

WEARABLES IN MEDICINE

Impact of wearable technologies in
prevention, monitoring and surgery



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What are **wearable devices**?

Wearable devices refer to a wide range of **smart devices** that can be connected to other electronic devices allowing not only the detection but also the storage and exchange of different types of data, immediately and often without the need for human intervention.

Thanks to the **Internet of Things (IoT)**, it is possible to connect virtually any object to the Internet and wearable devices represent the most common use of this technology.

More and more advanced, wearable devices are used for various **purposes** and in different **areas of use**.

Wearable technologies in **Medical Context**

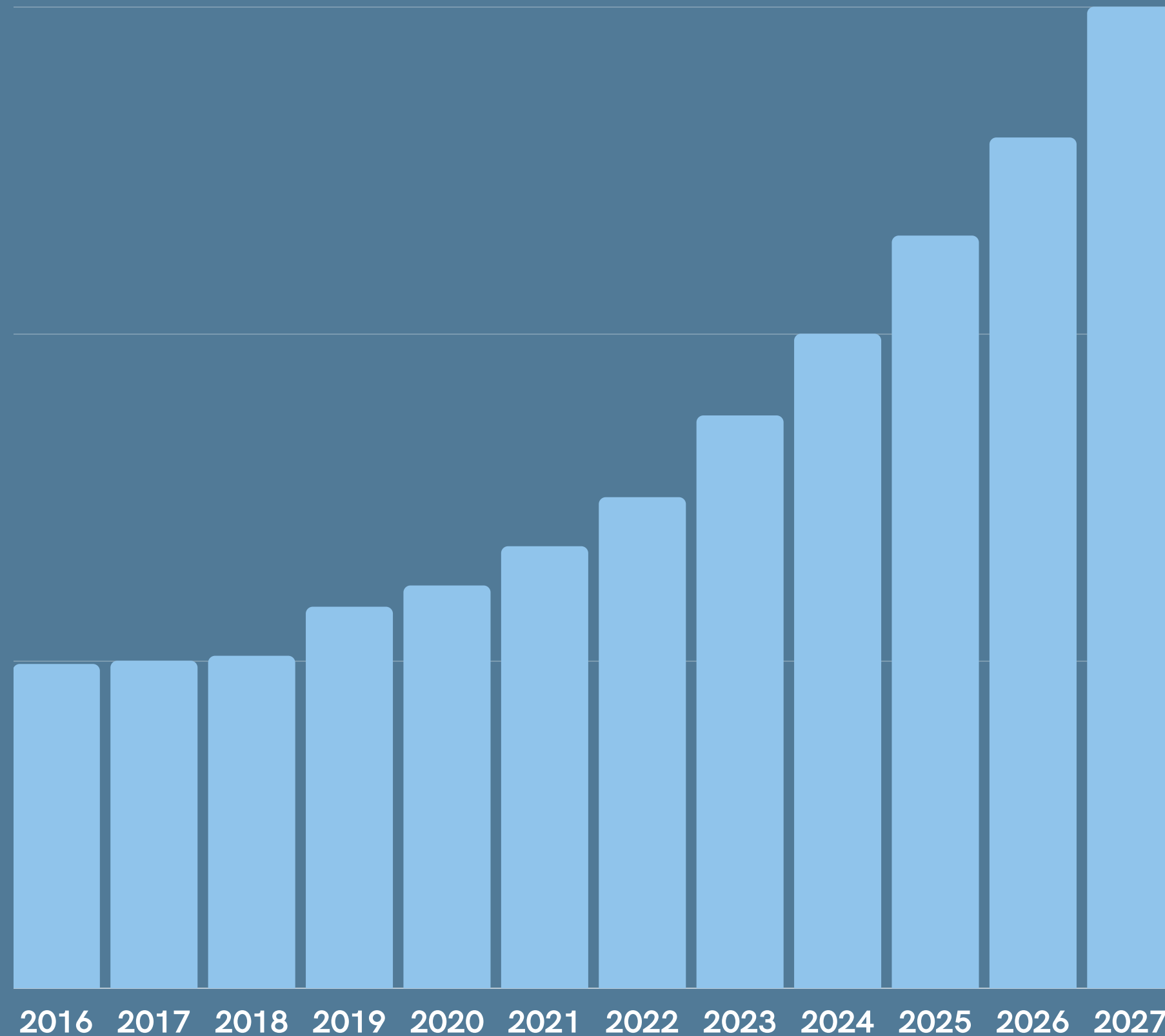
Wearable devices are already revolutionizing biomedicine through mobile and digital health by enabling continuous longitudinal health monitoring outside the clinic.

Wearable devices also facilitate the development of algorithms for the automated prevention and intervention of health events.

This technology is also starting to take hold within surgical departments, with tools that help physicians during operations and patient management.



North America wearable medical devices market size (USD Billion)



Market growth and numbers

The global wearable medical devices market size was USD 29.76 billion in 2019 and is projected to reach USD 195.57 billion by 2027, exhibiting a Compound Annual Growth Rate of 26.4% during the forecast period.

Source: [Fortunebusinessinsights](#)

Prevention & Monitoring

Wearable devices are becoming increasingly important in the role of disease prevention and monitoring. Particularly:

Prevention: People in good health conditions can also benefit from these tools that send clinical data to specialised medical staff who assess at a distance whether they need to be hospitalized

Remote monitoring: older and more fragile people when remotely controlled are able to lead a more independent life for a longer period of time while at the same time reducing costs

[A review of wearable technology in medicine](#)

Smartwatch

Smartwatch and fitness monitors have become widely used by consumers, especially for their potential contribution to naturalistic digital measurement of health in a scalable, mobile and non-intrusive way.

These devices are able to detect many vital signs, like glucose, blood pressure, ECG, EMG, body temperature, quality of sleep.

Studies have revealed that the best smartwatches that could be used in the medical context are the Apple Watch and FitBit, which appear to be useful in the ambulatory measurement of cardiac activity.



Apple Watch



From the Apple Watch Series 4 the users are able to take an electrocardiogram right from their wrist. The **ECG app** can capture heart rate on demand in a moment when users experience symptoms such as a rapid or skipped heart beat and helps provide clinically important data to physicians.

The irregular rhythm notification feature on Apple Watch occasionally checks heart rhythm in the background and sends a notification if an irregular heart rhythm that appears to be **atrial fibrillation (AFib)** is identified.

The irregular rhythm notification feature was studied in the Apple Heart Study, with over 400,000 participants. The study found evidence to support the claim that wearable technology has the ability to safely identify heart rate irregularities, which subsequent testing confirmed to be atrial fibrillation.

