Digital Health

Spring 2025

UNIVERSIDAD POLITÉCNICA DE MADRID

#6 mHealth: Medical apps, virtual reality, wearable sensors, monitoring, gamification

Agenda

- Medical apps, virtual reality, wearable sensors, monitoring, gamification and other tools
- Learning objectives: Discipline literacy, critical analysis skills, applied and integrative learning, ethical reasoning, global or civic engagement, written communications, oral communications, soft skills.
- Present Homework #2
- Lecture, videos, discussion questions
- Guest lecture
- Next week: Social media and public health. Read https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9925030/
- Homework Assignment #3

mHealth

- **mHealth** stands for mobile health. It is a general term for the use of mobile phones and other wireless technology in medical care.
- Includes apps, wearable sensors, virtual reality, gamification
- These consumer medical tools may fall outside of regulatory oversight (at least in the U.S.) so buyer BEWARE!

mHealth

- **Digital stethoscope** for consumers. The patient places it on their chest and the captured signal is sent via an app to be analyzed or to their doctor.
- 400 Euros

mHealth Market Segments

- 1. On-body segment
  - Clinical-grade wearables: regulated devices (eg, US FDA) and supporting platforms
    - For example, Holter monitor – patient wears for 1-2 days to detect heart arrhythmias
  - Consumer health wearables: activity trackers, bands, wristbands, sports watches, and smart garments.
- 2. In-home segment
  - Personal emergency response systems
    - For example, wearable devices helping home bound or limited-mobility seniors quickly communicate and receive medical care.
  - Remote patient monitoring (RPM)
    - For example, patients in locked dementia units

mHealth Market Segments

- 3. Community segment
  - Mobility services: allow passenger vehicles to track health parameters during transit.
  - Emergency response intelligence designed to assist first responders, paramedics and emergency department care providers.
  - Kiosks: physical structures, often with computer touchscreen displays, that can dispense products or provide services such as Covid-19 tests or overdose reversal medication.
  - Point-of-care devices: medical devices used by a provider outside of the home or traditional health care settings, such as at a medical camp.
  - Logistics: transport and delivery of goods and services including pharmaceuticals, medical and surgical supplies, medical devices and equipment needed by care providers, eg, sensors in pharmaceutical shipments that measure temperature, humidity

mHealth Market Segments

- 4. In-Clinic or In-Hospital segment
  - Devices that are used for administrative or clinical functions at the point of care, eg, digital stethoscope.
  - Asset management monitors and inventory management
  - Personnel management measures: staff efficiency and productivity.
  - Patient flow management
  - Environment (e.g., temperature and humidity) and energy monitoring ensuring optimal conditions

Medical Apps

Uses: virtually all kinds of health conditions, chronic pain, cancer, diabetes, cardiovascular diseases, drug information

Micromedex - Pharmaceutical reference app with features such as proper drug dosage and medicine recommendations, sold with a subscription

