Advanced Body Sensors & Networks for Inflight Biomedical Monitoring

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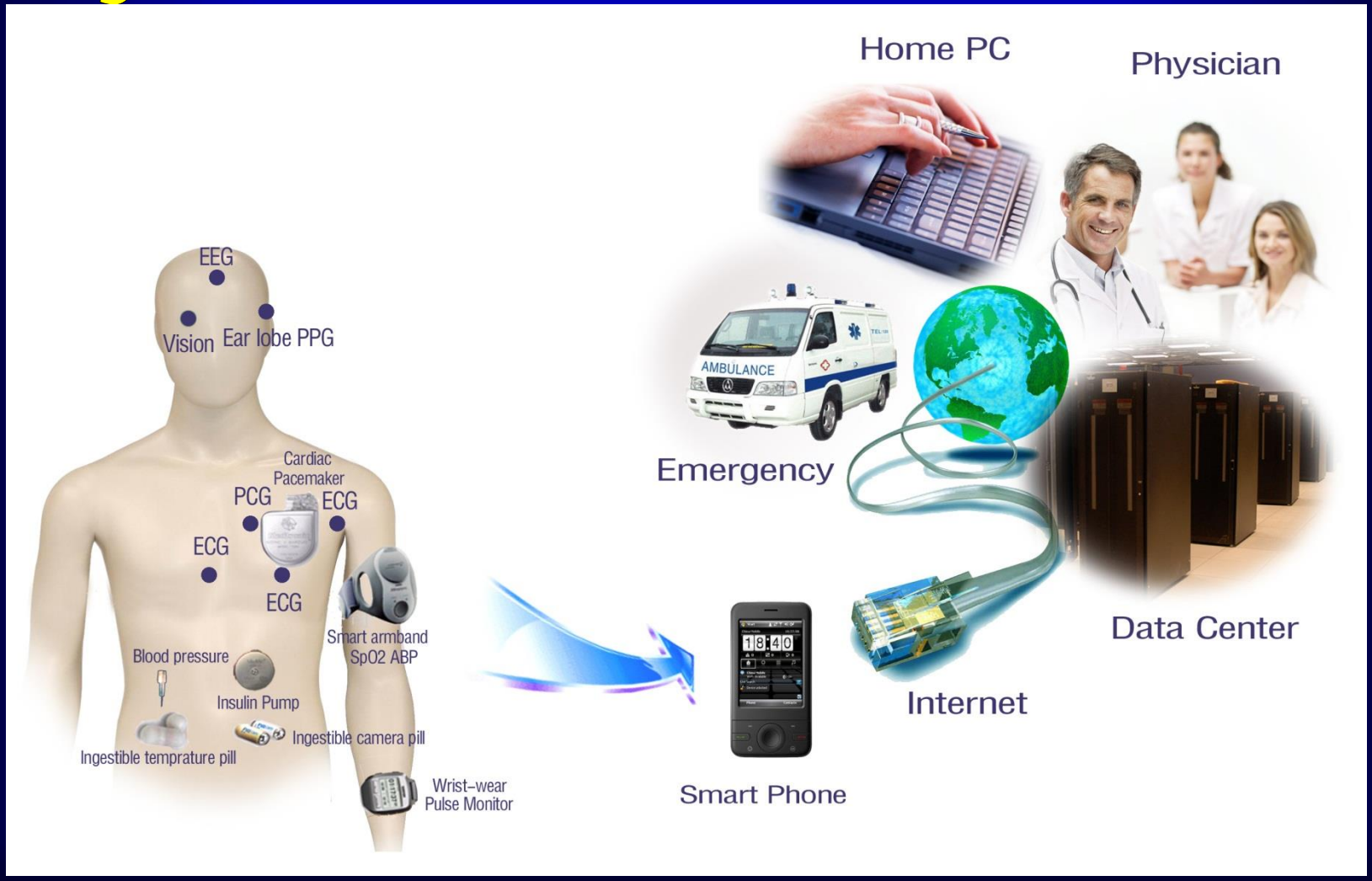
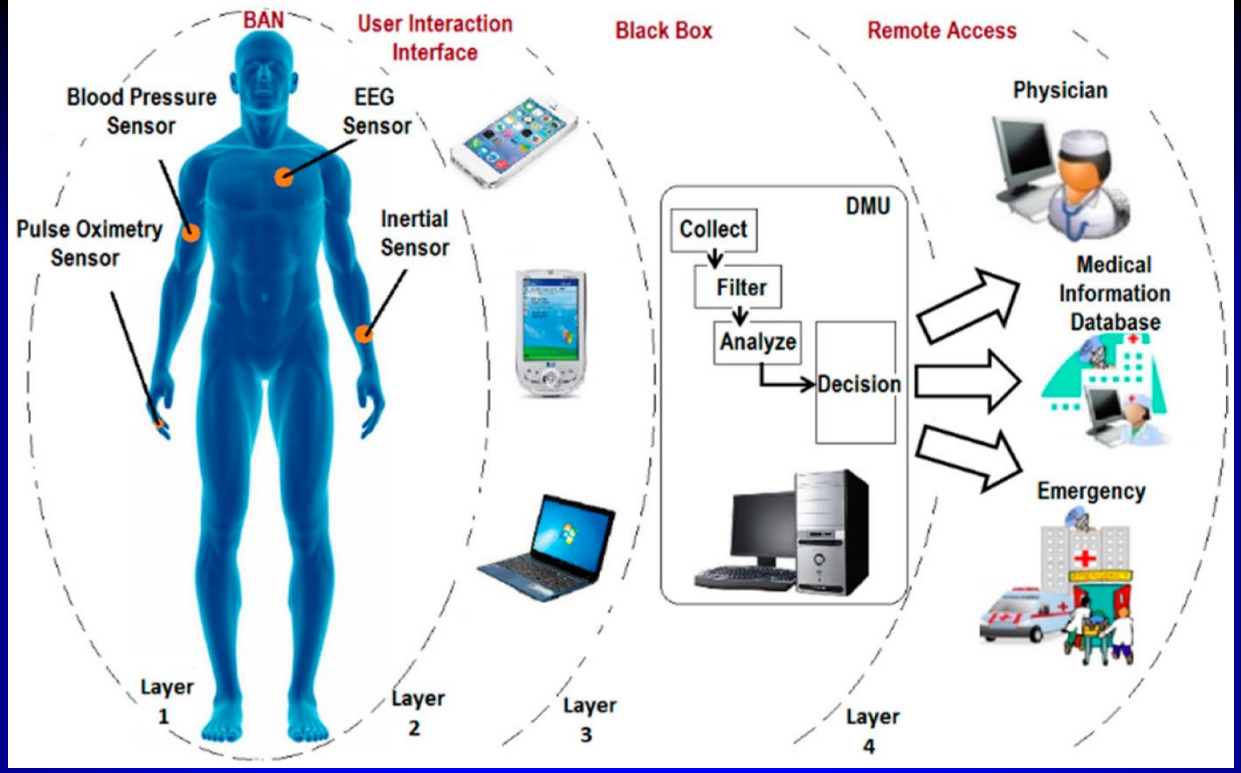
I have no financial interests and/or potential conflicts of interest to disclose

Body-Worn Medical Sensors





Advanced body sensors and networks could be used as the next generation of non-invasive, wireless, small, light-weight, low mass, and self-powered inflight biomedical monitoring devices for flight crews, flight attendants, passengers and air ambulance patients