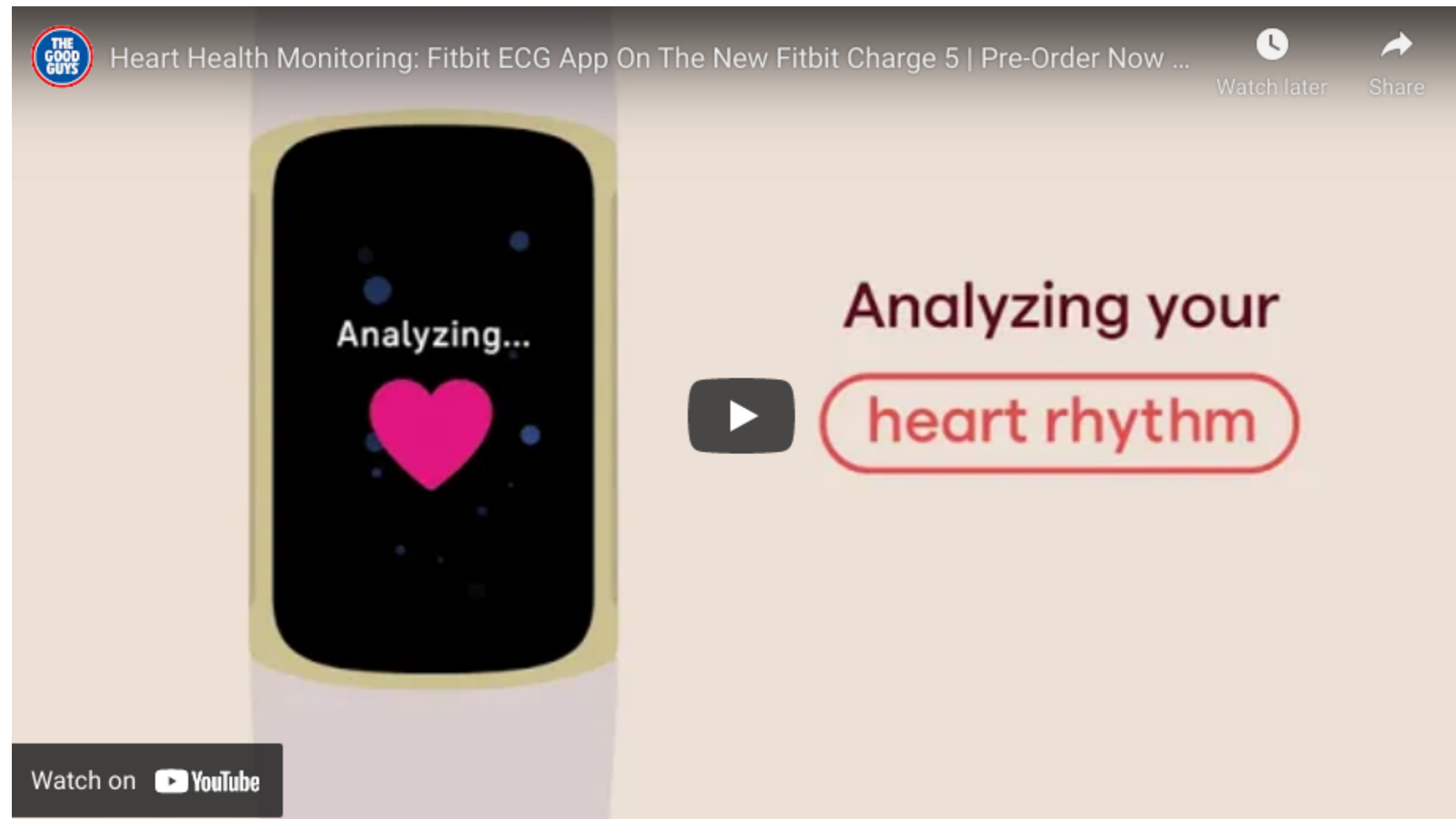
FitBit

This device has all the sensors that the user needs, but it also has an advanced ECG sensor validated in a clinical study to provide accurate results.

This study has investigated the heart rate accuracy of wearables during a continuous and ecologically valid 24-hour period of actual consumer device use conditions.

In conclusion, the Apple Watch and the Fitbit Charge provided acceptable heart rate accuracy ($<\pm 10\%$) across the 24 hour and during each activity.

[Accuracy of Consumer Wearable Heart Rate Measurement During an Ecologically Valid 24-Hour Period: Intraindividual Validation Study](#)



Posture correction

Upright Go is a small wearable device which helps patients training themselves to employ a healthier posture using feedback. It produces a small vibration when the person wearing the device is not assuming a correct posture.

This device is connected with an app. In the Homepage the user can see an onscreen avatar that mirrors their position as they wear the device. This avatar turns red when the posture is stooping, thus motivating the person to get into a straighter healthier position.

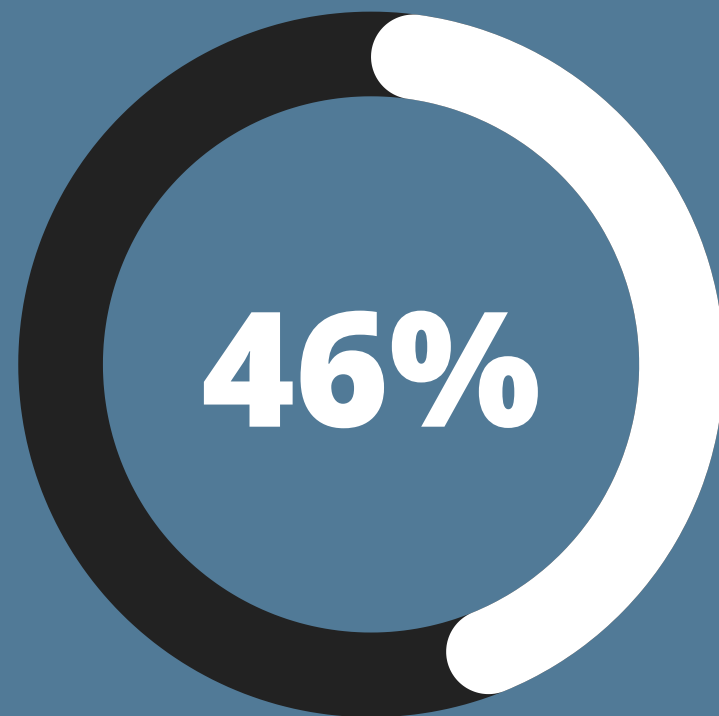
[uprightpose](https://uprightpose.com)



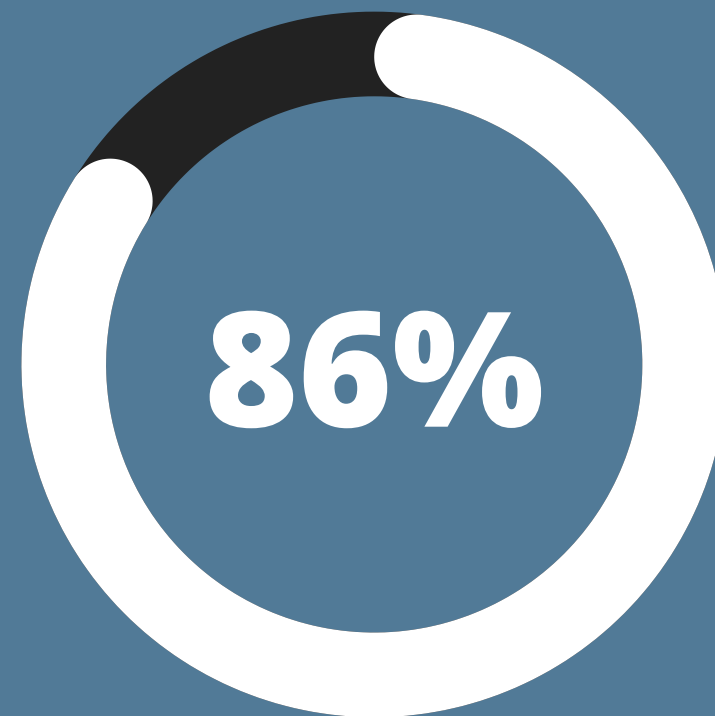
In addition, the feedback vibration helps users form better overall posture behaviors and reduce the possibility of future spinal problems.