The Rise of Femtech – 2016

Tech-enabled, consumer-centric solutions addressing women's health

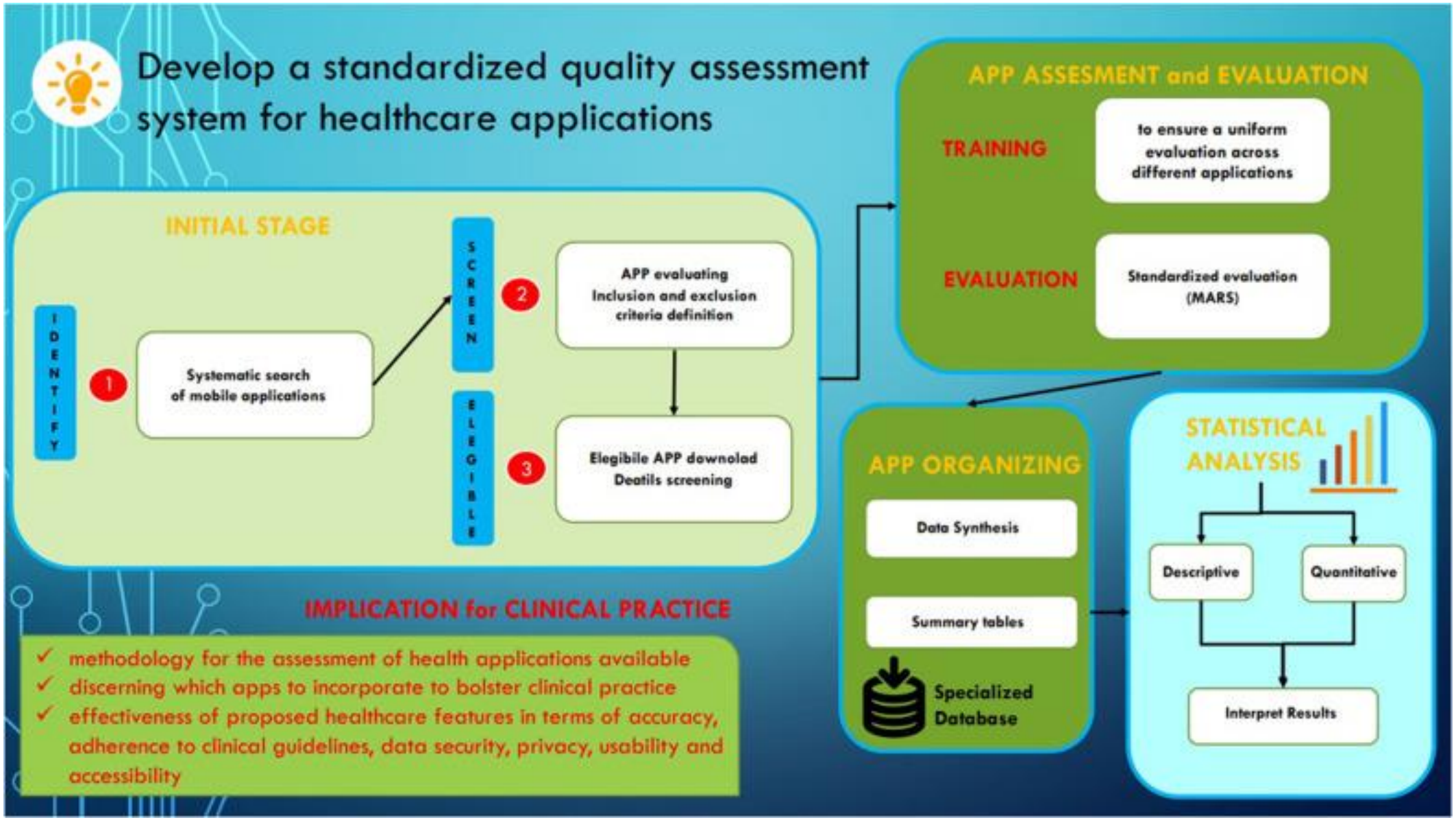
- Valley Electronics, Murnau, Germany created the original fertility tracking tech device, called the Lady-Comp fertility tracker.
- $500

Discussion Questions

- What process should an app developer use to ensure accuracy?
- As a consumer, what should be the criteria to select a medical app to use?
- Can doctors convince patients to use quality apps that may be more expensive?

