



INNOVATIONS

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Health Wearables



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Table of Contents

Health Wearables - History, trends and areas of application	1
Current main trends in the health care sector	4
• Healthcare Wearables for remote patient control	
• Healthcare Wearables for infection control	
• Healthcare Wearables with integrated artificial intelligence	
Gamechanger (national / international)	5
Interview	9
• Dr. Johannes Kreuzer (CEO of Cosinuss GmbH) talks about In-Ear sensors, the current market and the future potential in this field of innovation	
Deep Dive	13
• Foil sensor technology	
• Molecular cell technology - biosensors	
• Fluorescence sensor technology	
• Sensor-integrated textiles / Neurofabric technology	
Challenges & Prospects	17
Market insights	18
ABOUT arcoro	23



Health wearables - history, trends and areas of application

Wearable computing devices are mobile, portable data processing systems that establish an interaction between the user and the integrated IT system. The devices, which are worn directly on or in the body, capture, store and analyse information that is available to the user directly via the device or via an associated app. The healthcare sector is one of many areas in which wearables are being integrated into everyday life. The so-called healthcare wearables are used in prevention, diagnostics, medication and long-term monitoring of chronic diseases or acute conditions. It serves to give users more personal responsibility and to record vital parameters in an uncomplicated and continuous way, which serves to maintain good health in everyday life.

Let's take a little journey into the history of wearable computing. The trend, or rather its original form, was first initiated in 1966 by Ed Thorp and Claude Shannon, who developed a device that gave the user hints on the optimal time to play the ball in a roulette game. The origin of the head-mounted display also dates back to 1966. The first healthcare wearables as we know them today date back to the early 21st century and have been continuously developing in their technologies and areas of application ever since. They are not only becoming more powerful and smaller, but also more intelligent and accurate in data acquisition and processing.

In recent years, wearable devices have conquered the market at a rapid pace. In 2014, around 28.8 devices were used globally. In 2019, 346 million wearables were already in circulation, and sales of 527 million wearables are expected in 2024. Medical personnel also see great potential in smart devices: on the one hand, costs in the healthcare system can be reduced and medical staff can be relieved. On the other hand, patients can monitor their values themselves through permanent tracking and, if necessary, have them transmitted to medical institutions and evaluated, which means that care and treatments can be more flexible and data-based.

The use of healthcare wearables is also becoming increasingly popular in the workplace. Already 35% of employers provide their employees with access to various wellness, sports and mental health programmes through the use of wearables, which are intended to contribute to better health. More than 1/3 of the population owns at least one device that records and analyses vital data in everyday life. Although 76% of Germans consider the data security of wearables when buying them, in addition to a good price-performance ratio, the willingness to share the collected data and information with their family doctor or medical institutions (63%) and health insurance companies (26%) is high.



Healthcare wearables can be divided into the following categories and areas of application:

CATEGORY	WEARABLE DEVICE	FUNCTION
Activity tracking	<ul style="list-style-type: none"> • Smart Health Watches • Smart contact lenses 	<ul style="list-style-type: none"> • Vital signs measurement
Therapy	<ul style="list-style-type: none"> • Smart Patches • Smart pacemakers • Smart hearing aids • Airway monitoring • Posture correction • Diabetes care systems 	<ul style="list-style-type: none"> • Medication and wound care • Heart rate control • Posture improvement • Measurement of the blood glucose level
Diagnostics & Health Monitoring	<ul style="list-style-type: none"> • ECG / Heart rate monitor • Blood pressure monitors • Wearable glasses • Smart clothing • Sleep analysis devices • Pulse oximeter • Blood glucose meters • Biosensors • Wearable Neuromonitoring devices 	<ul style="list-style-type: none"> • Measurement of the heart functions • Measurement of blood pressure • Simulation and operation assistance • Measurement of vital parameters • Analysis of sleep behaviour • Measurement of the pulse • Measurement of the blood glucose level • Multiparametric measurements e.g. glucose, lactate, glutamate or glutamine • Measurement of mental & neurological values



Current main trends in the health sector are:

1) Healthcare wearables for remote patient control

The use of wearables as a treatment strategy has become increasingly important in the last two years. Doctors and hospitals are able to conduct medical examinations over longer periods of time without increasing the number of inpatients. Long-term therapies contribute to contactless, sustainable data collection and analysis and help medical staff to develop individual, patient-tailored treatment strategies and to find out the causes of abnormalities more quickly. Thus, medical care can be optimised and advanced for doctors and patients. Long-term monitoring with health wearables also makes it possible to quickly and easily record a large amount of data in clinical studies and thus accelerate approval processes.

2) Healthcare wearables for infection control

The use of wearables in general supports contact traceability during the pandemic. In 2020, numerous healthcare wearables and updates were developed and implemented that measure the body temperature of users in addition to various vital signs by integrating thermometers. This enables early detection of physical changes that may indicate infection with the Sars virus. By continuously recording and analysing vital data, transmission chains can be interrupted at an early stage, infected persons can be isolated and contact persons can be warned.