It has been shown that using this device over a long period leads to various benefits like:

Pain reduction

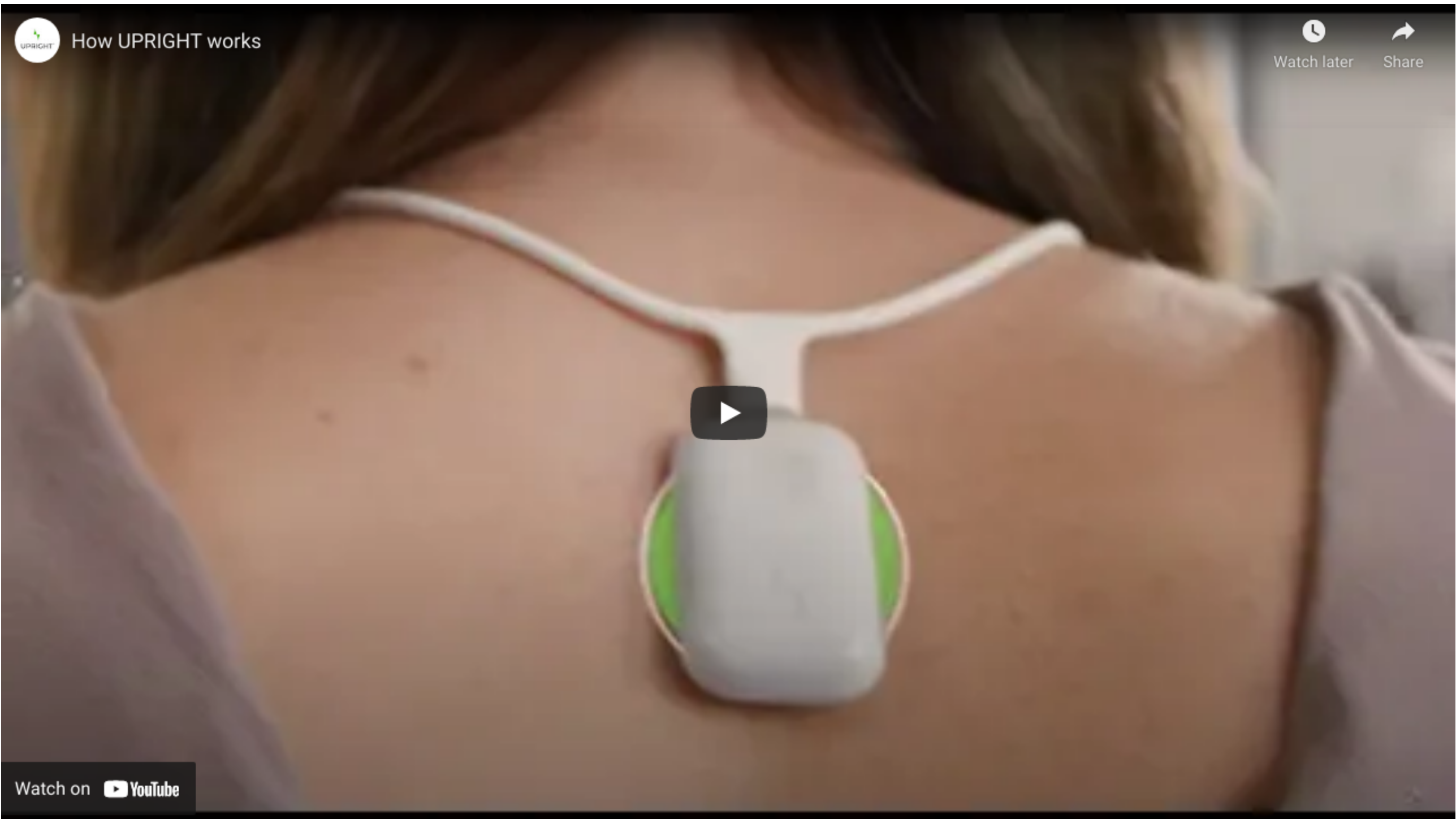


Posture improvement



Improved sitting discomfort





How UPRIGHT works

Watch later Share



Watch on  YouTube

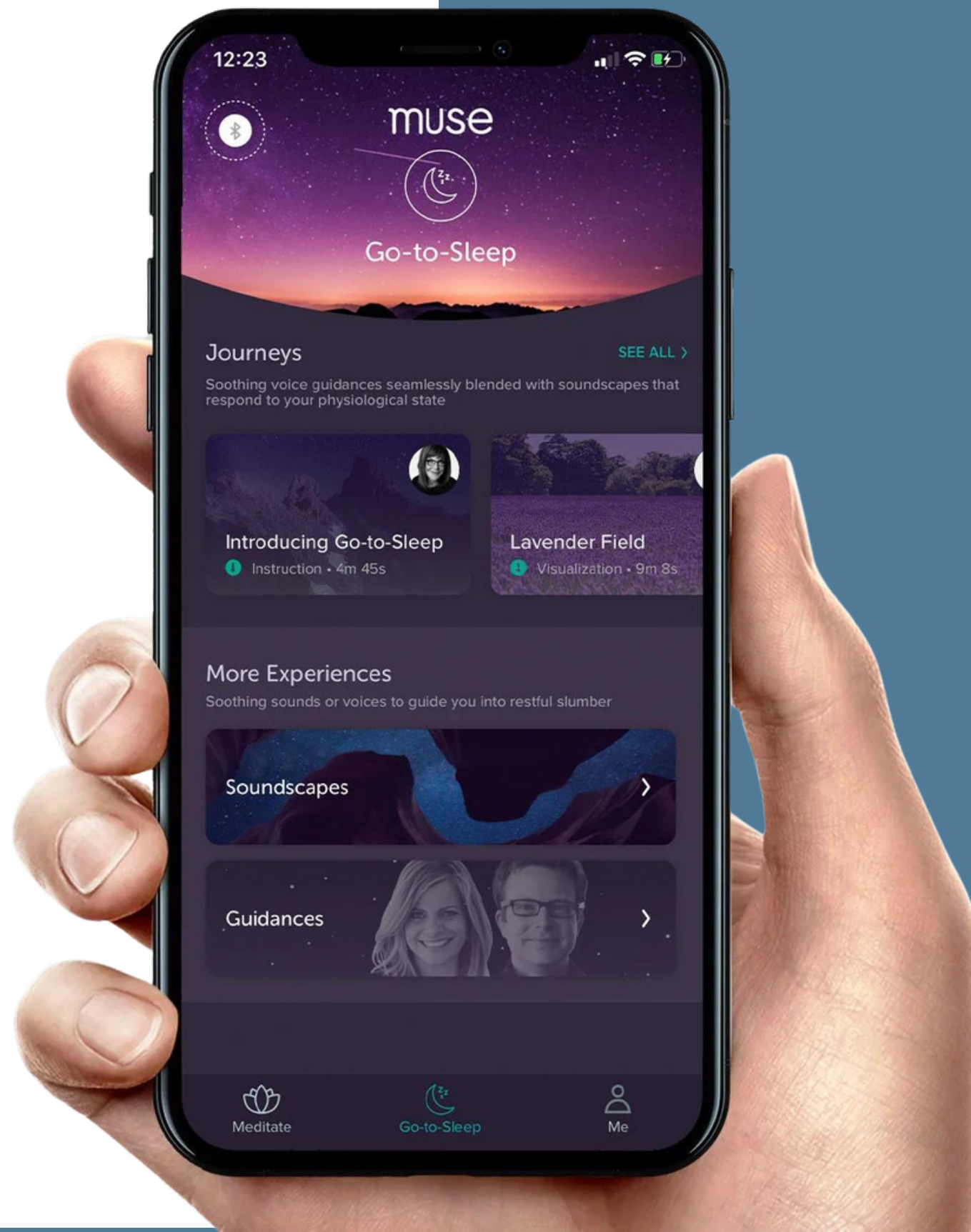
Brain-Sensing Headband

Muse is a powerful, compact electroencephalography (EEG) system. By leveraging improvements in dry sensor technology, Bluetooth and battery life, as well as significant advances in digital signal processing, Muse makes it easy to access and use brainwave data, inside and outside the laboratory and in real-world environments.

Using advanced EEG technology to respond to mind, heart, and breath, Muse is a comfy brain sensing headband that helps you understand and track how well you focus, sleep and recharge so you can refocus during the day and recover each night.

[Choosemuse](https://www.choosemuse.com)





In medical context, headband that measure electroencephalogram is used above all for the diagnosis and monitoring of epilepsy.

It is also often prescribed to cancer patients, because both primary brain tumors and any brain metastases caused by tumors of other organs can cause epilepsy.

It is also indicated in the presence of suspected inflammation of the nervous system and for sleep disorder diagnosis.

[Choose muse](#)

Foot care for Diabetes

People living with diabetes are subject to more than 30% risk of developing a feet ulcer in their lifetime. 10% of those ulcers will result in an amputation.

