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# **Wearable Medical Technology**

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# What is Wearable Technology?

- Technology that is designed to be used while worn.
- Such as smartwatches, smartglasses, smartrings, clothing, and attachable or implantable medical devices.
- Wearable electronic devices connected to the wearer that detect, analyze, and transmit information such as vital signs, and/or ambient data
- Can allow in some cases immediate biofeedback to the wearer.



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# What is Wearable Technology?

- Type 1- Non- FDA Approved
- Most wearable Over The Counter- “Smart” products
- Type 2- FDA Approved
- Class 1- Lowest risk to patients – stethoscope
- Class 2- If used incorrectly pose a risk to operator and patient- ECG
- Class 3- Can harm patients and users if they fail or are used incorrectly – Defib
  
- Some wearable medical devices fall into this category- such as Holter Monitor, and Insulin Pump. These are devices that are prescribed.



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# History of wearable medical devices

- 1800s:
  - Hearing aids
  - Eyeglasses
- 1900s
  - Wearable wristwatch
- 1930s- Pacemaker
- 1940s- Holter monitor- “radio telemetry”
- 1970s
  - Temperature detection- on watches
  - Calculator watches



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# History of wearable medical devices

- 2000s
- Wearable cameras on watches
- Bluetooth- key development
- 2010
- FitBit- movement tracker
- 2013
- Near Field Communication Ring (NFC Ring)  
“Smartring”
- Samsung Galaxy
- 2015- Apple Watch



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## Apple WATCH





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## Insulin Pump History

- Insulin Pump
- 1974- Biostator – Closed-loop insulin delivery system
- FDA Approved
- 60Kg bedside unit
- \$50K/month to rent
- Type 1 Diabetes





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## Insulin Pump History

- 2000s
- Wearable Glucometer
- Wearable Insulin Pump
- App for pump and glucometer
- Closed Loop
- Bluetooth
- Better A1C for patients
- Reports and alerts
- Type 1 diabetes





# Insulin Pump Data

**Overview**  
2 days | Sat Apr 1, 2023 - Sun Apr 2, 2023

## Devices

**Dexcom G6 Mobile App**

CGM ID

Serial Number: iPhone  
Uploaded On: April 2, 2023  
Model: G6

### Alert Settings for Device

General		
Low	On	70 mg/dL
Low Repeat	Off	0 min
High	On	250 mg/dL
High Repeat	Off	0 min
Fall Rate	On	3 mg/dL/min
Rise Rate	On	3 mg/dL/min
Urgent Low	On	55 mg/dL
Urgent Low Repeat	On	30 min
Urgent Low Soon	On	
Urgent Low Soon Repeat	On	30 min
Signal Loss	On	20 min

Automated

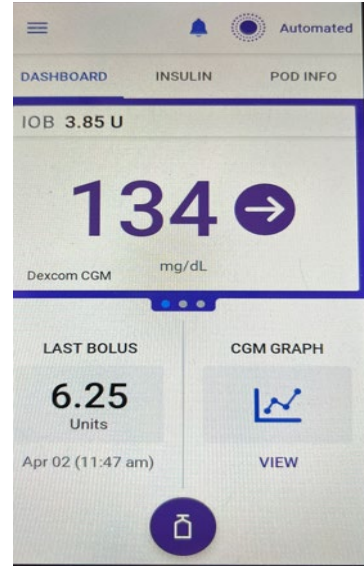
DASHBOARD INSULIN POD INFO

IOB 3.85 U

**134** →  
mg/dL  
Dexcom CGM

LAST BOLUS: **6.25** Units  
Apr 02 (11:47 am)

CGM GRAPH  
VIEW



**Overview**  
2 days | Sat Apr 1, 2023 - Sun Apr 2, 2023

## Glucose

Average Glucose: **147** mg/dL

Time in Range: 81%  
4% Very High  
8% High  
81% In-Range  
7% Low  
2% Very Low

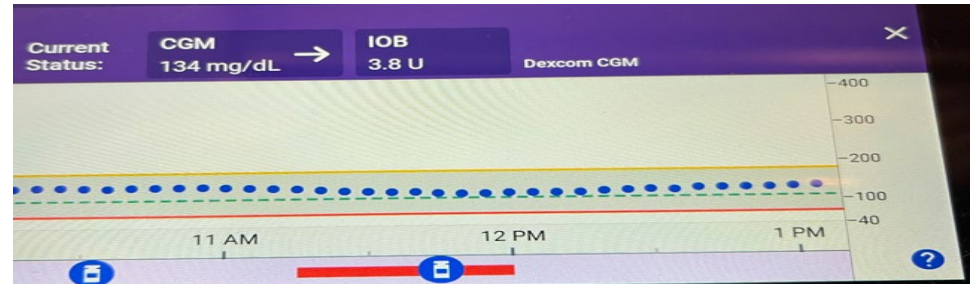
Sensory Usage: **100%**

Standard Deviation: **55** mg/dL  
COB: N/A

Top Patterns: **Carb's best glucose day was April 1, 2023**



Current Status: CGM **134 mg/dL** → IOB **3.8 U**  
Dexcom CGM



11 AM 12 PM 1 PM



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## Vital Signs

### NORMAL VITAL SIGNS IN ADULTS

**CORE TEMPERATURE**

98.6°F (37°C)