3) Healthcare wearables with integrated artificial intelligence

The health data generated by wearables still requires the support of medical professionals in order to correctly identify illnesses and seek optimal treatments. Due to the rapid increase in the use of healthcare wearables and the simultaneous decrease in the number of medical professionals, it is often difficult to process the amount of data. Therefore, wearables should recognise different patterns by means of algorithms in the future. This is favoured by increasing digitalisation, so that wearables can already carry out assessments and link information independently. The acceptance and willingness of users to use AI diagnostics through wearables is also high according to surveys, but it is no substitute for a personal visit at the doctor. Nevertheless, artificial intelligence in combination with healthcare wearables opens up the option to change and optimise healthcare from reactive to proactive.

Experts and statistics predict that health care wearables and medical apps will continue to grow in the future. Diagnostics and treatments will be modernised and changed by digital consultations in the context of telemedicine. The new system offers both patients, medical professionals and other stakeholders in the health sector new perspectives and methods for maintaining and improving overall health.



Gamechanger

COMPANY	AREA OF APPLICATION	WEBSITE
Abbott Laboratories	<ul style="list-style-type: none"> Blood glucose monitoring 	https://www.abbott.com/
Biotronik SE & Co. KG	<ul style="list-style-type: none"> Heart monitoring 	https://www.biotronik.com/de-de
Roche Diagnostics	<ul style="list-style-type: none"> Digital biomarkers (cancer diagnostics)/ blood glucose monitoring 	https://www.roche.de/
Drägerwerk AG & Co. KGaA	<ul style="list-style-type: none"> Breathing monitoring 	https://www.draeger.com/de_de
Cortronik	<ul style="list-style-type: none"> vascular implants (stents) 	https://www.cortronik.com/de
Bosch Healthcare Solutions GmbH	<ul style="list-style-type: none"> Breath analysis 	https://www.bosch-healthcare.com/
Zimmer Biomet	<ul style="list-style-type: none"> orthopaedic implants 	https://www.zimmerbiomet.eu/
Ottobock	<ul style="list-style-type: none"> Wearable Human Bionics 	https://www.ottobock.de/
iRhythm	<ul style="list-style-type: none"> Heart monitoring 	https://www.irhythmtech.com/
Huawei Technologies Co	<ul style="list-style-type: none"> Vital signs measurement 	https://www.huawei.com/de/
Cosinuss GmbH	<ul style="list-style-type: none"> Vital signs measurement 	https://www.cosinuss.com/de/
Apple Inc	<ul style="list-style-type: none"> Vital signs measurement 	https://www.apple.com/de/
FitBit Inc	<ul style="list-style-type: none"> Vital signs measurement 	https://www.fitbit.com/global/de
Garmin Ltd	<ul style="list-style-type: none"> Vital signs measurement 	https://www.garmin.com/de-DE/
Ascensia Diabetes Care	<ul style="list-style-type: none"> Blood glucose monitoring 	https://www.diabetes.ascensia.de/eversense/eversense-overview/
Cochlear Ltd	<ul style="list-style-type: none"> implantable hearing aids 	https://www.cochlear.com/de/de/
Dexcom	<ul style="list-style-type: none"> Blood glucose monitoring 	https://www.dexcom.com/de-DE
Insulet Corporation	<ul style="list-style-type: none"> Blood glucose monitoring 	https://www.insulet.com/
Medtronic	<ul style="list-style-type: none"> Implantable Cardiac Defibrillator 	https://www.medtronic.com/de-de/
MC10	<ul style="list-style-type: none"> BioStamp 	https://www.mc10inc.com/
Cala Health	<ul style="list-style-type: none"> tremor treatment 	https://calahhealth.com/
Zoll Medical Corporation	<ul style="list-style-type: none"> Defibrillator Vest 	https://www.zoll.com/de/profil
Protxx Inc	<ul style="list-style-type: none"> Neurological devices 	https://protxx.com/
AliveCor Ltd	<ul style="list-style-type: none"> ECG measurement 	https://www.alivecor.de/
BioTelemetry	<ul style="list-style-type: none"> Heart monitoring 	https://www.gobio.com/
Gentag Inc	<ul style="list-style-type: none"> Vital parameter measurement & medication 	https://gentag.com/
Senseonics	<ul style="list-style-type: none"> Smart Diabetes Device 	https://www.senseonics.com/
VivaLNK Inc	<ul style="list-style-type: none"> Sensors 	https://www.vivalink.com/
Siren Care Inc	<ul style="list-style-type: none"> Diabetes socks 	https://siren.care/
Omron Corporation	<ul style="list-style-type: none"> Blood pressure monitors 	https://www.omron-healthcare.de/de/
Boston Scientific Corporation	<ul style="list-style-type: none"> Heart monitoring 	https://www.bostonscientific.com
LG Electronics	<ul style="list-style-type: none"> Airpurifier 	https://www.lg.com/de
Vital Connect	<ul style="list-style-type: none"> Heart monitoring 	https://vitalconnect.com/
Preventice Solutions Inc	<ul style="list-style-type: none"> Heart monitoring 	https://www.preventicesolutions.com/healthcare-professionals
Biotricity Inc	<ul style="list-style-type: none"> ECG Monitoring 	https://www.biotricity.com/
ten3T healthcare	<ul style="list-style-type: none"> Heart monitoring 	https://ten3thealth.com/
Breazy Health GmbH	<ul style="list-style-type: none"> Asthma medical device 	https://breazy-health.com/
Vibrosonic	<ul style="list-style-type: none"> implantable hearing aids 	https://vibrosonic.de/
Ohrwerk GmbH - Lyric	<ul style="list-style-type: none"> implantable hearing aids 	https://www.ohrwerk-gmbh.info/
MOIO GmbH	<ul style="list-style-type: none"> Fall detection/ care assistance 	https://moio.care/



