C	D	E
1						11					
2						12					
3						13					
4						14					
5						15					
6											
7											
8											
9											
10											

STEP 4: EVALUATION

For the last step you will evaluate whether you have achieved your learning outcome and where you have applied this learning. You will also need to give an example of how you have applied this learning.

If you feel that your learning need was fully met, you may mention what you plan to do next (for example, educate colleagues on this topic).

If your learning need was not met or only partially met you may mention what actions you plan to take to achieve your learning need. For example, you may use the internet to search for more articles on this topic.

Learning objective met

Please tick only one box

- ☐ Fully
- ☐ Partially
- ☐ Not met

Applied the learning

Please tick only one box

- ☐ In my workplace
- ☐ Not yet
- ☐ Outside my workplace

Describe by providing examples, how you have applied what you have learned, including feedback on the impact of your learning and possible next steps if the learning objective was fully met. If the learning objective was only partially met or not met at all, please provide a reason.

Max 1000 characters

ONCE YOU HAVE COMPLETED THIS DOCUMENT, EMAIL IT TO INFO@FOH-CPD.CO.ZA.

END

QUESTIONNAIRE
G1(23) Part 3 of 3
Wearable tech in healthcare

INSTRUCTIONS

- Read through the article and answer the multiple-choice questions provided below.
- **Some questions may have more than one correct answer,** in which case you must mark **all** the correct answers.

OUR WEARABLE FUTURE, PART 1: WHAT WILL NEW TECH LOOK LIKE?

Question 1: Which of the following is arguably the greatest success to date with regard to wearables?

- **A:** Smartwatches diagnosing atrial fibrillation
- **B:** Being able to diagnose COVID-19 before symptoms occur
- **C:** The continuous glucose monitor

Question 2: A wearable could – through interstitial fluid or sweat – monitor which of the following?

- **A:** Cortisol levels: tracking whether a patient's stress levels are getting better or worse
- **B:** Drug adherence
- **C:** Drug metabolism
- **D:** Acidity of the GI tract

Question 3: Your psychologist "know-it-all" friend says wearables won't play any role in his field, because "it is just too complex". What will you tell him?

- **A:** Certain mental conditions could become more easily treatable
- **B:** This will be done through a brain patch measuring the release of feel-good hormones
- **C:** There is an increased interest in measuring stress hormones like cortisol through, for instance, sweat or interstitial fluid

OUR WEARABLE FUTURE, PART 2: WHAT WILL NEW TECH LOOK LIKE?

Question 4: Is it **TRUE** that a growing school of thought says wearables will drastically improve health care – providing a vehicle for continuous, long-term monitoring to predict adverse events and closely track disease?

- **A:** YES
- **B:** NO

Question 5: Chemical sensors are in development to measure internal markers in the body, for instance ……..?

- **A:** Combining blood pressure and glucose measurements which may reveal more about metabolic health than either one alone
- **B:** A rise in lactate levels and a drop in blood pressure can mean septic shock
- **C:** Measuring potassium levels can give information about heart rate changes
- **D:** Vaginal foreign bodies.

Question 6: Developments about wearable power sources include which of the following?

- **A:** Canadian researchers developed a flexible battery that can stretch to double its original length
- **B:** In Singapore, scientists created a paper-thin biodegradable zinc battery
- **C:** Misra is working on an energy generator that can convert the temperature difference between your skin and the room into energy to power a device
- **D:** Work is being done to convert excess energy generated by the brain to power wearables

PATTERNS OF USE AND KEY PREDICTORS FOR THE USE OF WEARABLE HEALTHCARE DEVICES

Question 7: Your practice manager, during a planning session, says the practice must immediately gear itself to accept the challenges and opportunities that wearables offer as "everybody will soon be donning it". You don't agree with her statement and quote data from a US survey which shows……?

- **A:** Men were more likely to be wearable users
- **B:** Use increased with age
- **C:** Adults that consider them to be "unhealthy" are more likely to use wearables
- **D:** Those more comfortable using electronic devices were more likely to use wearables

Question 8: A study using a national sample of 4 551 respondents in the US, found which of the following?

- **A:** Wearable devices were used by roughly 65% of adults
- **B:** Adults who considered themselves to be healthy were less likely to wear such devices
- **C:** While people with chronic conditions have greater potential to benefit from them, they were not actively using such devices
- **D:** Younger, healthier, wealthier, more educated, and techno-literate adults were more likely to use wearables

GLOBAL WEARABLE MEDICAL DEVICES MARKET REPORT 2021 – 2022

Question 9: As head of a pharmaceutical company specializing in the generics market, you investigate market trends and drivers. Which of the following did you find to be relevant to your company?

- **A:** Real-time, personalized medicine is becoming a reality
- **B:** A rise in chronic diseases increase the demand for wearables
- **C:** Wearables bring the promise of revolutionizing the effectiveness of long-term diabetes care
- **D:** None of the above

Question 10: Is it **TRUE** that mining healthcare big data is becoming big business and wearable medical devices will add to this data boom?

- **A:** YES
- **B:** NO

NOVEL SMARTPHONE APP HELPS REDUCE FEAR OF CANCER RECURRENCE

Question 11: A novel "smartphone psychotherapy" application ……..?

- **A:** Has been tested in a study involving 447 survivors of breast cancer
- **B:** Is the most recent of a multitude of smartphone-based psychological therapies to demonstrate efficacy in reducing FCR among breast cancer survivors
- **C:** Has demonstrable efficacy in treating depression
- **D:** All the above

THE TOP MEDICAL MONITORING AND HEALTHCARE WEARABLE DEVICE TRENDS OF 2022

Question 12: Apple's Series 7 released in 2021 came with which of the following?

- **A:** A faster electrocardiogram sensor (non-FDA approved)
- **B:** Fall detection
- **C:** Blood oxygen saturation monitor
- **D:** An adrenaline injector in case of an anaphylactic reaction

Question 13: The number of smartwatch users in the US is expected to grow to …… by 2024?

- **A:** 30.5 million
- **B:** 45 million
- **C:** 51.9 million
- **D:** 110 million

Question 14: According to a February 2021 poll conducted by the COVID-19 Healthcare coalition, the highest percentage of telehealth users were interested in monitoring which of the following?

- **A:** How daily habits impact blood sugar
- **B:** Blood oxygen saturation
- **C:** Chronic conditions
- **D:** Daily activity in terms of steps taken, active calories burned, exercise intensity

Question 15: Is it **TRUE** that Omron healthcare launched the first wearable oscillometric blood pressure monitor in 2019?

- **A:** YES
- **B:** NO

THE END