**HEART RATE**

60–100 beats per minute

**RESPIRATORY RATE**

12–18 breaths per minute

**BLOOD OXYGEN**

95–100%

**BLOOD PRESSURE**

120/80 mm Hg



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## NFC Rings

- Heart rate
- SpO2 (blood oxygen)
- Respiration
- Blood Pressure
- Body temperature tracking
- Tracks steps
- Track sleep
- Heart Rate Variability (HRV)





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## Smart Watch

- Step Counter
- Heart Rate
- Respiratory Rate
- Blood Pressure
- Calorie Counter
- Pulse Ox (blood oxygen)
- Temperature
- ECG – Electrocardiograph
- Fall Detection
- Connectivity- to phone or “home base”





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## Is it Comparable to Hospital Equipment?



What do you think?



Have any of you done any  
comparing or thought about it?



Do you know of any interaction  
with hospital equipment?

# Accuracy

- Can these devices be trusted?
- How can accuracy be tested?





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# Creating a Healthier Patient Population

- **Patients with chronic diseases, wearable devices can reduce the number of hospitalizations**
- **Patients can adjust routines and diets according to the display of the wearable device data**
- **This can save expensive treatment costs or hospitalization**



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# Creating a Healthier Patient Population

- **Monitoring Sleep:**
- **Heart Rate Variability- Spacing between R waves. Why is this important?**
- **Blood Oxygen- This can tell if the wearer stops breathing or if O2 is lowered**
- **Motion while sleeping**
- **Can help detect early Sleep Apnea**
- **Sleep Apnea can lead to other problems if untreated**





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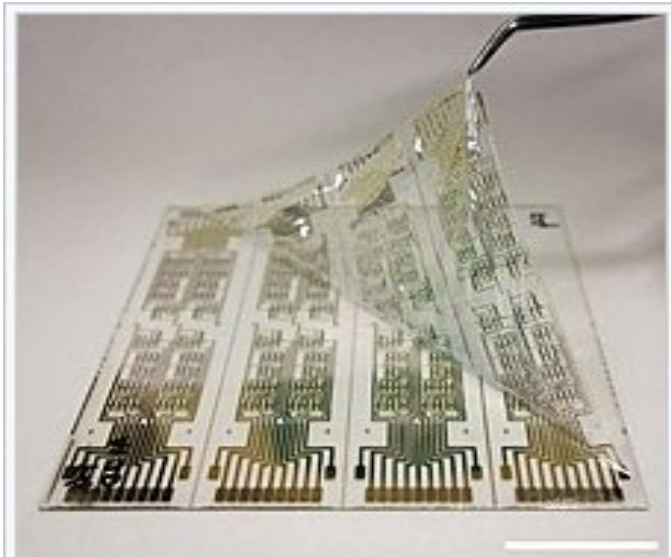
# Wearable Sensors in Clothing

- **Hexoskin- Brand Name**
- **3 lead ECG**
- **Respiration**
- **Pulse Ox**
- **Blood Pressure**
- **Skin Temperature**
- **3 Axis Accelerometer**
- **Non-invasive**
- **Machine washable**
- **36+ hour battery**
- **Bluetooth to phones**
- **Clinically validated by research labs**

# Wearable Sensors- Astroskin



# Miniaturization and Organic Electronics



Organic CMOS logic circuit. Total thickness is less than 3  $\mu\text{m}$ . Scale bar: 25 mm



Organics-based flexible display

# Heart Rate Variability

HRV stands for heart rate variability and is the measurement of how the interval of time between heartbeats changes. You don't notice these tiny variances but devices like Apple Watch capture HRV, which is measured in milliseconds.

# Heart Rate Variability

AVERAGE

**32** ms

Friday, October 6, 2023



# Heart Rate Variability

AVERAGE

**166** ms

Thursday, October 5, 2023



# Heart Rate Variability



The image shows a screenshot of a mobile application interface titled "Beat-to-Beat Measurements". At the top left, there is a blue back arrow. Below the title, the unit "BPM" is displayed. The main content is a list of ten rows, each representing a heart rate measurement at a specific time. The heart rate values are 106, 66, 82, 54, 73, 97, 100, 53, 99, and 89. The corresponding times are 12:17:25.37 AM, 12:17:26.28 AM, 12:17:27.01 AM, 12:17:28.12 AM, 12:17:28.94 AM, 12:17:29.56 AM, 12:17:30.16 AM, 12:17:31.30 AM, 12:17:31.90 AM, and 12:17:32.58 AM.