In the following, we would like to introduce you to some of the companies on the list. The selected companies are international big players in medical technology and each specialises in different medical fields. Years of experience, extensive expertise, visionary innovative ideas as well as the willingness to take risks and the desire to sustainably and continuously improve the healthcare system are what drive these companies. We would be happy to establish contact between you and the company.

ABBOTT LABORATORIES



Abbott

Founding year: 1888

Location: Chicago, Illinois (USA)

CEO: Robert Ford

Number of employees (worldwide): > 5000

Revenue: 34,61 Mrd USD

Medical speciality (Wearables): Diabetology

Product: FreeStyle Libre

BIOTRONIK SE & CO. KG



Founding year: 1963

Location: Berlin, Germany

CEO: Dr. Lothar Krings

Number of employees (worldwide): > 5000

Revenue: 694,6 Mio Euro

Medical speciality (Wearables): Cardiology

Product: Biomonitor (implantable event recorder), Biotronik Home Monitoring

DRÄGERWERK AG & CO. KGAA



Founding year: 1889

Location: Lübeck, Germany

CEO: Stefan Dräger

Number of employees (worldwide): > 5000

Revenue: 2,78 Mrd Euro

Medical speciality (Wearables): Pulmonology

Product: Dreamguard



OTTOBOCK HEALTHCARE DEUTSCHLAND GMBH



Founding year: 1919
 Location: Berlin, Germany
 CEO: Hans Georg Näder
 Number of employees (worldwide): > 5000
 Revenue: 1,003 Mrd Euro
 Medical speciality (Wearables): Orthopaedics
 Product: Myoplus

COCHLEAR LTD



Founding year: 1981
 Location: Sydney, Australia
 CEO: Dr. Lothar Krings
 Number of employees (worldwide): <1000
 Revenue: 1,24 Mrd AUD
 Medical speciality (Wearables): Oto-Rhino-Laryngology
 Product: Nucleus

ABBOTT LABORATORIES



Founding year: 2013
 Location: Burlingame, California (USA)
 CEO: Renee Ryan
 Number of employees (worldwide): <1000
 Revenue: 16,8 Mio USD
 Medical speciality (Wearables): Neurologie
 Product: Cala Trio

KONINKLIJKE PHILIPS N.V



Founding year: 1891
 Location: Amsterdam, Netherlands
 CEO: Frans van Houten
 Number of employees (worldwide): > 5000
 Revenue: 19,54 Mrd Euro
 Medical speciality (Wearables): Vital sign measurement
 Product: Biosensor BX100

**MINDPAX S.R.O.**

Mindpax.me

Founding year: 2015

Location: Prague, Czech

CEO: Pavel Nevický

Number of employees (worldwide): <1000

Revenue: > 1 Mio €

Medical speciality (Wearables): Neurology

Product: Mindpax Wristband

LG ELECTRONICS**LG Electronics**

Founding year: 1958

Location: Seoul, South Korea

CEO: Kwon Bong-Seok

Number of employees (worldwide): > 5000

Revenue: 55 Mrd USD

Medical speciality (Wearables): Vital sign measurement

Product: LG PuriCare

ZOLL MEDICAL CORPORATION

Founding year: 1980

Location: Chelmsford, Massachusetts (USA)

CEO: Jonathan A. Rennert

Number of employees (worldwide): > 5000

Revenue: 398 Mio USD

Medical speciality (Wearables): Cardiology

Product: ZOLL LifeVest



Interview

With the intention of gaining deeper and more personal insights into what is happening in the industry, we have made it our task to exchange views with industry experts in order to find out their perspectives and thoughts on key innovations in medical technology and to explore the background. For the launch of the first arcoro innovations, we were able to win Dr. Johannes Kreuzer for an interview. Learn more about healthcare wearables on the following pages - especially about in-ear vital sign measurements, future prospects and challenges of the industry.



Name: Dr. Johannes Kreuzer

Company: Cosinuss GmbH

Field of expertise: HealthCare Wearables

Job position: CEO

Part of the company since: 2011

According to our research, you operate in a very specialized market that is not heavily penetrated by competitors. Can you tell us how you position yourself in terms of innovation and how you perceive yourself doing so?

JK: We are the world leader with in-ear measurement, but there are only very few companies that measure equally. There are, or were, many companies that measured at the ear, but have moved away from that method. No other part of the body offers so many medical advantages for measuring vital parameters. The measurement is very accurate and easy to use because all you have to do is put the product in your ear. It is possible to collect data over a short or a long period of time. The challenge, however, is the sensitivity of the ear canal.