Remote patient monitoring to save $36B by 2018

Remote patient monitoring will save the world's healthcare systems up to $36 billion by 2018, according to a new projection by **Juniper Research**

North America will account for a little over ¾ of the savings, with Western Europe making up the next biggest chunk

Practical Implications of Advanced Medical Technologies for Flight Crews

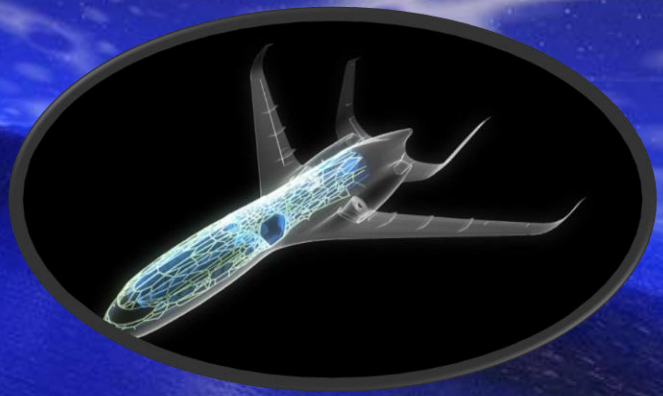
Aerospace crews are directly responsible for the safety of flight operations, and the main challenge for aerospace medicine practitioners is to ensure the medical fitness and performance readiness of generally “normal” individuals who work in “abnormal” aerospace environments

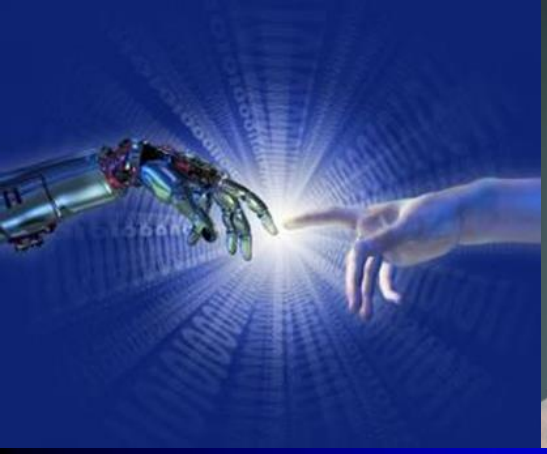
Practical Implications of Advanced Medical Technologies for Passengers

Regarding passengers, the role of aerospace medicine providers is to ensure that all individuals, whose health status may vary from clinically normal to diseased, will not die or experience in-flight medical emergencies, and will safely reach their final destination

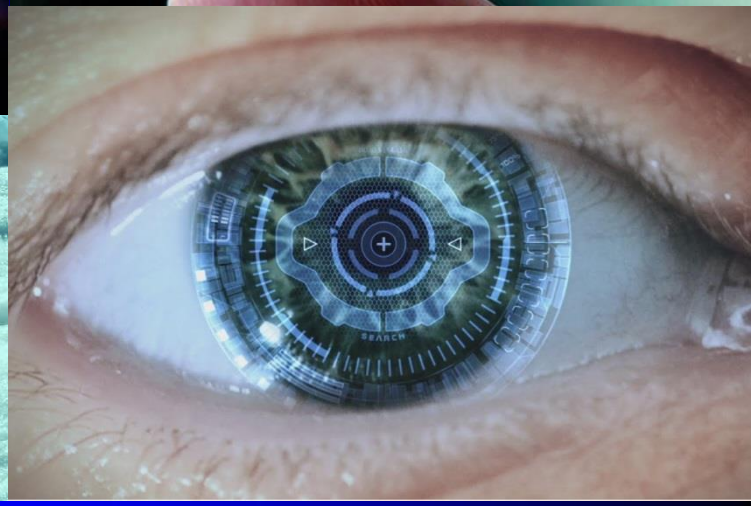
Aerospace Human Factors Considerations Relevant to the Operational Performance of Aerospace Crews

Human-Machine-Environment Interactions

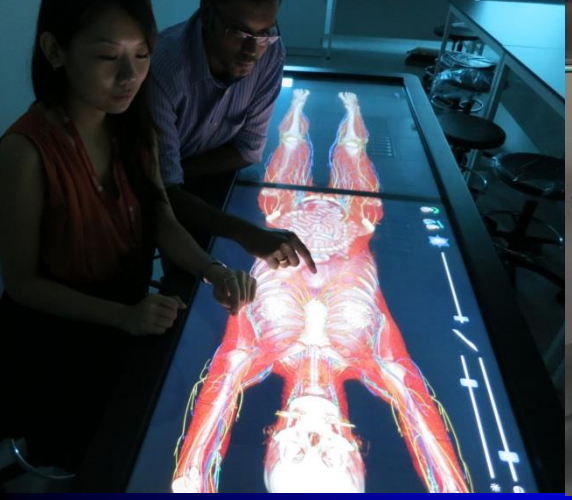




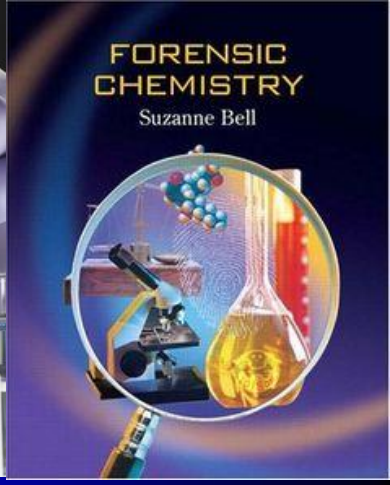
The traditional approach to understand the complex interactions between humans, machines and environment is evolving fast with the implementation of advanced medical technologies that can blur the differences between purely human and purely machine, and where the human body even has the potential to be modified to tolerate different types of environments



Some advanced medical technologies are intended to restore normal functions to individuals, but they also have the potential to increase human performance capabilities beyond the range of what is considered normal, or even provide new capabilities that humans do not or cannot possess naturally



Appropriateness of Current Autopsy Methods and Tools to Identify Evidence of New Advanced Medical Technologies

Appropriateness of Postmortem Toxicology Analytical Methods and Tools Available Today

UV LIGHT EXPOSURE MONITOR

UVA+B Sunfriend®

Sunfriend's UVeBand measures the period of effectiveness of sunscreen based on cumulative UV exposure and prompt users to reapply sunscreen when approaching its UV absorption threshold

UV sensors with LED indicators light up as UV exposure accumulates, before flashing once the safe limit has been reached

Fitness Monitoring Systems

StepWatch

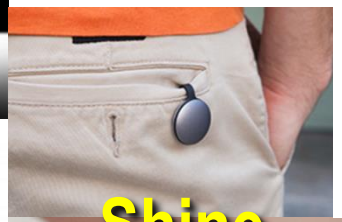
Sensoria Smart Socks

Primo 3

iRiver Earbuds

Angel Sensor

Fit Core



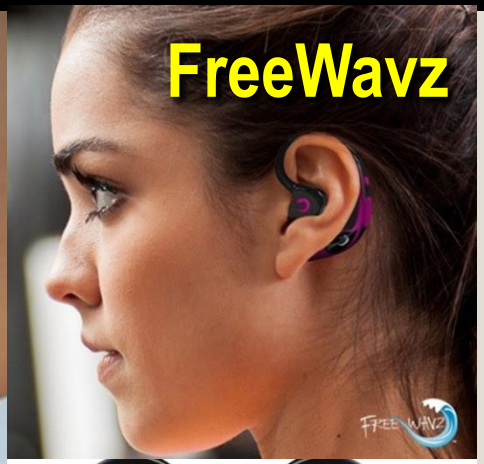
Shine

Airo

Vívofit

Fitness Monitoring Systems

Fitness + Oxymetry Monitoring Systems



Loop is a clinical-grade wearable designed to provide continuous vital sign monitoring and early detection of clinical deterioration