Siren are a smart Socks measure foot temperature to help reduce your risk of ulcers. Rising foot temperature indicates that inflammation is developing, which may be a sign of injury. Temperature monitoring has been shown to reduce the number of diabetic foot ulcers by up to 87.5%.

[Siren Care](#)





It works in **three** phases:

- 1** The socks continuously measure foot temperature, an early indicator of injury that may lead to ulcers.
- 2** Licensed nurses review the data for signs of inflammation and call patients regularly to check on their health.
- 3** Providers manage patient care and they are alerted to potential injuries and determine if a clinic diagnosis is necessary.



Health Care Ring

Fitness and health wearables in the form of watches are common, but there are many other devices that do the same things.

Motiv Ring is an alternative for users who are put off by watches and other wearables. Motiv is a wearable design ring slips to monitor activity, sleep and heart rate. The device has an app which allows users track and adjust their goals.

This device has the same function of the smartwatch like:

- 1** Sleep control: In the morning, the user can check sleep patterns and resting heart rate.
- 2** Identify and monitor heart health.

Mobile ECG

KardiaMobile is a medical device and artificial intelligence company that is developing products for screening, diagnosis and treatment. KardiaMobile is an electrocardiogram (ECG) attached to the back of mobile devices like iPhones and Androids. It tracks heart activity and transmits the activity to a mobile app through chest and finger sensors.

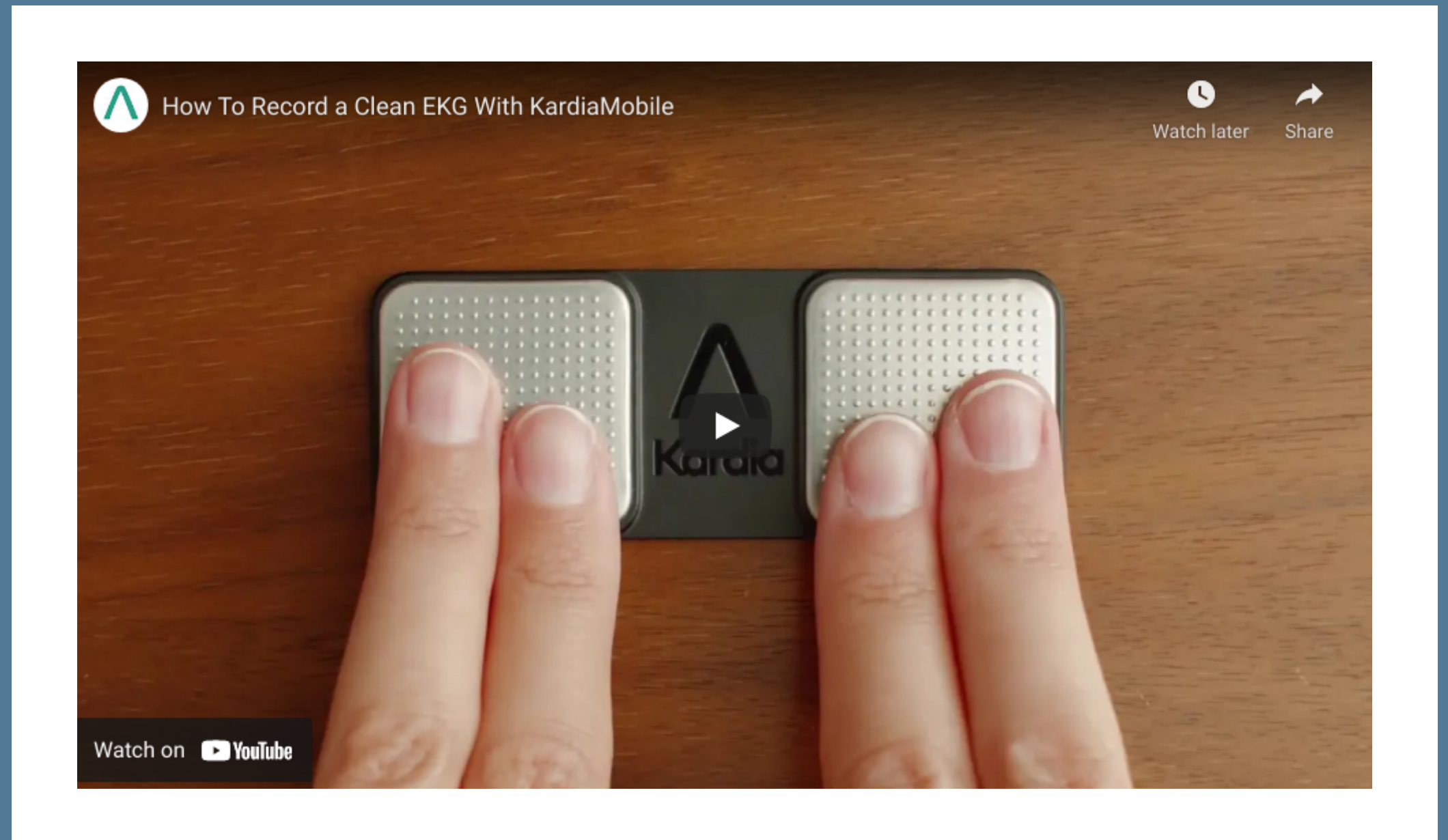
This product is a FDA-cleared personal EKG: The world's most clinically validated personal EKG, FDA-cleared to detect Atrial Fibrillation, Bradycardia, and Tachycardia.

[KardiaMobile](#)



You can take this device anywhere thanks to its small size. Even the use is very simple, just place your fingers on the sensors, without wires, patches or gels so you can acquire a medical grade ECG in 30 seconds. The collected data can then be viewed in an instant analysis directly on the smartphone.

[KardiaMobile](#)



Wearable Artificial Intelligence System

Current is a device that can measure various vital signs including heart rate, respiration, oxygen saturation, patient's temperature and mobility. Recently, the wearable, based on an artificial intelligence (AI) system, has obtained further approval that allows it to be used even during medical visits at home. Current is a wireless device that provides physicians with real-time updates on their patients' health, enabling them to promptly manage any complications. The technology uses machine learning to analyze collected data and detects problematic changes within this data.

[Current](#)



Home
Activity
Calls
Management
Account

SA Study Alpha

Admit

Home
Activity
Calendar
Management
Account

Richard Gallagher **COVID-19: Positive**
15% - Until 5:00pm High priority

WEARABLE
Resp rpm
Pulse bpm

Monday, Oct 12th
8:00 8:15 8:30 8:45 9:00 9:15 9:30 9:45

Patient Information
History
TODAY
Chris Francis said 'Patient has received antibiotics. Reports feeling systemically well and will review again in 6 hours'
4:45pm
Marie Roads said 'Reviewed patient, prescribing antibiotics and sending to the patients home. Flagging for review again in 6 hours.'
10:40am

All Patients Tags HCP Location (2) Search for patient

SEA CLIFF OUTER RICHMOND RICHMOND DISTRICT OUTER SUNSET INNER SUNSET COLE VALLEY HAYES VALLEY WESTERN ADDITION THE CASTRO NOE VALLEY PACIFIC HEIGHTS PRESIDIO HEIGHTS LOWER PACIFIC HEIGHTS HAIGHT-ASHBURY THE CASTRO MISSION DISTRICT NOB HILL FINANCIAL DISTRICT TENDERLOIN SOUTH BEACH SOMA CHINA BASIN MISSION BAY DOGPATCH

Sorted by priority No grouping 80 Patients / 2 alarming

Richard Gallagher	15%	High	Dr. Moodley	St. Mary's	Hospital at Home	COVID-19: Positive
Sepsis Risk started 10:01 Low battery started 09:27						
Judy Plaidstow	15%	High	Dr. Moodley	St. Mary's	CHF Stage IV	COVID-19: Positive
Low SpO ₂ started 9:30						
Alain Boghossian	78%	Low	Dr. Carter-	Eugenio Litta	Hospital at Home	Heart Failure
Ava Long	78%	Low	Dr. Zhang	St. Mary's	Hospital at Home	

Patients using the wearable device can also access a tablet with educational content, medication reminders, and a chatbot designed to gather information on patients' symptoms.