What vital signs can you cover with in-ear measurement?

JK: There are a total of five vital signs, four of which we can already measure reliably and non invasively: core body temperature, heart rate, oxygen saturation and respiratory rate. We are still working on the fifth parameter, blood pressure, and are currently conducting two studies on this. We are convinced that this can also be done reliably and accurately in the ear canal. However, this must first be validated, especially in the medical sector but the initial study results look very good. The next step will be to test it on a larger group of test subjects. We use all the parameters known from home health and all of them can be measured and transmitted with a small device. The ease of use and accuracy is the building block of our technology and the whole company. We focus on the meaningfulness, validity and accuracy of the data and that it is properly evaluated by physicians or other professionals. It should also be noted that the preparation of the data focuses on different aspects depending on the user.



Why do you think there are few competitors and how do you protect yourself to maintain your innovation curve and place on the market?

JK: Back when I was writing my doctoral thesis, my professor suggested to address the topic of continuous temperature measurement. I was an electrical engineer at the time and thought to myself „continuous fever thermometer - how boring!“. But then I realized why he chose it, because there was no one else on the market researching on it and I still can't tell you why there are hardly any other competitors. There were many that measured at the ear and most of them failed because the validity of the data was not good enough. The advantages of our ear measurement technology are that we can rely on the validity and accuracy of our data. We are not primarily competing in the consumer market, where a 100% accuracy of data is not necessarily required, but refer to medicine where expectancies rise above inaccurate assessments of the situation. This is where we see our reason for existence, because our device measures accurately. In addition, we maintain our innovative edge by being in permanent exchange with users. We don't just develop, we develop based on a need and continuously optimize based on feedback, suggestions and requests from users. We are very happy about our cooperations, which are more like friendly partnerships to get regular and constructive feedback.

What is the biggest threat you see regarding your technology? It doesn't seem to be a lack of use cases or a lack of acceptance in medicine which means that the pressure has to come from somewhere else, doesn't it?

JK: In Germany, we face the problem that the medical field is very conservative and thus represents a big challenge. If you compare the Nordics or the Benelux countries, they are much more progressive. The USA works quite differently again. Technologically, we are not afraid because we have a big advantage and innovative progress through measurement in the ear canal. Our patents, which we applied for at a very early stage, protect us and give us a good amount of security. That's the logic behind it, because we want to continue to have a say in the market in the future. We see a lot of potential in our products, because we can measure everything reliably and accurately in one, and that is ultimately our USP. It is difficult to achieve this on other parts of the body, such as the wrist, yet hardly anyone dares to measure in the ear.

What do you think is the product of the future? What is your point of view on data, the integration of artificial intelligence as well as data analytics?

JK: There are enough companies that don't care where the data comes from. They just throw it all together and create their own truth with it. But anyone who knows a little bit about neural truth and AI knows that it can't work that way. We definitely aim for evaluations with machine learning or patented algorithms and are already exploring this in various collaborations - even if it is still in the very early stages. But you can only focus on the evaluation if the basis, namely the data collection, works exactly. Here again, we see an advantage, since we can cover the entire chain from data collection, data connection and storage to data evaluation. Our product is not a party device, but a medical product that delivers high quality and traceable data.



Do you see your product through the validity of vital signs combined with Machine Learning able to also perform a wide range of derived analysis? You could draw broader scaled data pictures due to your very valid vital signs data. Is that a path you want to take?

JK: Definitely. At the moment, we are constantly getting requests for exactly that. Especially in the context of early warning scores and the polyscore, for which we can provide all relevant parameters. With valid data, it is possible to derive further treatments and perhaps also make prognoses. Among other things, we are currently conducting two studies in epilepsy treatment and hope to be able to detect or even predict seizures at an early stage. We are still in the very early stages of research, but with good, valid data, this is possible!

Where do you see your company in 5 years? They could enter different existing medical fields through their collaborations. What local approach are you currently pursuing?

JK: Our focus is currently on Europe, but we also have sufficient inquiries from the USA and Japan, which we also serve and will also focus on more strongly in the future. Europe is currently big enough for us, and of course we have a few advantages over here. We definitely see ourselves in patient monitoring in hospitals as well as remote patient monitoring at home as well as the related facets. The fact that there is still a lot of untapped potential in this area can be recognized by looking at pulse oximeters, blood pressure cuffs and ECGs which have hardly evolved technically in recent years. The devices have become smaller and more mobile, but otherwise remained the same. The difficulty is the lengthy approval process that has to be gone through, which is why everything is moving very slowly. The move from MDD to MDR hasn't made this any easier either.

As a founder, how do you view the general Med-Tech scene in terms of wearable innovation in Europe?