The device is capable of non-invasively measuring blood pressure, heart rate, oxygen saturation, CO_2 levels, and breathing rate

The Reliefband Neurowave is a smart-band that offers a drug-free treatment for nausea and vomiting associated with motion sickness, morning sickness, post-surgery, and even with virtual reality sickness

The Reliefband Neurowave employs FDA-cleared and patented technology that delivers electric pulses of a specific waveform, frequency, and intensity to the median nerve on the underside of the user's wrist.

SMARTWATCHES

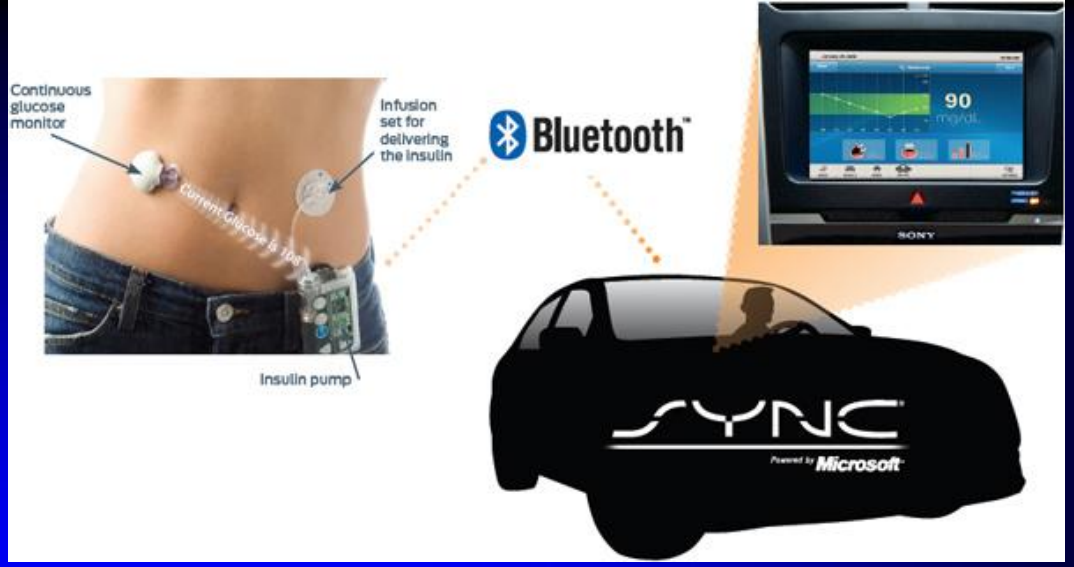
Continuous Blood Glucose Monitoring Systems

SugarBEAT

SugarSenz

iPro2 CGM

In-Car Health-Management SystemSystem



Ford partnered with **Medtronic** and others to develop a complete In-Car Health-Management System

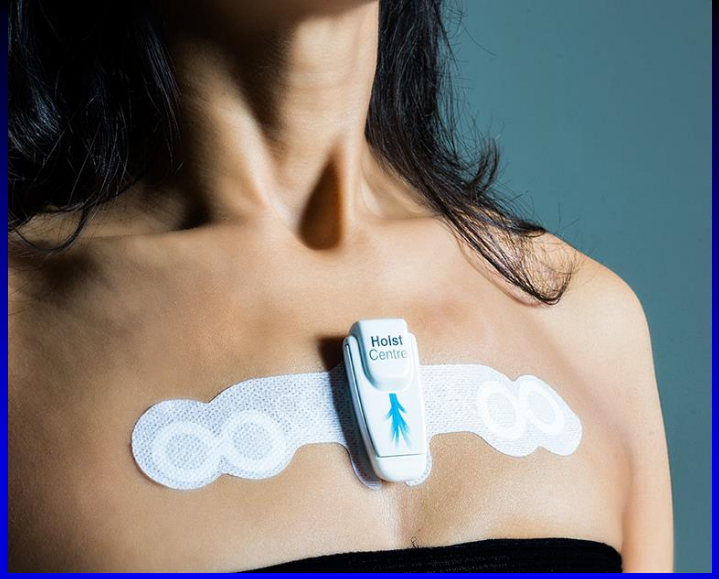
The system compromises of a Bluetooth-enabled continuous glucose monitor that connects to Ford's Sync hands-free control system, WellDoc's disease management platform where patients can document asthma attacks, glucose levels, and allergic reactions, all without letting go of the steering wheel, and access to data from SDI Health's Allergy Alert app that can provides local allergy related information as well as some other environmental health indices

Home Monitoring Health Patch

Vital Connect announced that the FDA cleared its reusable HealthPatch MD sensor for monitoring patients while they're at home

The device sticks to the chest and continuously records a one lead ECG, heart rate, heart rate variability, respiratory rate, as well as the temperature of the skin

It also has an accelerometer built in that senses the person's posture and can detect falls

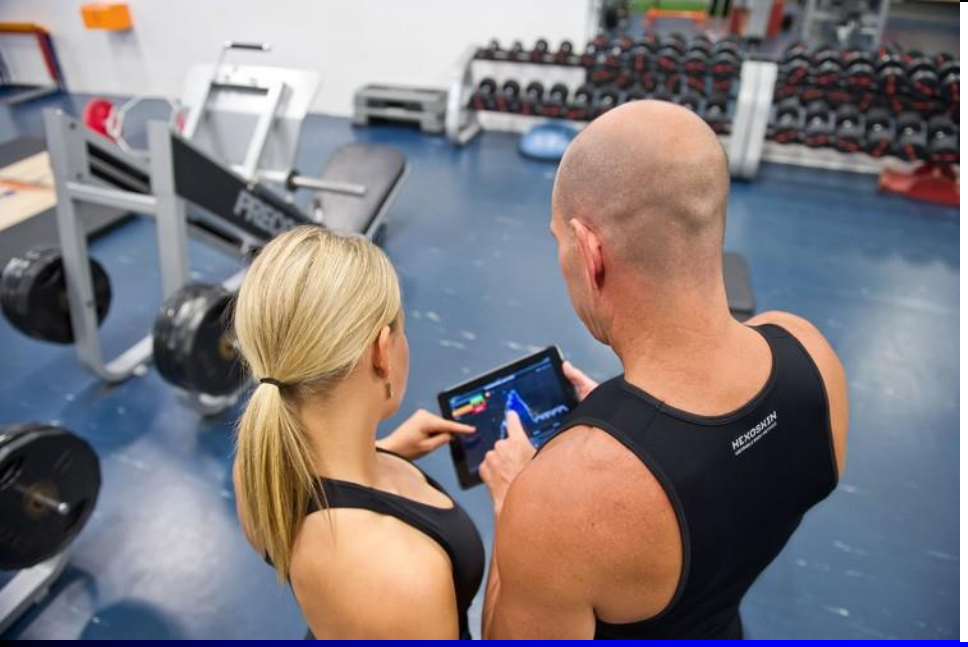


Holst Centre's health patch consists of a reusable main unit that connects to a disposable sticker with two embedded electrodes on each side