The company has highlighted that all of Current's functions are capable of producing a high volumes of data that can help doctors identify and analyze any warning signs, in order to intervene promptly.

While the patient is being monitored remotely, the provider is still communicating with them via text messages and video visits on a secure server.

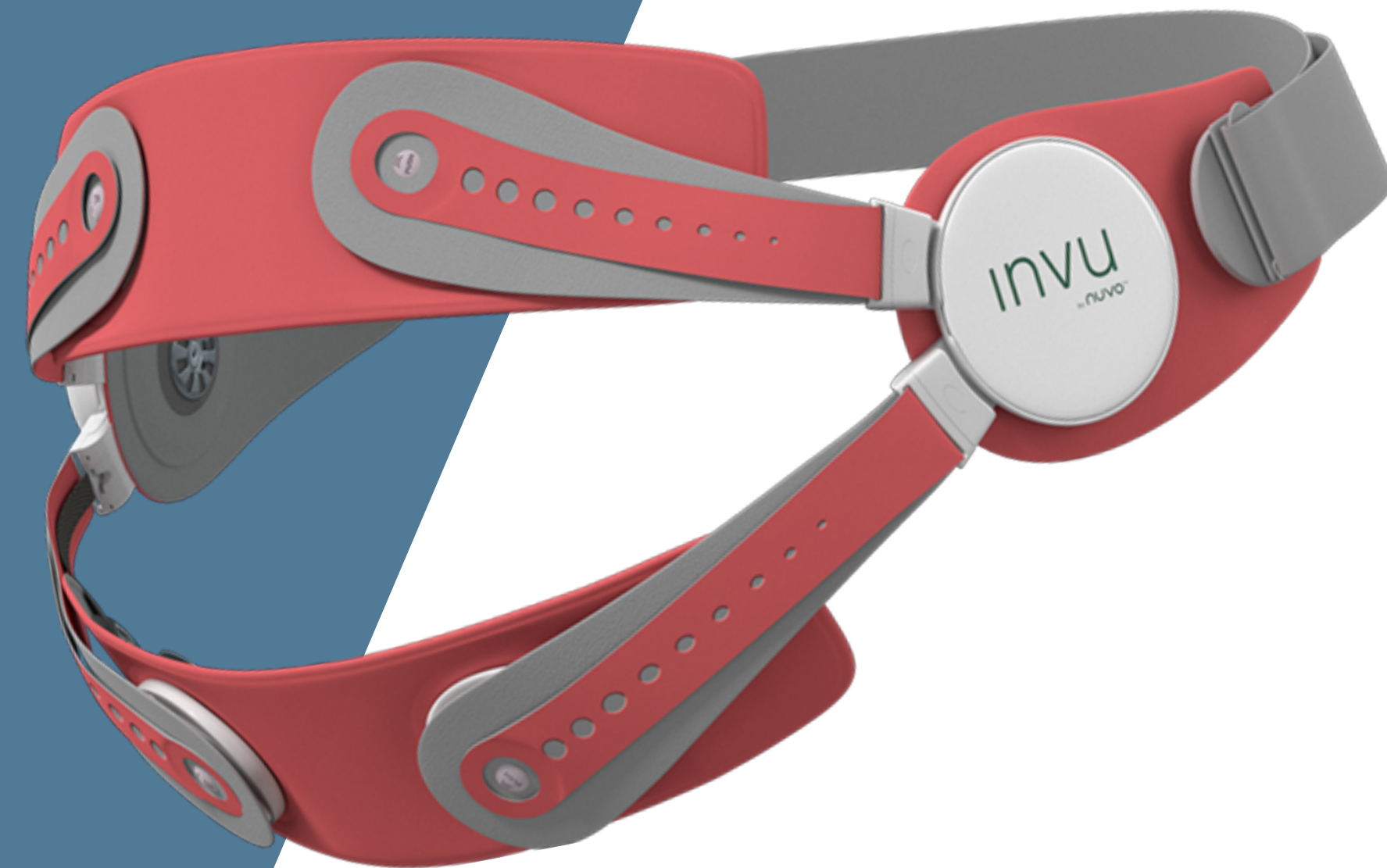
Current

Pregnancy Care

It is an abdominal belt in which a series of sensors are inserted and which can collect data on the fetal and maternal heart rate. This smart band of sensors can be prescribed by doctors to help women monitor fetal health in the third trimester of pregnancy. The FDA has given approval for use after having found the accuracy and ease of use of the device in a study conducted on 149 people.

This device has been designed for remote health monitoring, reducing the exposure of pregnant women to crowded and potentially infectious hospitals.

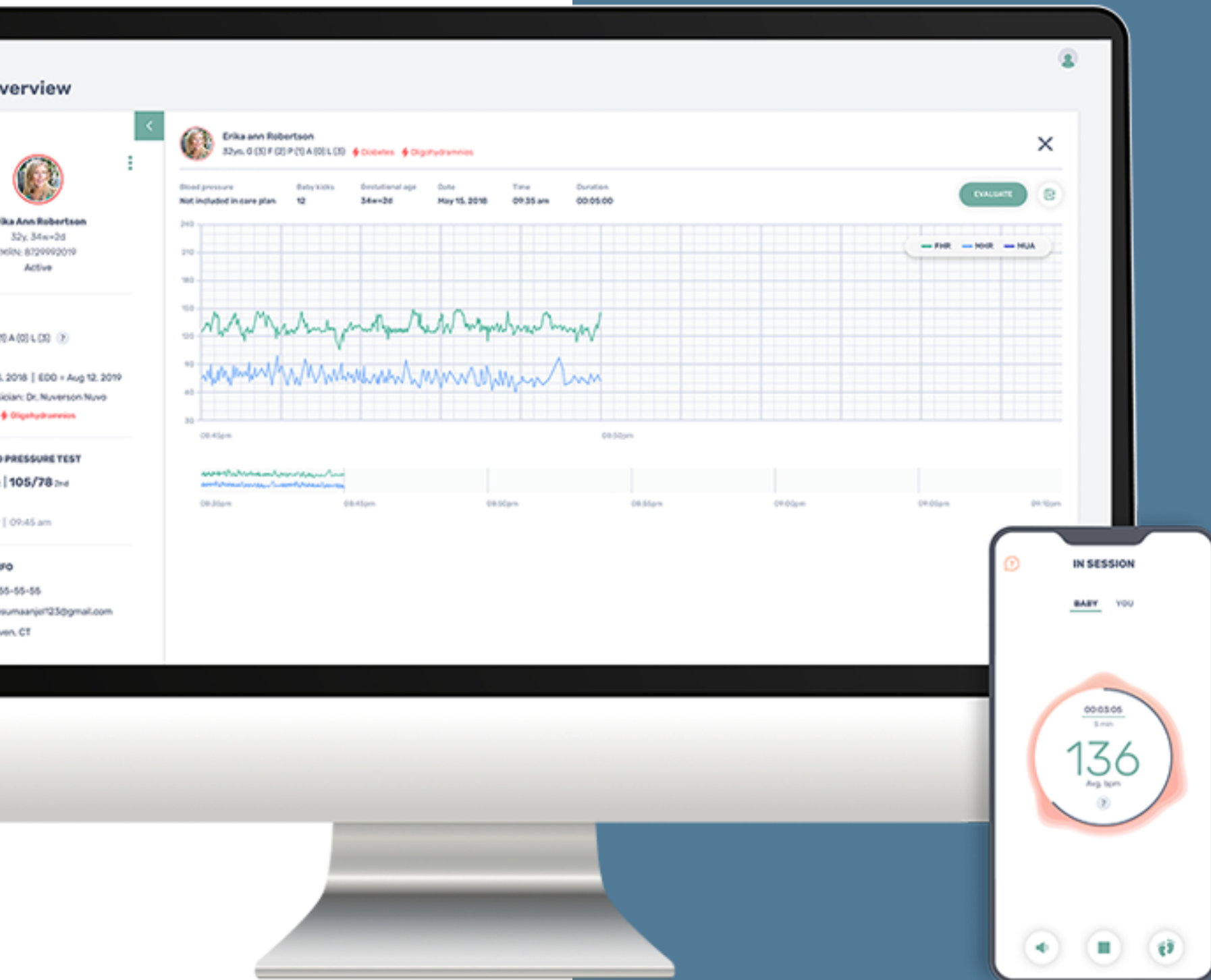
[Nuvocares](#)



It differs from other devices for two characteristics:

- 1 Dynamic Cloud Computing:**
INVU is enabled by cloud-based data capture and management. Digital signal processing and proprietary algorithms analyze data, allowing providers to observe changes and evaluate trends that inform decisions about each pregnancy.
- 2 Data Designed for Action:**
Clinician dashboard provides access to patient vitals comparable to in-office readings, for timely decision-making.