JK: In general terms, start-ups in Europe work differently than in the U.S., which is mainly due to the funding perspectives. While you can raise around one million in funding in Germany, you can generate ten times of it at the same time period in the USA. On the other hand, you have a very good standing here in Europe, especially with regard to technologies, because „made in Germany“ or „engineered in Germany“ enjoys a high reputation. Asia, on the other hand, is geared to mass and cheap production. You will always be able to complain or to adapt and find the best way for yourself. Europe does not offer a lot of technologies in the wearable sector. It is a come and go, either because the product didn't work or because the market wasn't ready for it. When we founded back in 2011, the market wasn't ready either and first investors asked if there was even enough demand for self-measurement. Then Fitbit came along and showed everyone that it could work. That's why sometimes you just have to have a bit of luck, show stamina and find your own way.

**What do you think are the top wearable trends worldwide?**

JK: The two big trends I see are accuracy and meaningfulness of data and contactless measurement of vital signs. The focus is more and more on generating data from which you can derive something meaningful. Everything has its justification for existence, but not everything brings added value. Contactless measurement as another trend has to face the big challenge that it is already hard to get accurate and good data with contact, which is further complicated by contactless. Nevertheless, it will hype, many will fail and then individual technologies will emerge that make sense. A lot of things work well in the lab but not yet on a broad scale, so I think it will take another 10 to 15 years.

Much of what we experience today we saw years ago in science fiction movies. In terms of sensor technology, do you think it's realistic that at some point we'll swallow something that measures data from the inside and possibly even stays there permanently?

JK: Well, theoretically, the further you are inside the body, the better you can measure. But I am not quite sure if it will really go in that direction. For many people it offers a certain hurdle and is a step too far to wear something permanently - how would it be to wear something permanently under the skin? Normally, the user wants to retain sovereignty and decide when vital signs should be measured and when not. I think it will be a long time before we see a change in this respect.

What crazy use case with future potential do you see in the next 10+ years?

JK: Some kind of tricorder from Star Trek that can track health. A device that is used for prevention or root cause research of diseases. I think you can already see this trend coming. People tend to pay more attention to themselves and their health. Methods that act preventively looking ahead, could gain in importance in the future. Using the Polyscore as an example, it is possible to determine the probability of dying from heart disease in the next 5 to 7 years. If you know this now, you can do something about it.



Deep Dive

HealthCare Wearables and innovations in medical technology in general are driven by technological advances. A dynamic market that determines people's health and lives requires continuous optimisation and making the impossible possible! In our „Deep Dive“ category, we dedicate ourselves to successful and innovative key technologies that are in the context of healthcare wearables. We offer you insights into the core of smart wearables, explain how they work and refer to companies that use the technology. Are you familiar with the key technologies of medical wearables? Compact and aggregated. Learn more now and stay up-to-date.

1. Foil sensor technology

Foil sensor technology is based on the integration of microsensors into various medical products. On the one hand, foil sensors are based on different materials that are layered on top of each other. Electrodes are attached to these at predefined points and their shape can be varied. The structure consists of conductive materials that are firmly bonded to a carrier foil by means of adhesion promoters. The total layer height of the connected materials is usually between 15µm and 500µm.

This technology is used in various areas such as the non-invasive measurement of vital parameters such as heart rate, temperature measurements and blood sugar. They are also used for fall detection, in orthotics and prosthetics as well as for measuring sleep apnoea. Other areas of application in medical technology are the dosage of medication in infusion syringe pumps or the control of electric wheelchairs by means of foil sensors in the joystick.

In general, foil sensors offer many advantages for medical technology. These include their precision and tightness, but also their safety and reliability. In addition, foil sensors have a long service life compared to other sensors.

Current trends are continuously focussing on miniaturisation as well as increasing comfort and a constant optimisation of the functionalities of healthcare wearables, which are equipped with sensor technology.

An innovative sensor solution in the form of a smart patch was developed by Covestro in collaboration with Accensors (Inno-ME). The aim was to replace single-use items in medical technology with more sustainable solutions. Based on a modified raw material composition of adhesives, foams and films, a new sensor and electronics module was created. The smart patch consists of two components, one of which is non-reusable (disposable patch) and the other is reusable (ReUse patch). The ReUse patch contains all the necessary electronics and is inserted into the disposable patch, which contains the sensors close to the body, by means of an adhesive on the skin. The newly developed, specially integrated foil sensor forms the interface between the health wearable and the patient and enables the detection parameters to be individually adjusted to the patient.

INNOVATIVE APPROACH

- **Basis:**
Foil sensors
- **Company:**
Covestro & accensors
- **Product:**
Smart Patch for measuring vital parameters & for chronic wound care
- **Special feature:**
sustainability through multiple use, special raw material composition & multiple components
- **Website**
<https://accensors.com/home/>



2. Molecular cell technology – Biosensors

Biosensors are used to measure and analyse biological compounds. They establish in medicine by assisting in the diagnosis and various treatments of diverse diseases through continuous and reliable analysis.

Biosensors are a molecular cell technology based on a biological component and a physical sensor that continuously communicate with each other. The biological basis is provided by enzymes, DNA receptors, complete cells, tissue sections and antibodies, which react together with a substance to be tested and create a biological-chemical signal. This signal is transformed into an electrical signal by the physical sensor.