BPM	Time
106	12:17:25.37 AM
66	12:17:26.28 AM
82	12:17:27.01 AM
54	12:17:28.12 AM
73	12:17:28.94 AM
97	12:17:29.56 AM
100	12:17:30.16 AM
53	12:17:31.30 AM
99	12:17:31.90 AM
89	12:17:32.58 AM

**Atrial Fibrillation — ❤️ 129 BPM Average**

This ECG shows signs of AFib and a high heart rate.

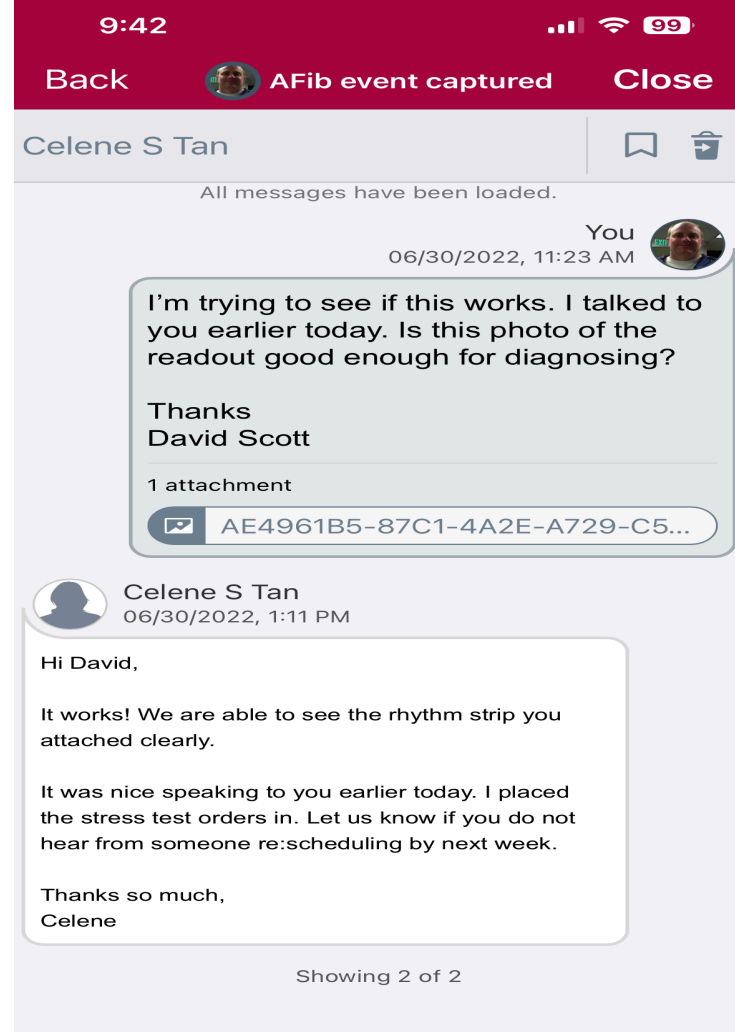
If this is an unexpected result, or your heart rate stays high, you should talk to your doctor soon.



25 mm/s, 10 mm/mV, Lead I, 512Hz, iOS 16.3.1, watchOS 8.6, Watch6,7, Algorithm Version 2 — The waveform is similar to a Lead I ECG. For more information, see Instructions for Use.



# Healthcare App on phone





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# Future

- **Biosensors can measure skin conductance, heart rate, and body temperature, as well as detect changes in pH, glucose, and salt in the human body through sweat and tears**
- **Tattoo-based epidermal biosensors**
- **Clothing- metal woven fabric**
- **Sweat glucose monitoring systems that combine pH, humidity, and temperature sensors have led to improvements in the therapeutic application of diabetes care.**



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# Future

- **Power- battery technology – solid cell technology, advancements in electric cars. Solar on wearables.**
- **More sensors in development- cancer detection, early detection for other health issues**
- **More sensors could lead to more/different technology in hospitals**
- **Better/more connectivity**
- **More data**
- **More miniaturization**
- **AI interpretation- even “smarter”**

Future





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# Conclusions

- **Need- Secure data transmission- maybe a medical Wi-Fi?**
- **Earlier detection of possible health issues- better outcomes**
- **Healthier patient population**
- **More and better healthcare at home**
- **Hospitals- will have higher acuity patients**
- **Doctors or “AI Doctors” will be more in touch with patients, more “data crunching”**
- **BMETs will be involved with technology and advancements**



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## References

- [Hexoskin Smart Shirts - Cardiac, Respiratory, Sleep & Activity Metrics](#)
- [The best smart clothing: From biometric shirts to contactless payment jackets – Wareable](#)
- [E-textiles – Wikipedia](#)
- [Organic electronics – Wikipedia](#)
- [Smartwatch – Wikipedia](#)
- [Smart ring – Wikipedia](#)
- [Reshaping healthcare with wearable biosensors | Scientific Reports \(nature.com\)](#)
- [A wearable ultrasound scanner could detect breast cancer earlier \(medicalxpress.com\)](#)



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**Thank You!**