[Nuvocares](#)



Smart socks for babies

Smart Sock is the first baby monitor capable of detecting the baby's oxygen levels and heart rate during sleep. It is connected in real time to the Owlet app where all the collected data is shown.

- It measures the progress of sleep by viewing the total hours of sleep, the quality and number of awakenings
- Monitors heart rate and oxygen in real time
- If the data exceeds standard values, the app warns that the child needs attention.

[Owletcare](#)



Hospitalization and Surgery

Hospitalization: Wearable technology allows clinicians to gather data where it matters. Direct observations concerning the impact of clinical interventions on mobility, level of independence, and quality of life can be performed by means of wearable systems.

Surgery: Also surgeons can benefit from these devices, thanks to their use in the operating room to facilitate operations and have all patient data under control.

A review of wearable technology in medicine

[Advances in wearable technology and applications in physical medicine and rehabilitation](#)



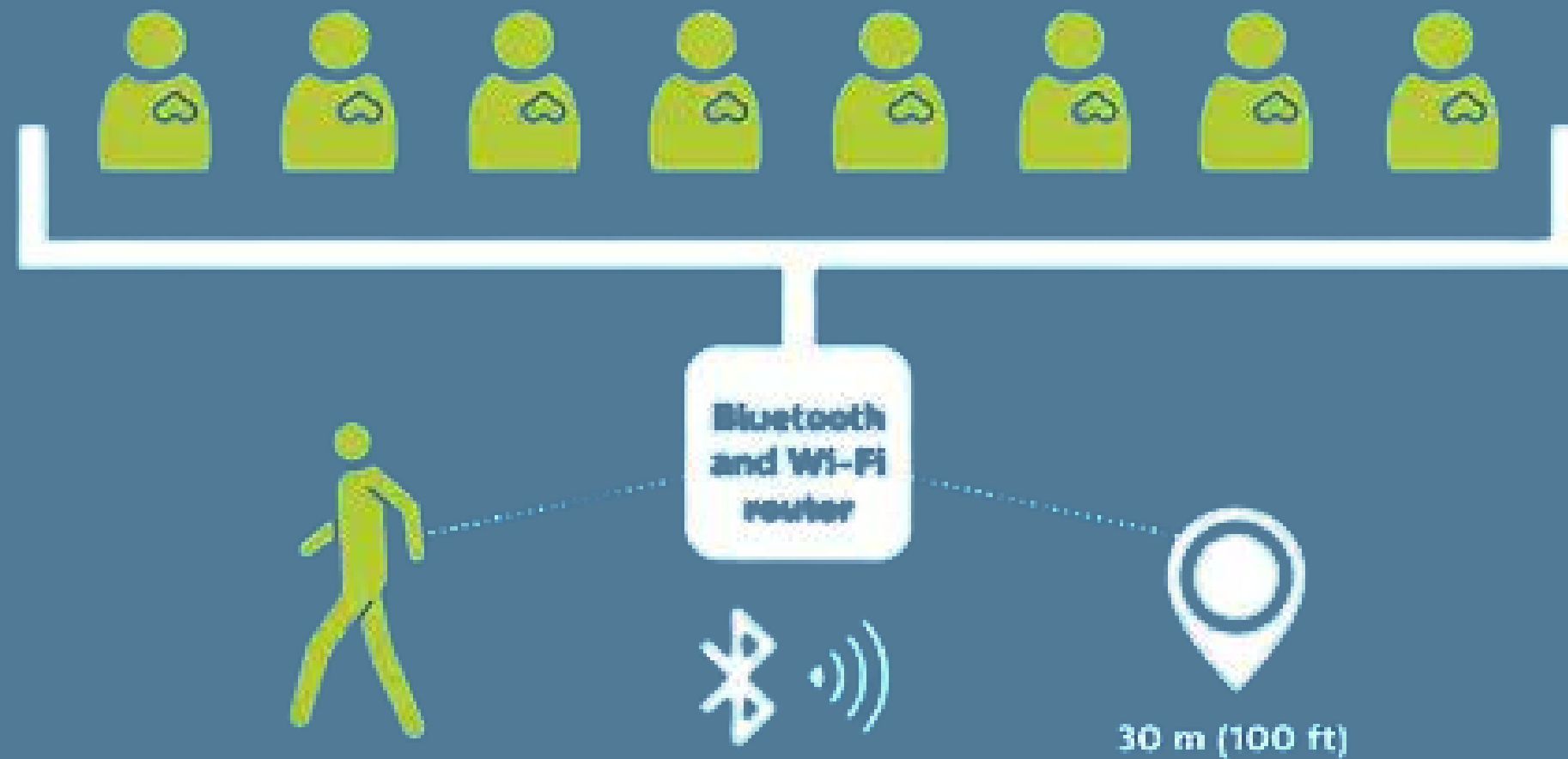
Philips Biosensor BX100

The most recent and current case in hospitalization is a product of Philips General Care, a patch form device developed for breathing monitoring. BX100 is a disposable patch capable of monitoring respiratory rate and heart rate, the main predictors of a worsening of the patient's health conditions.

The Biosensor BX100 has been designed as an excellent solution for outpatient care for constant and continuous monitoring.

The Philips wearable has received FDA clearance and is currently approved for use in hospitals, in particular to monitor the recovery times of patients who have just undergone surgery or come out of intensive care.





The patch is a single use device that can be worn on the breastbone for up to five days. The biosensor has an integrated battery and connects to a hospital's back-end infrastructure via Bluetooth.

The BX100 is designed to connect with the rapid alert system, which then interacts with a hospital's electronic health record system, telling doctors if a patient's care needs to be intensified. The entire system was developed in about three years, including sensors and management software.

Philips



Keep a close watch on patients with the Philips wearable biosensor




Watch later



Share



Watch on  YouTube

Surgery with Google Glass

[Google Glass in Medical Environment](#)

Wearable devices not only help prevent and monitor patient health, but can also be a useful tool for doctors and surgeons in the operating room. An example of this application is Google Glass.

Google glass is one of the latest innovations based on augmented reality and ubiquitous computing. It is a wearable technology which is being projected as the affordable future technology for healthcare applications.