Considering that biophysical sensors can only measure vital and mobility parameters, biochemical sensors are able to explore human health on a biomolecular level. To perform such analyses, biofluids are used. These can be sweat, tears, saliva or extracellular fluids, among others. The biofluids make it possible to provide physiological information without an invasive procedure, which can monitor biomarkers such as metabolites, hormones and drugs in the biofluids through various techniques. The monitoring is then used to diagnose and treat mental illness, gout and cystic fibrosis. Furthermore, it can be used to treat drug abuse.

The coupling of biomaterials and electronics enables measurements based on biocatalytic reactions. The innovative technology promises to improve the analytical capability of healthcare wearables through the interaction of biomaterials, electrochemical sensors, microfluids, big data and cloud computing allows a direct interaction with the human skin without the use of rigid wristbands. As a rule, biosensors are based on two-dimensional materials such as nanomaterials that are bonded together with polymer coating, various printing techniques or conductive polymers, making them more flexible, lighter and highly biocompatible.

The advantages of invasive and non-invasive biochemical sensors are their rapid data acquisition, ease of use, size and flexibility, which promises the user a high level of comfort as well as detailed and complete results.

INNOVATIVE APPROACH

- **Company:**
Innovative Sensor-Technology IST AG
- **Basis:**
Biosensors
- **Fields of application:**
Multiparametric measurement of the concentration of glucose, lactate, glutamine and glutamate in aqueous media on
- **Measuring technique:**
enzymatic-amperometric measuring principle
- **Website**
<https://www.ist-ag.com/>



3. Fluorescence sensor technology

Healthcare wearables such as CGM devices, which are used for continuous blood glucose monitoring, make use of a special form of sensor technology. The miniaturised sensor is encased in biocompatible materials. The basis for measuring the blood glucose value is a fluorescence-based technology.

The sensor, which is usually inserted on the back of the upper arm by a doctor or, if necessary, by means of an auto-applicator, measures the glucose level in the interstitial fluid, which binds reversibly to the glucose-indicating polymer. The technology enables automatic and continuous measurement and display of blood glucose levels without the patient having to actively initiate this.

Pioneers in the field of blood glucose measurement by sensors are Eversense, Dexcom and Abbott. The companies' sensor technology is based on miniaturised, thin sensors that are placed under the skin by means of an applicator and transmit real-time data on blood glucose levels and their changes via Bluetooth to the smartphone via a transmitter placed on the skin above the sensor. By regularly scanning the sensor, a comprehensive glycaemic profile can be created and stored.

The wearable CGM system from Eversense is currently the most innovative and, above all, the most durable glucose device. Unlike competing products from Abbott or Dexcom, the sensor is inserted by a doctor, but can remain under the skin for up to 180 days without being replaced. In comparison, the sensors from competitors have to be replaced after a maximum of 14 days.

Clinical studies show a significant improvement in diabetes management and increased satisfaction of affected persons. Immediately after insertion, the sensor measures reliably and accurately and immediately reports any abnormalities through slight vibrations on the arm.

INNOVATIVE APPROACH

- **Company:** Ascensia Diabetes Care
- **Technological basis:** Fluorescence-sensor, transmitter & App
- **Product:** Eversense - CGM system for measuring and monitoring blood glucose levels
- **Special feature:** application period of up to half a year, sensor is inserted under the skin and transmits data in real time
- **Website:** <https://www.diabetes.ascensia.de/eversense/eversense-cgm-system/>



4. Sensor-integrated textiles / Neurofabric technology

Smart textiles are garments that are manufactured with textile-integrated sensor technology. In the future, the synergy of textiles and miniaturized technology will primarily be used in the treatment of neuronal disorders, such as after strokes. Sensor- and actuator-supported clothing, however, also includes memo functions that refine and support the grasping function in the case of motor disorders or lack of sensation in the upper body. Another area of application is in diabetology through the use of integrated temperature sensors.

In processing, a distinction is made between textile-integrated (electronic components are embroidered on) and textile-based (use of electronically conductive fibers and coatings as a basis) sensor technology.

Connextyle focuses on user-oriented rehabilitation garments designed to detect muscle activity and improve the rehabilitation process through a combination of specially designed TexPCBs (textile printed circuit boards) and laminated electromyography (EMG) sensors. The Tshirt is constructed based on a cotton shirt that contains sensor technology only in the inner sleeves. By means of a special silver coating laminated between thermoplastic material, it is possible to measure muscle movements via dry electrodes. The individual parts are connected to each other by a small module clip that sends the vital data to an app via Bluetooth. This construction system allows the rehabilitation shirt to be taken apart and washed without any problems, so that a high level of hygiene can also be guaranteed. By linking it to the associated app, the recorded data is analyzed, visual brief reports on the treatment progress are created and thus enables doctors and therapists to determine follow-up measures for the patient in a targeted manner.

The Siren Care company focuses its Siren Socks on strict and continuous monitoring of body temperature to detect early signs of potential infections and prevent amputations. Research showed that controlling body temperature on the underside of the feet is the most effective form of therapy to prevent ulcers. Neurofabric is based on a special textile fabric that seamlessly incorporates microsensors and small thermistors at six different points on the bottom of the foot that track the temperature on the bottom of the foot. The temperature is measured every 5 seconds and changes are checked. The sensors send a signal to a label embedded in the left sock, which transmits the temperature data to the Siren app and Siren Hub via Bluetooth. The label also contains an accelerometer that counts steps and a microcontroller unit that stores temperature data for up to 6 days. A big advantage is the reusability - the socks are suitable for both washing machine and dryer use.