The health patch incorporates an accelerometer to monitor physical activity, ECG, and is also able to track body temperature, respiratory rate, and body composition

All of this critical data will be transferred to the user's mobile device using wireless Bluetooth technology, and can be easily shared with the user's healthcare provider for immediate review


er Jacket
Nuubo
OMSignal
Smart Clothes
FitnessSHIRT
Hexoskin



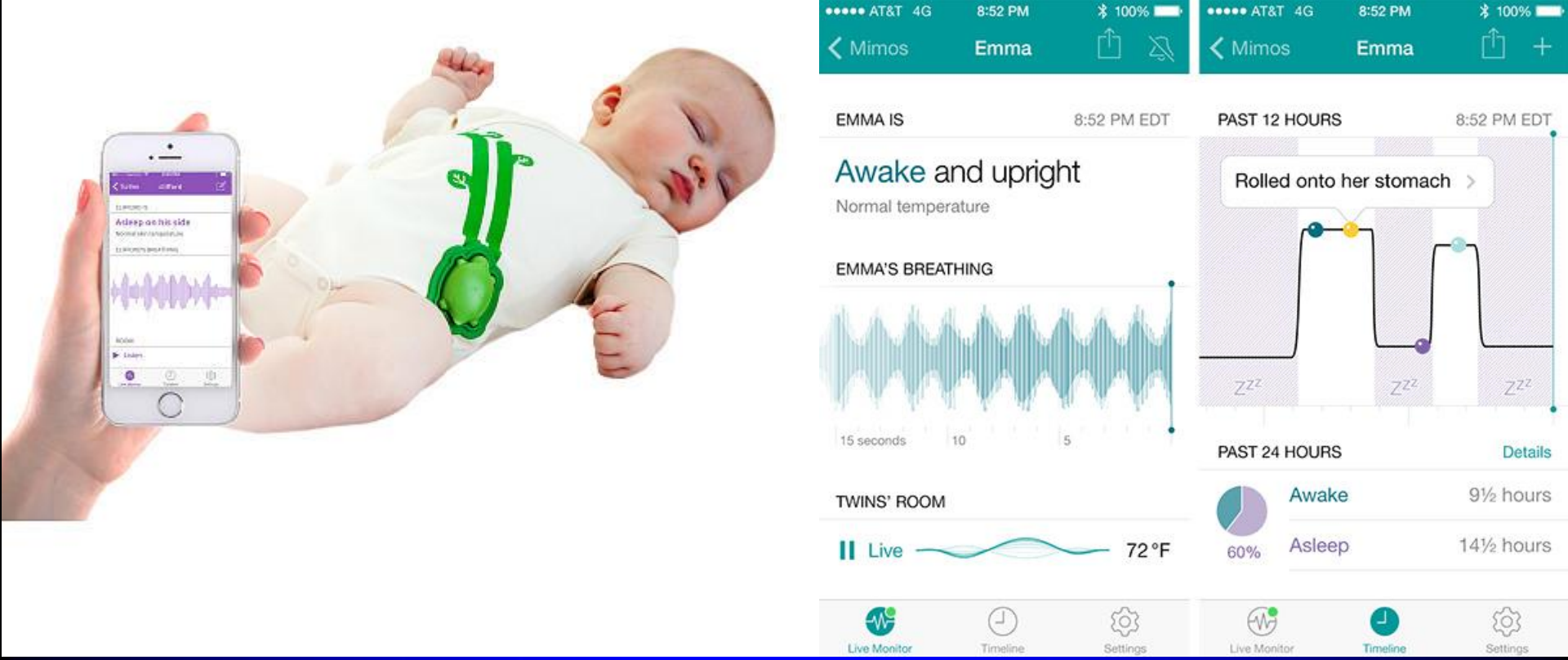
The **Hexoskin System** is a new sensor-fitted T-shirt and companion device that analyzes physical activity, heart rate and variability, respiratory rate and volume, and sleep, then sends the data to an online account via a smartphone

Infant Vital Signs & Ambient Conditions Monitors

Sproutling

Owlet Baby Care

Monbaby Smart Button



Rest Devices Mimo baby monitor helps parents remotely track their infant's sleep and biometric data

Wearable Pregnancy Monitor

Bellabeat developed a smartphone-enabled, fetal monitor device

Pregnant women can listen to and record their babies' heartbeat and track other aspects of their pregnancy from the companion app, including movement, kicks, and prenatal care

Wearable Pregnancy Monitor

Israeli firm **Nuvo Group** unveiled a wearable pregnancy monitor designed to let expecting parents and their physicians keep an eye on how the baby is developing

The PregSense is a belt that wraps around the mom's tummy and that has sensors that detect the baby's heartbeat, kicks, and even position within the womb

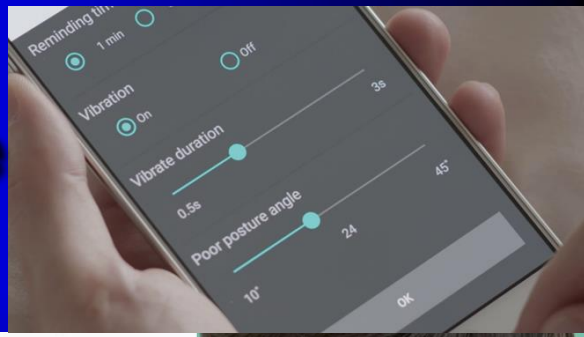
A consumer version of the device, called Ritmo Beats, will be available sometime later this year

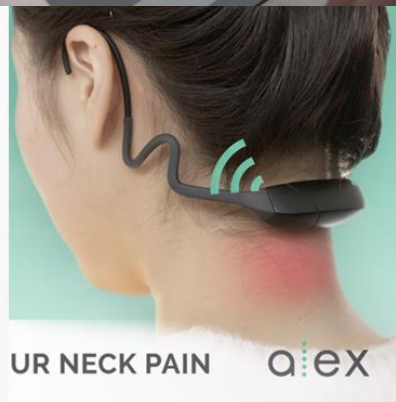
EarlySense is now releasing a new FDA cleared Chair Sensor that gleams the heart rate, respiratory rate, and motion from the patient's buttocks

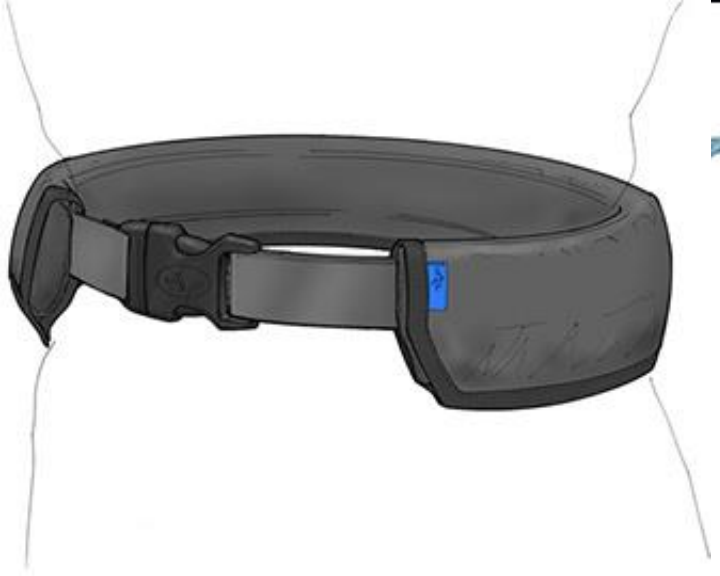
In addition to raising alarms when the heart or breathing rates are abnormal, the technology will also warn clinicians when a patient is trying to get up from the chair, helping make sure that someone is there to assist at a moment's notice