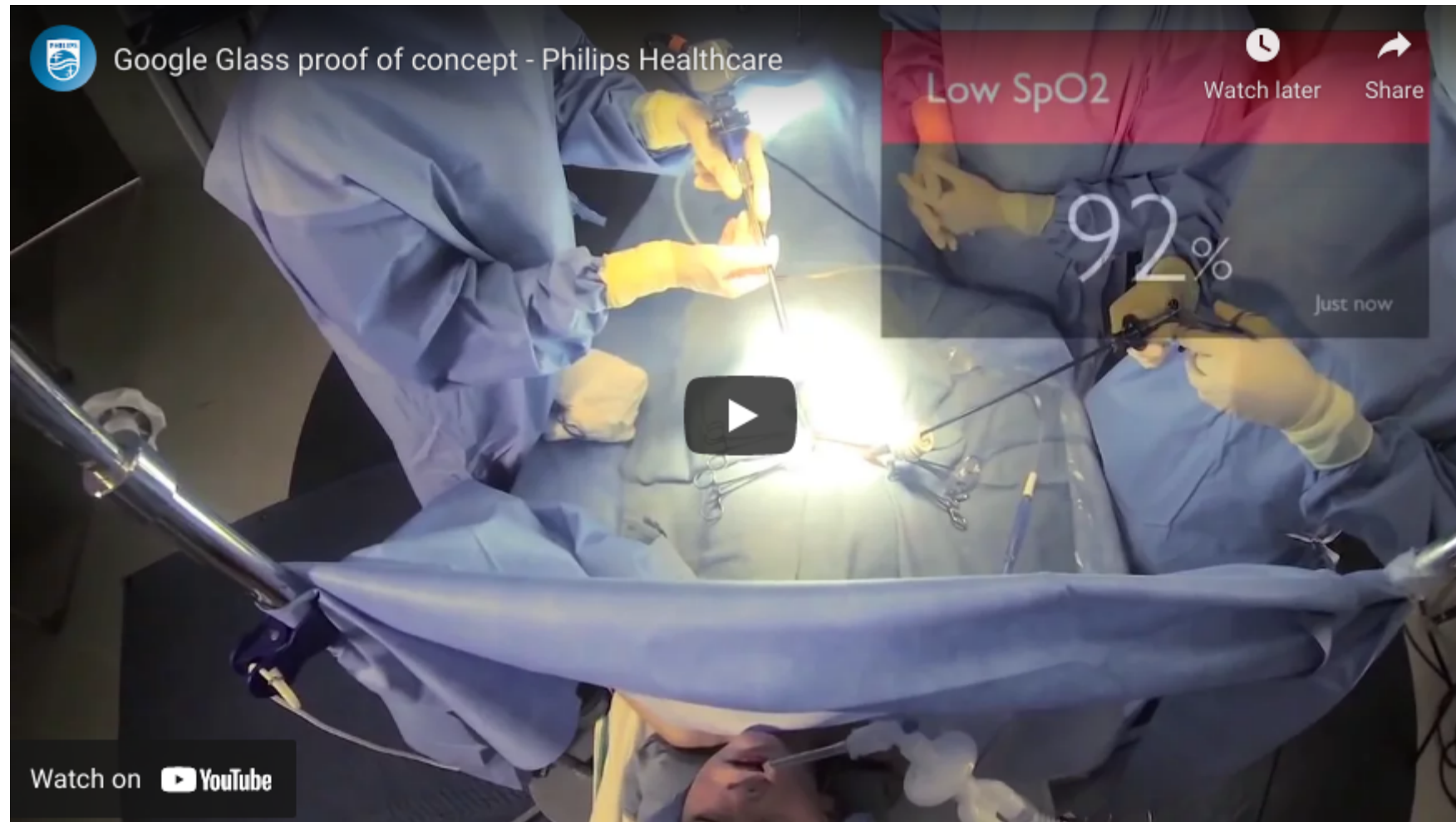
The concept behind this glass technology is to integrate many types of information and define a new path to this information to help healthcare personnel deliver an organized and more effective patient care. Making use of the Eye tap technology, it can record the scene available in the field of vision and superimposes computer generated images on the scene available to the eye to facilitate surgeries.

The health sector witnessed the use of Google glass technology for the first time in June 2013, when a Spanish surgeon Guilin, Dr. Pedro wore Google Glass while performing a transplant.

Google Glasses are an extra weapon for surgeons to:

- 1** Communicate remotely with other doctors by sharing in real time what they are observing, creating an innovative cooperation environment. this function can help surgeons in the most delicate operations
- 2** Access, through the images generated by the glasses, to the physiological data generated by other connected wearable devices, medical history of patients and reports written by other doctors
- 3** Help students gain field experience by remotely observing interventions





There are various indications in different departments of hospitals where the discussed technology can be applied.

Google Glass has the potential to transfer the healthcare industry from the point of view of physicians as well as patients. The latest innovation by Google and its attempt on product differentiation with styled frames and prescription lenses can bring about instrumental change in the healthcare industry.

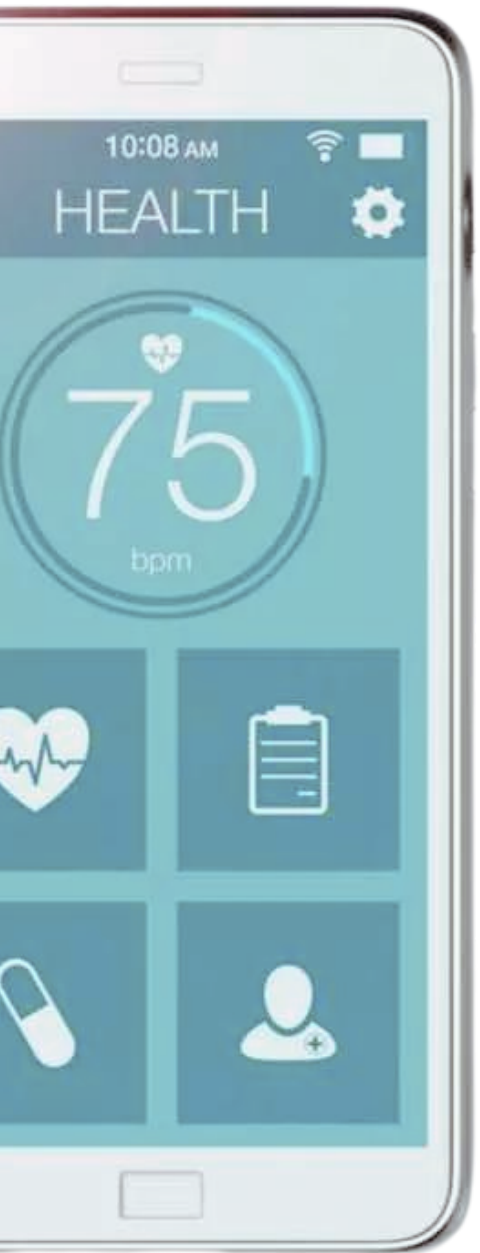
[Google Glass in Medical Environment](#)

After this list of wearable devices, we can say that these technologies have great potential to help address contemporary [global health problems](#).

Unfortunately, like all existing technologies, there are [positive and negative aspects](#).