INNOVATIVE APPROACHES

- **Technological basis:**

textile-integrated & textile-based sensor technology

- **Company:**

1. Connextyle
2. Siren Care

- **Product:**

1. Rehabilitation clothing
2. Diabetes socks

- **Special Feature:**

1. TexPCBs transmit data of motion sequences and muscle movements via Bluetooth to app
2. Microsensors & thermistors help prevent wounds in diabetics

Smart textiles are experienced by patients like a second skin!



Challenges & Prospects

Healthcare wearables have proven their reason of existence and it will be impossible to imagine the healthcare sector without them in the future. The smart helpers not only optimise diagnostics, treatment and rehabilitation, but also help users to take more responsibility and gain a better understanding of their own body and overall health. Nevertheless, wearables will continue to face some challenges in the future.

One of the biggest hurdles will remain the approval of the healthcare wearable under the continuously changing and strict regulations of the MDR. The research and development, as well as the need to conduct clinical trials and obtain approval from the relevant authorities, takes a lot of time.

Another challenge that will have to be overcome is the complete acceptance of wearables by doctors and their integration into everyday medical practice. On the one hand, the smart helpers could relieve medical staff through a high degree of user autonomy. On the other hand, the data can be anxiety-provoking due to misinterpretation and overwhelm professionals with patient self-diagnoses and burden them with additional work.

Nevertheless, the opportunities offered by the use of healthcare wearables outweigh the risks. Early diagnosis as well as data-based and optimised cause research will be possible through long-term monitoring and self-measurement. Preventive treatments and a higher motivation to lead a healthier lifestyle in order to take better care of one's own body can also result from it in the future. Wearables are establishing themselves in all medical fields and contribute to the development of individual and best possible therapy options, so that the number of acute situations for chronically ill people, for example, can also be drastically reduced.

Through the data-based insights and analyses, algorithms can be developed that, in combination with artificial intelligence, can recognise problems, suggest individual approaches to solutions and initiate them. This will result in diagnostics and treatments that are independently optimised. One thing is certain, the development, innovation and establishment of healthcare wearables will continue to progress in leaps and bounds. The potential is enormous and far from exhausted. The versatility and flexibility in the areas of application and use of healthcare wearables will revolutionise the healthcare sector.



Market insights

arcoro has set itself the task of actively shaping the future of medical technology by bringing together medtech companies and experts. Through our large network and personal exchange with industry experts in medical technology, we are able to deliver results that also offer you real added value and exciting insights into the current environment but also into the future. Thanks to surveys of specific target groups, the concentrated expertise of specialists and comprehensive research, you are able to stay close to the market. The result: international aggregated and detailed insider knowledge summarised compactly for you. Candidates gain the opportunity to share their own perspective and compare themselves with colleagues in the industry. Companies get an additional, independent source to gain valuable impressions of the medical technology market and to follow its development with regard to various areas of innovation.

Innovations in medical technology: Healthcare wearables

Survey background:

Period of the survey: 16.08.2021 to 05.09.2021

Number of participants: 48

Survey type: Questionnaire (focus on open questions)

Tool: Survey Monkey

Participant profile: international specialists in the field of healthcare wearables

1. Development of health care through the use of healthcare wearables

- Remote Patient Monitoring
- More self-reliant health care
- Smarter aging
- AI as a basis for machine learning / for the development of data-based diagnostics & treatment
- Digitization of all processes
- Change in the health insurance sector
- Early diagnostics
- New players and business models
- Relief of medical staff
- Reduction of inpatient stays through increased outpatient treatment



2. HealthCare Wearables - which products promise high success potential?

Neurological wearables for stroke detection	★★★★
Smart Patches	★★★★
Cardiology wearables / warable ECG monitoring	★★★★
Permanent implantable CGM systems	★★★★
Ovulation phase control	★★
Smart implants	★★
Personalized therapies and agents	★★
Remote Patient Monitoring	★★
Respiratory monitoring / vital signs measurement in newborns	★
Wearables to support pregnancy safety	★
Wearables to improve mental disorders	★
Wearables to support mental health	★

3. Gamechangers and Opinion Leader – who shapes the market at national and international level?

GAMECHANGER			
Dexcom	Afon Technology	Medtronic	Temptraq
AliveCor	Draeger	Google	VivaLNK
Abbott	Ava Woman	Apple	Wellue's duo ek
Irythm	Withings	Roche	
Cardiogo	Philips	Mindpax	

**OPINION LEADER**

Prof. Dr. Hans-Jürgen Thiesen

Joseph Wang

Dr. Yeshpal Mathangi

Bertalan Mesko

Bijan Najafi

Irma Rastegayeva

RESEARCH INSTITUTES

Fraunhofer Institut

UMass Amherst's Institute for Applied Life Sciences and Center for Personalized Health Monitoring