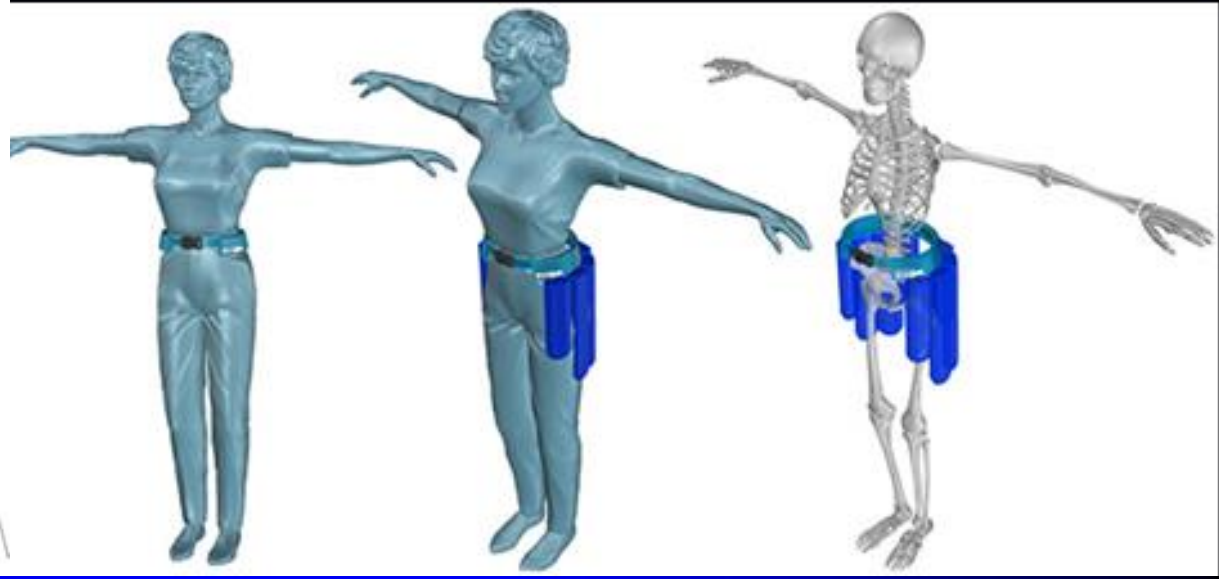
Posture Sensors

Alex posture tracker









ActiveProtective out of Lehigh Valley, Pennsylvania is developing belt worn airbags for elderly people prone to falling to prevent hip fractures

X-Prize and Qualcomm Announce $10 Million Tricorder Prize

Will be a tool capable of capturing key health metrics and diagnosing a set of 15 diseases

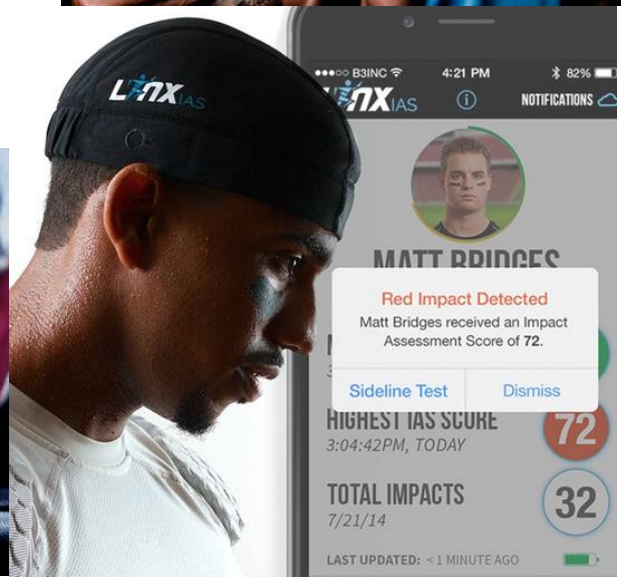
It will collect large volumes of data from ongoing measurement of health states through a combination of wireless sensors, imaging technologies, and portable, non-invasive laboratory tests

The Tricorder XPrize winner was the Final Frontier Medical Devices' DxtER isn't so much an all-in-one scanner as collection of noninvasive medical-diagnosis gadgets

DxtER is actually a small collection of specialized and smart medical devices that interact with the user's tablet designed for patients to use themselves

This includes a compact spirometer, a Mono test kit, medical-grade heart-rate and respiration monitors, and devices like the DxtER Orb, which doubles as a thermometer and stethoscope

BRAIN TRAUMA MONITORS



INTRACREANEAL HEMATOMA DETECTOR

Infrascan has received FDA approval for its Infrascanner 2000, a device for detecting intracranial hematomas

The Infrascanner is an easy-to-use screening tool which can be used to identify high-risk patients which should undergo further work-up including CT

Scanning a patient with the device takes about 2-3 minutes

It can detect hematomas greater than 3.5 cc in volume and up to 2.5 cm deep from the surface of the brain (or 3.5 cm from the skin surface)

Seizure Notification Device

The Embrace device, developed by **Empatica** (Cambridge, MA) has electrodes that press against the skin, a thermometer to track temperature changes, and accelerometers that detect motion

During a seizure, electrodermal activity goes up, driven by the brain's electrical hyperactivity and these electric current fluctuations in the skin help identify the ocurrence of a seizure

Google Glass

Production Ended January 2015

Google Glass-Based Pilot Information System

Pilots at Europe's leading Aviation School, Adventia, flew the first Google Glass operated flight in March 2014

The school believes this technology holds great promise for aviation, the high-tech capabilities of Google Glass was ideally designed for information (checklists, maps, charts, and guidance)

Google Glass-Based Fatigue Monitor

DriveSafe is an app for Google Glass that alerts drivers to when they are getting sleepy

Detects when the driver is falling asleep, sounding an alert through the Google Glass bone conduction speaker

DriveSafe can integrate with Glass' navigation capabilities to direct tired drivers to the nearest rest area

Vigo records various parameters each time you blink, such as duration and eyelid closing and reopening time and transmits this data to the app for processing