03

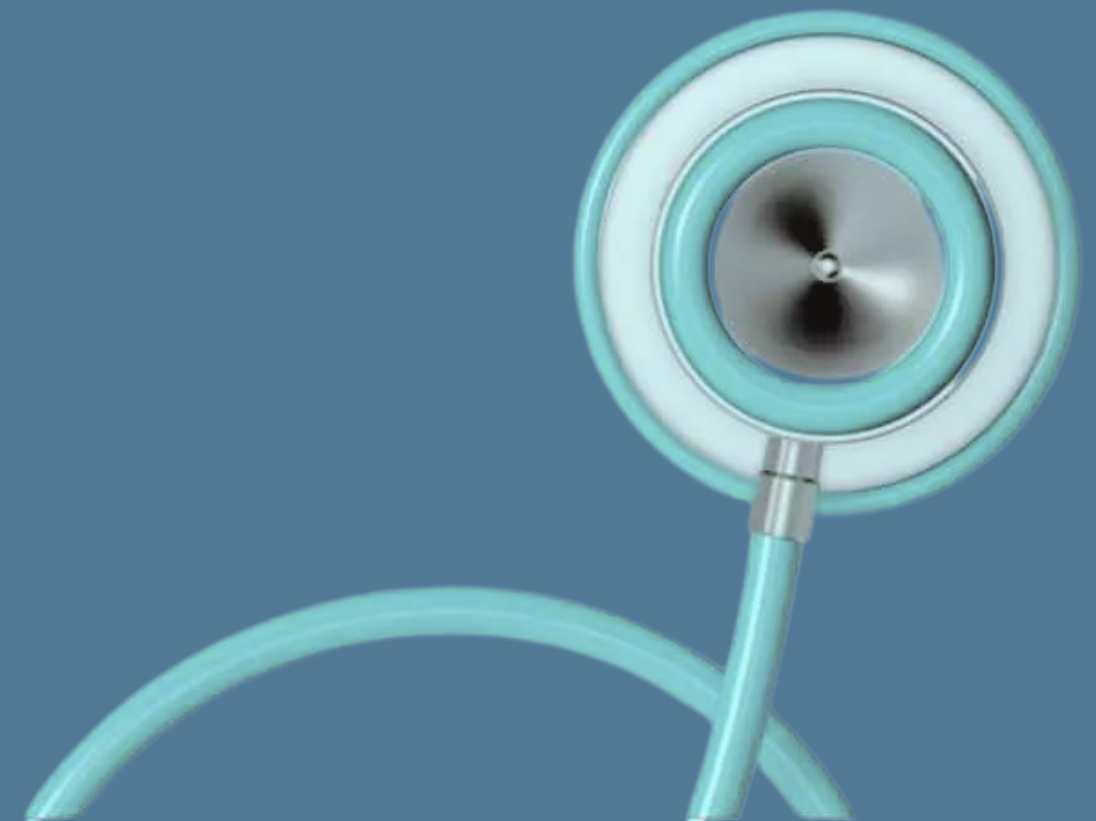
PROMISES AND
BARRIERS



Telemedicine and Telemonitoring

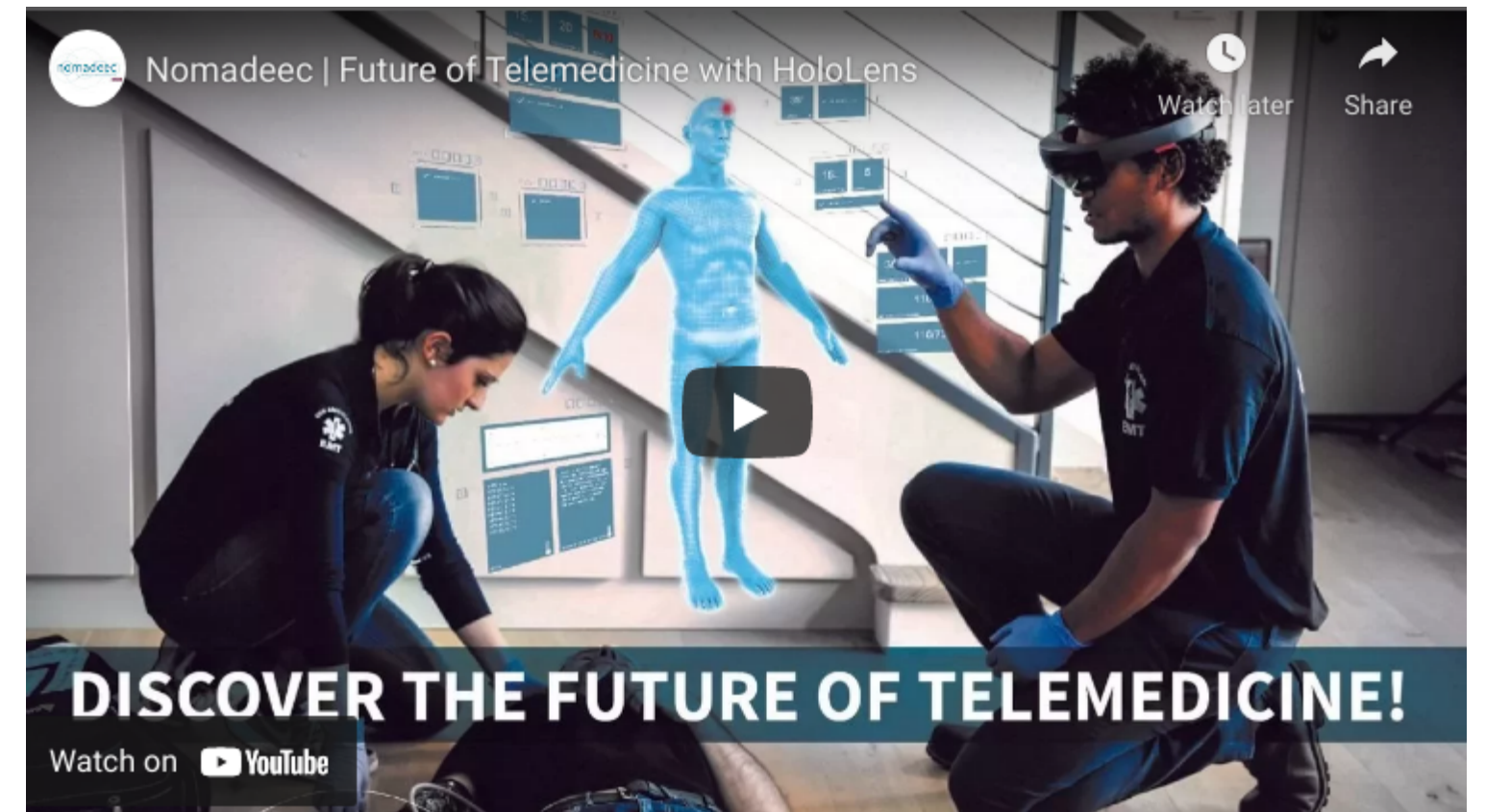
Certainly, a positive aspect consists in the uprise of telemedicine. **Telemedicine** is the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies, such as wearable devices, for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation.

[Telemedicine: Opportunities and developments in member states](#)



A particular form of telemedicine is telemonitoring, which makes it possible to remotely observe the health status of patients thanks to different kind of technologies.

Thanks to wearable devices, doctors and surgeons can apply telemedicine and telemonitoring to take an overview in real-time regarding a patient's health and make decisions based on the data taken from a person's technologies.





Data Overload

An important aspect is the difficulty of managing the huge amount of data produced by these wearable devices.

If we think that a single wearable product records and transmits **thousands of data every day**, we could face an overcrowding of hospitals and a lack of care for each patient.

It is necessary to establish through various studies the stakes within which wearable systems generate alarms and accurate diagnoses.

[Information overload: A tsunami of personal health data from new wearables](#)

Safety/Reliability and patient Data Protection

It is highly conceivable that people can become addicted to automated systems that provide a false sense of security or induces a self-guided misdiagnosis.

The devices are marketed under the premise that they will help improve overall health and fitness, but most manufacturers do not provide empirical evidence to support the effectiveness of the products sold.

Finally, for patients and doctors, the privacy and security of personal data generated by consumer wearables remain problematic.



Overdiagnosis

When we talk about wearable technologies, one of the major problems is over-diagnosis.

A person who always keeps track of his vital signs through a smartwatch or any other wearable device could be subject to conditioning and be led to carry out unnecessary treatments or care.

[Overdiagnosis: what it is and what it isn't](#)



While many advocate wearables as tools that will revolutionize 21st century medicine, the issue remains a huge question mark.

Moving forward, doctors, researchers and computer scientists should seek to work together and open a constructive dialogue on how to address and embrace these technological advances in order to ensure that wearable technology can become a valuable resource for healthcare.

04

CONCLUSION

The future at a glance



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Sitography

ChooseMUSE Apple uprightpose Philips FortuneBusinessInsights Information overload: A tsunami of personal health data from new wearables
Siren Care MyMotiv KardiaMobile Current Nuvocares Owletcare Insidemarketing

Videos

- [Google Glass proof of concept - Philips Healthcare](#)
- [Heart Health Monitoring: Fitbit ECG App On The New Fitbit Charge 5](#)
- [How UPRIGHT works](#)
- [How To Record a Clean EKG With KardiaMobile](#)
- [Keep a close watch on patients with the Philips wearable biosensor](#)

- [Nomadeec | Future of Telemedicine with HoloLens](#)
- [The Future of Healthcare](#)