Deutsches Zentrum für Herz-Kreislauf Forschung

Stanford University - precision health and integrated diagnostic center

Deutsches Forschungszentrum für künstliche Intelligenz

4. Opportunities and risks of medical technology through the use of HealthCare Wearables

Opportunities



- Fewer acute situations for chronically ill patients
- Early detection
- Self-monitoring
- Optimized cause research
- Preventive treatment
- Fast data transfer to medical professionals
- Motivation for a healthier lifestyle
- Development of best possible treatment strategies
- More attentiveness to own body
- Decentralized treatments

Risks

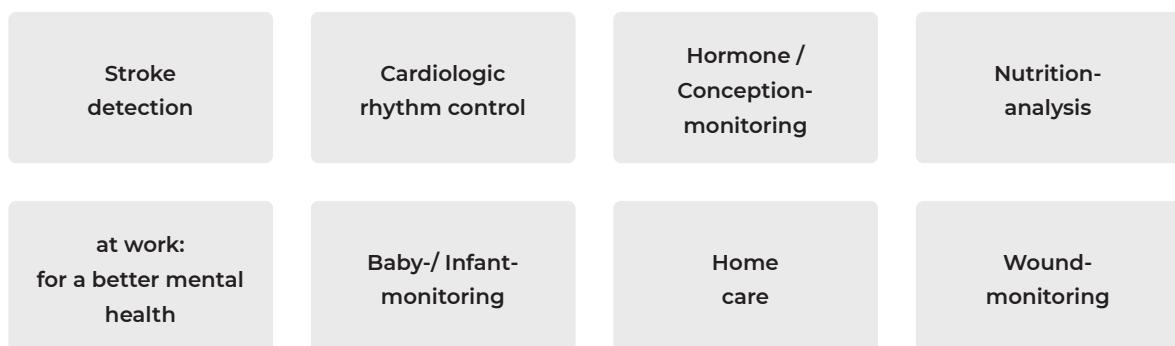
- High costs
- Inaccurate data collection
- Completeness of data
- Technical failures
- Overloading of medical staff with self-diagnostics
- Data security / protection of personal data and sensitive health data
- Generalization by algorithms
- Interpretation and evaluation problems
- Fear triggers



5. Innovative key technologies

TECHNOLOGY	INNOVATION LEVEL
LED sensors	39 percent
Textile-integrated sensors	84 percent
Pressure sensors	32 percent
Temperature sensors	39 percent
Foil sensors	92 percent
Fluorescence sensors	76 percent
AI sensors	98 percent
Biosensors	93 percent
Microchips	31 percent
EMG sensors	36 percent
Near-infrared sensors	63 percent

6. Possible areas of application in the future





7. Use cases that could be part of everyday life in the near future

- Wearables that can determine specific stroke risk years in advance and suggest preventive measures. Possible through screening or vital signs measurement and sensor placement in the brain for possible stimulation.
- Sensors that continuously determine hormonal balance and provide information about female cycles, thus providing information about natural contraception and pregnancy.
- Nutritional analysis through sensors that sit under the skin and provide information about potential disease patterns with current nutritional routines via a transponder. An associated app is used to display progressions and target dietary changes.
- Baby monitoring through smart patches or other wearables that monitor vital parameters to prevent the risk of SIDS.
- Expanding health monitoring in ambulatory care and remote patient monitoring.
- Smart patches, which are permanently printed on the skin, detect heart rhythm irregularities and atrial fibrillation. These automatically issue an emergency call and contact an emergency contact about the situation and location which is stored in the associated app. Based on data from the patch, first aid tips and instructions are immediately launched visually, so that the victim can be treated directly by first responders.
- Sensor under the skin provides information about deficiencies or excesses of vitamins and nutrients via app.
- Hearing aids that are fully integrated in the ear and enable people with severe hearing loss or deafness a good level of hearing while permanently recording and analyzing vital parameters.



ABOUT arcoro

arcoro is a renowned, highly specialised HR services boutique with the visionary goal of „connecting MedTech companies of the future“. To this end, we offer flexible and diverse solutions for medical technology companies and medical technology experts. We see ourselves as a facilitator of expertise and years of experience of our industry experts in companies pursuing significant, innovative and exciting projects in the industry.

In doing so, we focus on different areas of expertise, covering Clinical Affairs, Regulatory Affairs, Research and Development as well as Production and Quality Management. We provide companies with access to more than 3000 medical technology experts from our database. We offer candidates new development opportunities and impulses through deployment in innovative projects of the future in a constantly growing environment of renowned companies with high innovative strength.

What drives us? Personal contact, years of expertise in the dynamic environment of the medical technology industry and the pursuit of innovation. Let's revolutionise medical technology together.

We are available for you at 2 arcoro locations!

We are happy to help you out!

Office Munich

arcoro GmbH
Innere Wiener Straße 36
81667 Munich

Tel +49 89 2620 9940
E-Mail: info@arcoro.de



Office Heidelberg

arcoro GmbH
Ziegelhäuser Landstraße 39
69120 Heidelberg

Tel +49 6221 4784 20
E-Mail: info@arcoro.de