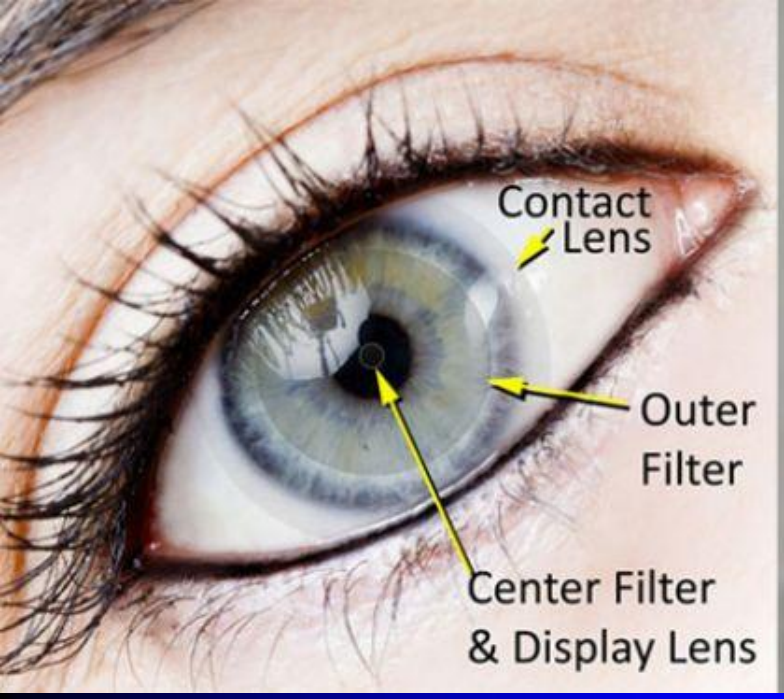
When it detects sleepiness, the device "nudges" the user, alerting them to their drowsy state and prompting them to re-focus

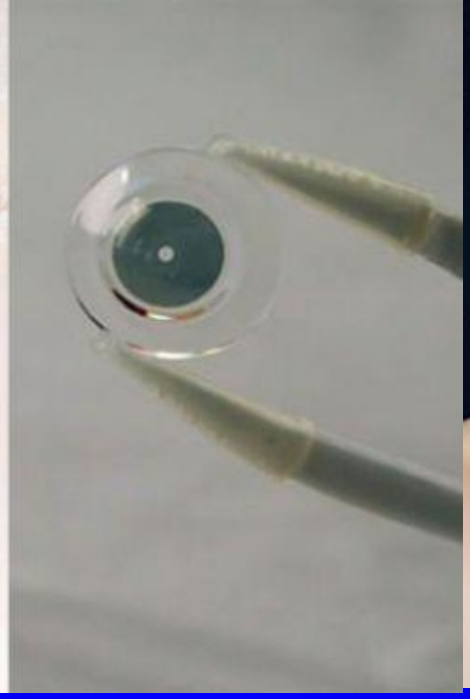
Other Glasses

Smart Contact Lenses

Applications include:

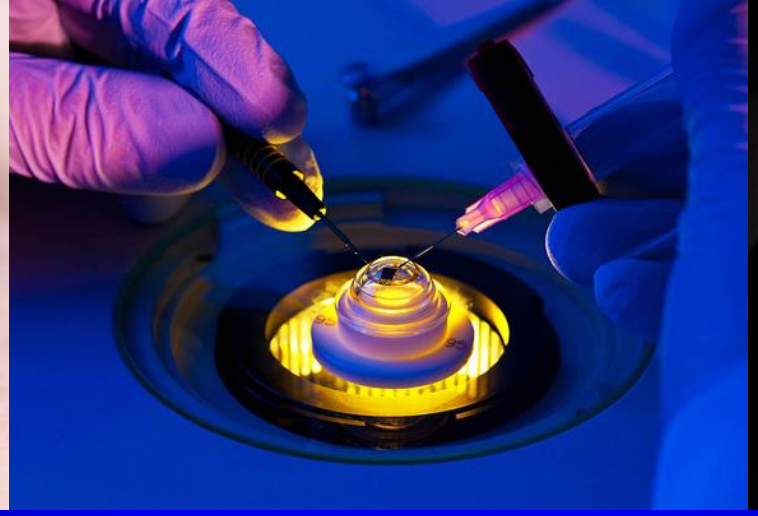
- Zooming in on distant objects
- Get useful facts to pop up in the field of view
- Create virtual cross-hairs
- Holographic driving panels surfing the Web
- Visual aids for vision-impaired people
- Immersive video games





Smart Contact Lenses

DARPA funded **Innovega's iOptik** contact lenses are intended to enhance normal vision by allowing to view virtual and augmented reality images without the use of any bulky device


Smart Contact Lenses to Monitor Intraocular Pressure

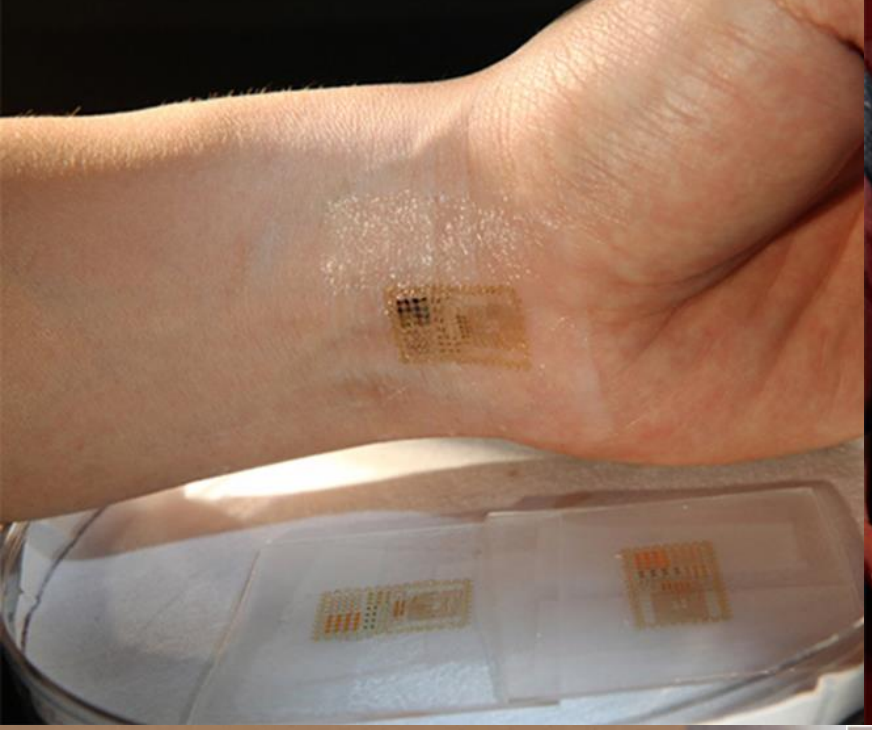
The **Sensimed** Triggerfish is a smart contact lens capable of continuous measurement of intra-ocular pressure throughout the day and is currently in clinical trials