Quality of apps

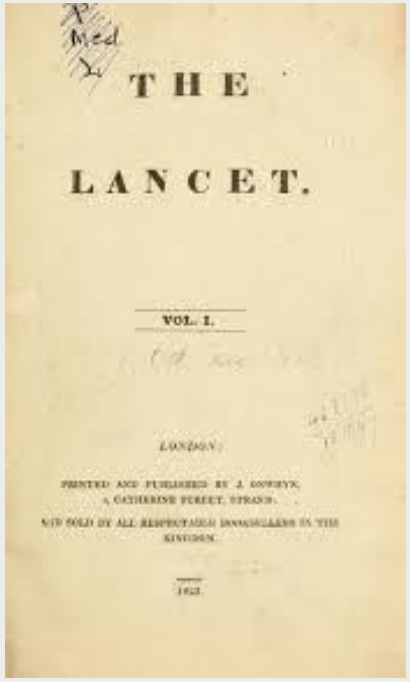
- Need for quality, accuracy, efficacy, adherence to established medical practices, data security, privacy.
- Need for a stringent selection process within mobile app stores using standardized assessment.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10542414/
- https://www.annualreviews.org/content/journals/10.1146/annurev-publhealth-052020-103738



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10542414/

Virtual reality

Virtual reality



Lancet Study -2018

Avatar virtual coach for fear of heights

100 patients with a control group

Positive results

- Freeman, D. (2018) Automated psychological therapy using immersive virtual reality for treatment of fear of heights: a single-blind, parallel-group, randomised controlled trial.
- Lancet, Psychiatry
- https://www.thelancet.com/action/showPdf?pii=S2215-0366%2818%2930226-8

Virtual reality

- Watch: CNN: Can VR cure your fear of heights?
- Can VR Cure Your Fear Of Heights?
- https://www.google.com/search?q=fear+of+heights+virtual+reality+exposure+therapy&rlz=1C1JZAP_enUS848US849&oq=fear+of+heights+virtual+reality+&gs_lcrp=EgZjaHJvbWUqBwgAEAAYgAQyBwgAEAAYgAQyBggBEEUYOTIICAIQABgWGB4yCAgDEAAYFhgeMggIBBAAGBYYHjIICAUQABgWGB4yCAgGEAAYFhgeMggIBxAAGBYYHjIICAgQABgWGB4yDQgJEAAYhgMYgAQYigXSAQk3NzE5ajBqMTWoAgiwAgE&sourceid=chrome&ie=UTF-8#fpstate=ive&vld=cid:3bbc07e1,vid:qhsJD-2loZE,st:0
- Frontiers | Virtual Reality Exposure Therapy for Fear of Heights: Clinicians' Attitudes Become More Positive After Trying VRET

Virtual reality

For learning anatomy. Watch https://www.facebook.com/VRMedicine/videos/476636357566178/ (2min)

Surgeons are using Meta’s Quest 2/3 to simulate procedures, allowing doctors to practice from home.

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- https://www.cnbc.com/2023/09/09/metas-vr-technology-is-helping-to-train-surgeons-and-treat-patients.html#:~:text=Surgeons%20are%20using%20Meta's%20Quest,insert%20VR%20into%20the%20curriculum.

Virtual Reality Uses in Medicine

- Mental health disorders like PTSD
  - https://www.verywellmind.com/virtual-reality-exposure-therapy-vret-2797340
- **Medical training, for both doctors in training and students**
- **Surgical training**
- **Dentistry**
- **Operation planning and "test runs"**
- **Patient informing and consulting**
- **Helping patients with Alzheimer's or stroke**
- **Dealing with motor skill disorders**
- **Overcoming stress, fears, and complexes**