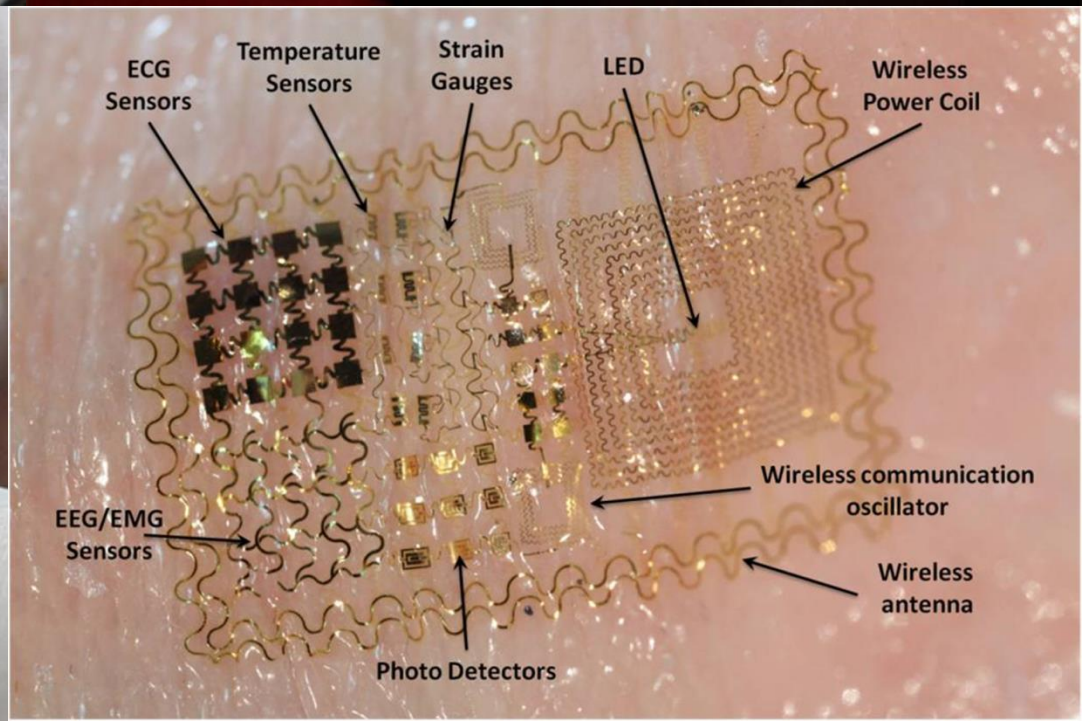
Smart Contact Lenses for Glucose Monitoring

Google developed a wireless chip and miniaturized glucose sensor, embedding them between two layers of soft contact lens material

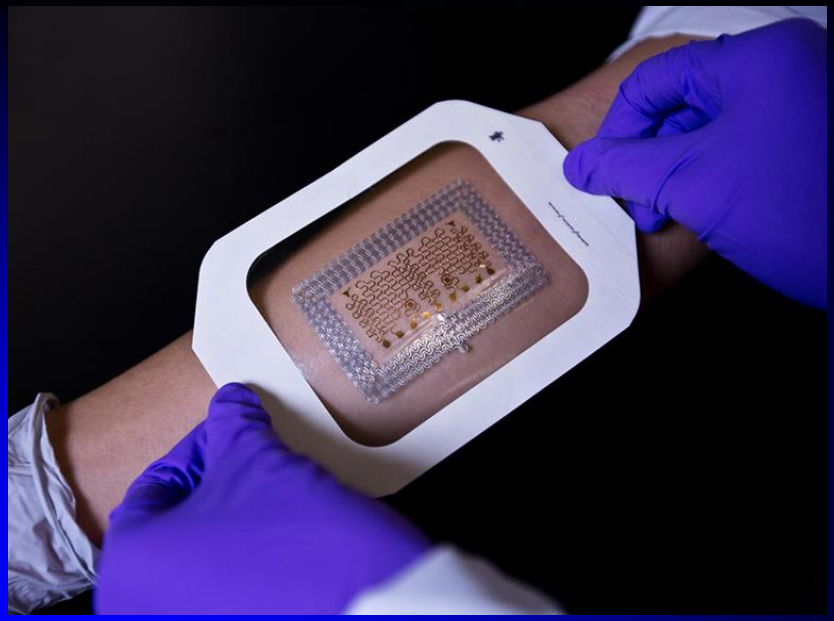
This formed a prototype of a smart contact lens capable of generating one reading of glucose levels per second

Electronic Skin Patches



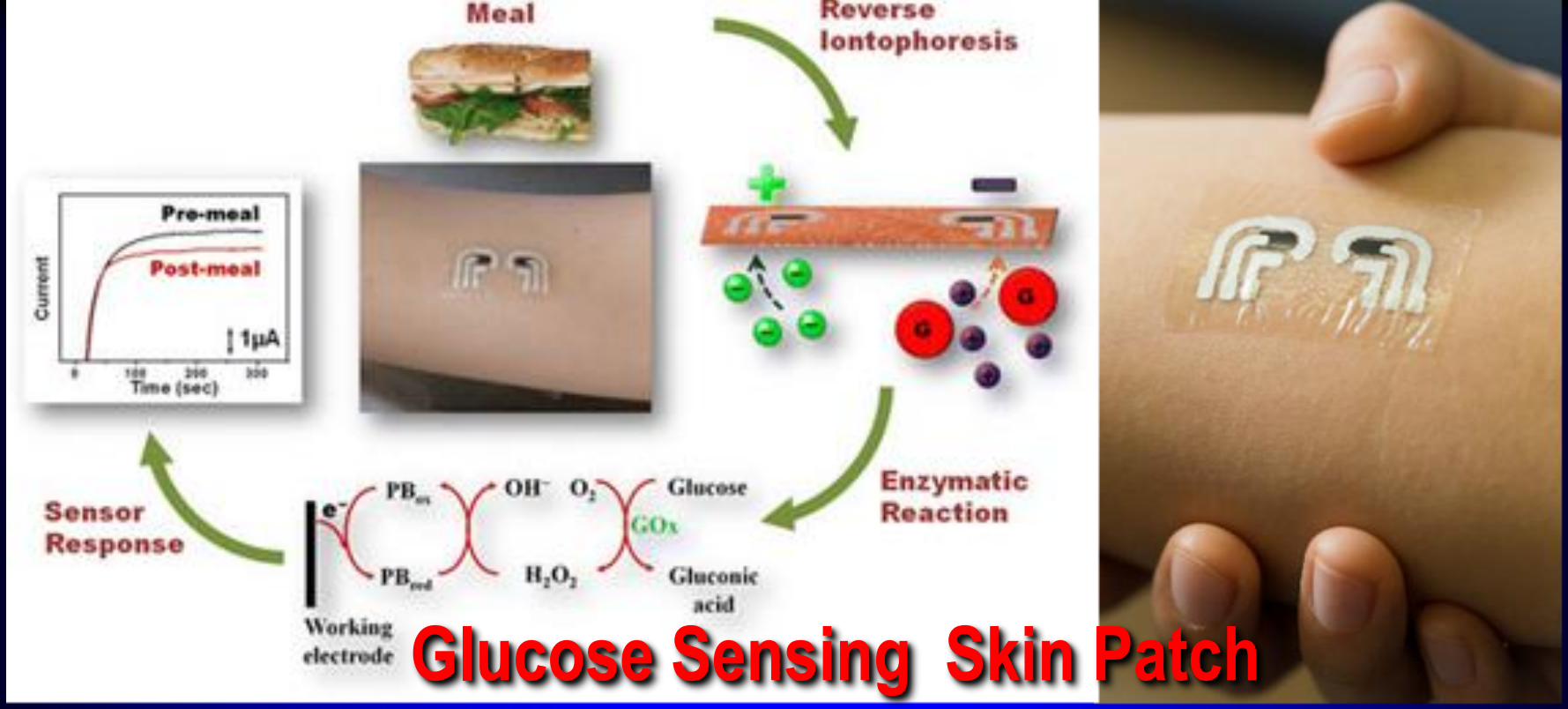


Physiological Monitoring Skin Patch



At the University of Texas at Austin investigators have come up with a technique for building flexible electronic skin patches for body monitoring of various electrophysiological signals, as well as skin temperature, hydration, and respiratory rate