Discussion Questions

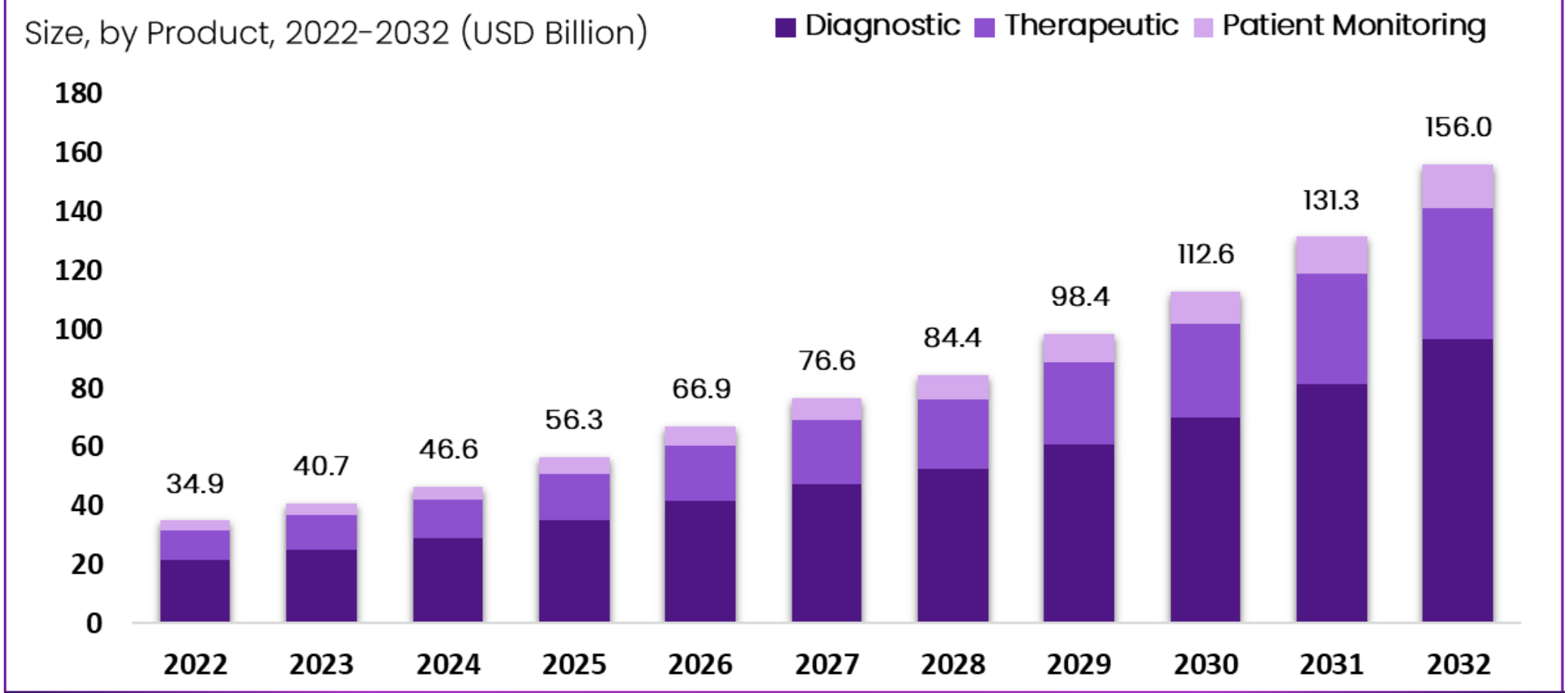
- How many studies or patients are needed to validate virtual reality therapy?
- Does this technology become standard practice?
- Any limitations?
- How would an entrepreneur discover other opportunities for the use of virtual reality in medicine?
- Are the costs prohibitive for most patients?
  - $300-$500 for one headset

Wearables

- Huge opportunity!
- Data varies!

Global Wearable Medical Device Market

Size, by Product, 2022-2032 (USD Billion)



The Market will Grow At the CAGR of: 16.6%

The forecasted market size for 2032 in USD: $156.0B

market.us
ONE STOP SHOP FOR THE REPORTS

Global Market Insights

WEARABLE MEDICAL DEVICES MARKET

EUROPE

Value (2032)
>$200 BN

GLOBAL STATISTICS

Value (2022)
>$78 BN

Value (2032)
>$750 BN

CAGR (2023-32)
>24%

- **Sleep tracking segment**
  Market Value (2032): **>$48.5 BN**
- **Respiratory monitors segment**
  Market Value (2032): **>$83.5 BN**
- **Remote patient monitoring segment**
  CAGR (2023-32): **>24%**

GLOBAL WEARABLE MEDICAL DEVICES MARKET OVERVIEW

MARKET SIZE

2021

23,581 (USD Million)

26.5% CAGR

(2022-2030)

MARKET BY REGION

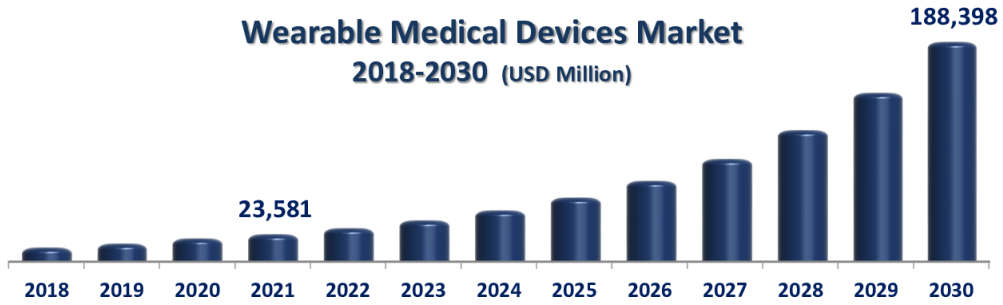
2021

KEY PLAYERS

- VitalConnect
- Xiaomi Technology
- Samsung Electronics
- OMRON Corporation
- Fitbit, Inc.
- Polar Electro
- Apple Inc.
- Others

Wearable Medical Devices Market

2018-2030 (USD Million)



DRIVERS

- Increasing awareness of fitness, lifestyle, and home healthcare
- Development of technologically advanced products

RESTRAINTS

- Unfavorable standards and regulations
- Data security challenges

Source: www.acumenresearchandconsulting.com

Wearable Sensors

- Biomedical equipment that measures physiologic functions in real continuous time
- Empowers patients to take control of their health.
  - By monitoring their health status, patients can detect potential health issues earlier and manage their conditions more effectively.
- Expand the collection of patient-generated health data between visits
- Provide healthcare providers with insight into their patients' health.
  - Consequently, doctors can customize care plans better and intervene when patients deviate from their goals, reducing the likelihood of expensive readmissions or emergency department visits.

Wearable Sensors

- Valuable in chronic disease and high-risk care management programs aimed at improving patient outcomes and reducing costs for vulnerable populations.
- Healthcare organizations must have data management systems that can collect, aggregate, filter, store, and analyze these data and integrate the resulting information into an EMR.
  - Also, incorporating self-reported health status of symptoms or condition.
- Mostly proprietary algorithms

Wearable Sensors

- Freestylelibre helps diabetics track blood sugar levels without having to prick their fingers
- Revenues for Abbott, the company (2023): FreeStyle Libre sales were $1.4 billion globally

- Watch: https://www.youtube.com/watch?v=TMNjRRmP2yc (10 minutes)
- **Freestylelibre,** by Abbott – glucose monitoring for diabetes
  - **Starter Pack** – reader plus two 14 day sensors: £200.00

Wearable Sensors

Dexcom and how does it work?

- Dexcom measures glucose levels up to every 5 minutes using a sensor inserted just underneath the skin, and wirelessly transmits glucose readings to a receiver or smart device.

U.S. Dexcom $3.6 Billion in revenues in 2023

Discussion Questions

- As a patient, would you be worried about alarms?
- Where is the oversight for accuracy?
  - Variability in daily step counts or sleep measurement
- How are the data collected used?
- How is patient privacy protected?

Discussion Questions

- How important is this technology to diabetic patients?
- How attractive is this business opportunity for Abbott and Dexcom?
- What about all the patients who cannot afford the technology?

Wearable Sensors

Continuous ambulatory monitoring of human vital signs during daily life by an Israeli start up company.