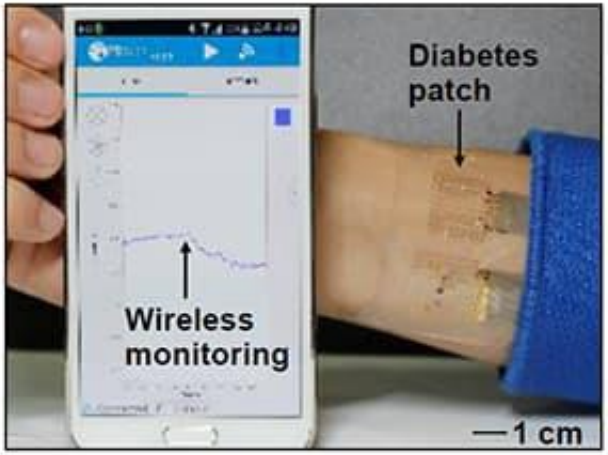
The researchers tested the new patches, capturing high quality ECG signals and demonstrating high flexibility and adhesion to skin folds. The next steps include trying to integrate other sensors into the patches and moving forward to bringing this technology into clinical use

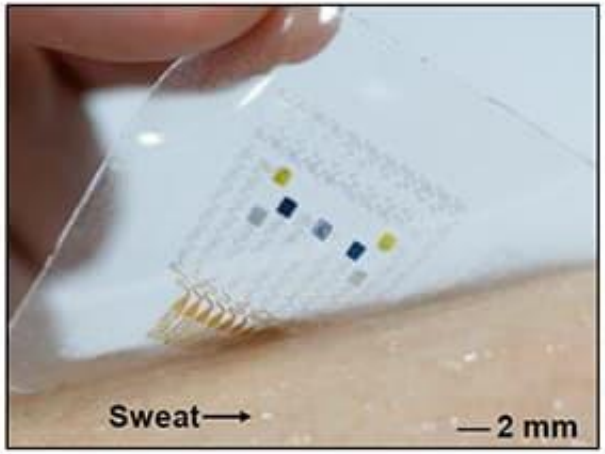


Researchers at University of California, San Diego have demonstrated in a proof-of-concept study a glucose sensing skin patch

The device samples interstitial fluid within the skin that contains glucose, among other analytes

The patch is entirely printed and remains flexible while stuck to the skin



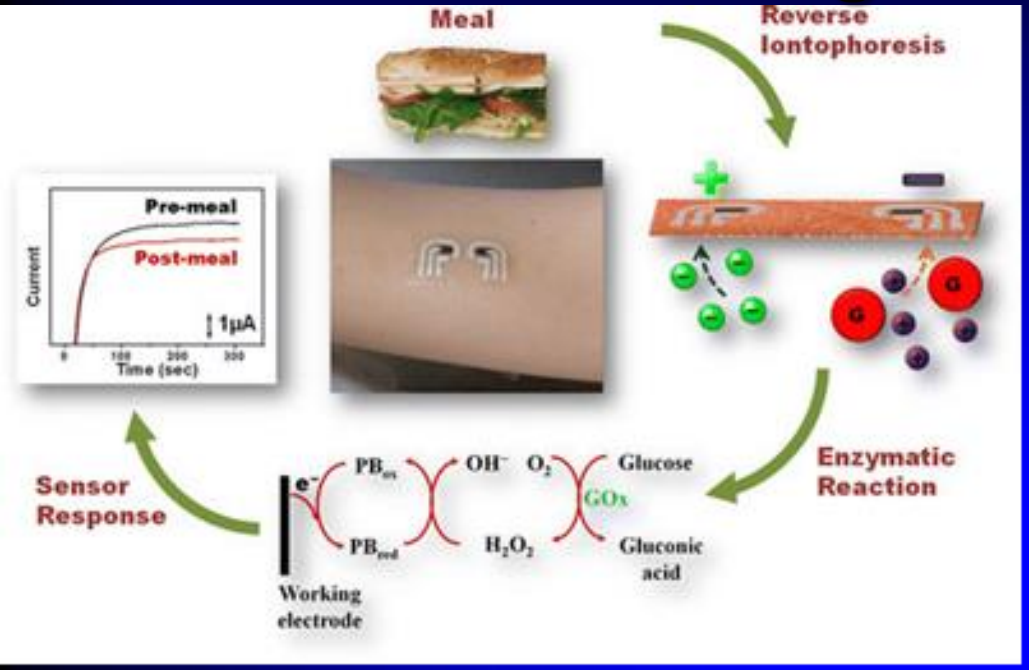


Glucose Sensing Skin Patch

Scientists at Korea's Institute for Basic Science built a sweat-sensing patch that contains sensors to monitor humidity and glucose, which are sandwiched in between a silicone water-proof film and a sweat-collecting layer

Humidity sensor monitors the increase in relative humidity (RH). It takes an average of 15 minutes for the sweat-uptake layer of the patch to collect sweat and reach a RH over 80 percent at which time glucose and pH measurements are initiated

Glucose Sensing Skin Patch



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Glucose, Lactate and Electrolytes Sensing Skin Patch

University of California, Berkeley researchers developed a new wearable sensor that can measure metabolites such as glucose and lactate, and electrolytes including sodium and potassium ions, within the sweat on the skin

Chemical Sensing Skin Patch

Australia Royal Melbourne Institute of Technology scientists are working on flexible body-worn patches that can detect the presence of different chemicals

They developed a prototype device that's transparent and conforms to the skin, while being able to detect the presence of hydrogen and nitrogen dioxide, as well as ultraviolet radiation

Researchers at Tel Aviv University in Israel developed new dry electrodes that are able to record high quality EMG while being comfortable for the wearer

The reserchers made a tattoo-like device that is able to continuously perform electromyography on the muscles of the face and hand

The new electrodes consist of a carbon ink screen printed onto a soft, flexible material

Because they have high conductivity while staying adhered to the skin during movement, the conductive gel becomes unnecessary

Skin Blood Flow Monitor

The Rogers Research Group at the University of Illinois at Urbana-Champaign developed a flexible skin sensor to measure blood flow in vessels 1 to 2 millimeters under the skin

Current methods to measure blood flow in a clinical setting rely on optical imaging techniques that require patients to remain still for the duration of the measurement

The skin sensor, which attaches to the skin like a temporary tattoo, would enable blood flow measurement over 24 hours

Low Cost EEG for Neuro-Feedback

A working prototype of a low-cost electroencephalography device funded by the US Defense Advanced Research Projects Agency (DARPA) is the first step in the agency's effort to jumpstart a do-it-yourself revolution in neuroscience

The main goal is to develop an ultra simple electroencephalography device for less than $30 that would allow anyone to take research-grade measurements of their own brain

Brain Controlled UAS

Researchers at the University of Minnesota are developing a mind-controlled quad-copter UAS using a skullcap fitted with a Brain Computer Interface (BCI)

Brainflight Project

Scientists at the Institute for Flight System Dynamics at Technische Universität München (TUM) and Technische Universität Berlin (TU Berlin) are involved in the EU-funded Brainflight project

The goal of project BRAINFLIGHT is to investigate what are the best approaches and parameters that allow fast learning to control an aircraft using brain signals, while allowing pilots to multitask