A t-shirt that can produce an EKG waveform?

https://smarttelecardiology.com/blog/ecg-t-shirts-for-preventing-heart-attacks

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9244148/

Wearable Sensors

- For detection of seizures in epilepsy patients. Watch (first five min)

- https://www.google.com/search?sca_esv=afe8e10e33d3e81e&sca_upv=1&rlz=1C1JZAP_enUS848US849&sxsrf=ADLYWILHd8ZcnhtBCp0BK1Oxe8QSpjgvTg:1715572441085&q=smart+watch+epilepsy&tbm=vid&source=lnms&prmd=svinmbtz&sa=X&ved=2ahUKEwiav7-v3YmGAxXDJzQIHdHcDv0Q0pQJegQICxAB&biw=1280&bih=585&dpr=3#fpstate=ive&vld=cid:d3dac1c3,vid:h0V1pBAXMWk,st:0
- smart watch epilepsy - Google Search

Monitoring

Remote Patient Monitoring

- Medical and health data collected from individuals in one location and electronically transmitted securely to health care providers in a different location for assessment and recommendations.
- Examples:
  - Digital blood pressure cuffs that enable patients to remotely send physicians their blood pressure and pulse.
  - Maternal and fetal waveforms enabling doctors to interpret data and manage patients especially high risk rural mothers
  - Monitor sleep apnea and chronic obstructive pulmonary disease
- Benefits: Improve patient outcomes, limit costs, expand reach

Remote Patient Monitoring

- Huge market opportunity; one study said 20% to 28% growth from 2023-2028 (https://finance.yahoo.com/news/20-fastest-growing-health-tech-153424027.html)
- Many companies offer digital patient monitoring: Biotricity, ihealth, Medtronic, Philips Healthcare, ResMed, Senseonics

Discussion Questions

- In every Metro station in Madrid, there are defibrillators, are these connected to remote monitoring?
- A ride in the ambulance should start the sharing of monitoring data with the emergency department, does it?
- What other situations would remote monitoring be helpful?

Gamification

Gamification

- Medical schools are incorporating technology-enhanced active learning and multimedia education tools into their curriculum, ie, electronic games.
- Use in preclinical and clinical training such as virtual patient simulations that improve learning, allow for risk-free healthcare decision-making, and quick feedback.

  Make medical school studying fun. (WATCH 3 min)

- gamification in medical schools - Google Search
  https://www.google.com/search?sca_esv=abf976e12d8dcb8e&sca_upv=1&rlz=1C1JZAP_enUS848US849&sxsrf=ADLYWILRC3FD9CUmair72evw183TyYeMeg:1715275101087&q=gamification+in+medical+schools&tbm=vid&source=lnms&prmd=invbmtz&sa=X&ved=2ahUKEwiYmt7YiYGGAxVGFjQIHTmwBIsQ0pQJegQIDRAB&biw=1280&bih=585&dpr=3#fpstate=ive&vld=cid:54084b6a,vid:g0N7x-RLfMw,st:0

Gamification

- Games, quizzes and recognition programs to support patients, doctors and pharmacists, from awareness and prevention to motivation to get and stay healthy.
- Attributes of gamification in health care
  - Behavioral economics - influence desired actions and address predictable barriers to behavior change.
  - Opt in or Opt Out?
  - Personalized goal setting
  - Pre-commitment pledge
  - Loss aversion, fresh start, social incentives
  - Uses: quit smoking, lose weight, exercise more
  - Patel, M.S. et al (2019, May): Improving Health Care by Gamifying It, Harvard Business Review, https://hbr.org/2019/05/improving-health-care-by-gamifying-it

Gamification

- Heal your brain with video games. Watch (6 min):
- https://www.youtube.com/watch?v=9zyNcov087U

- 64 gamification apps to get fit and live longer
  - Review https://gamifylist.com/goal/health

Discussion questions

- Do you have an idea for a game that could impact health and wellness?
- With so many choices for the consumer, how does an entrepreneur make a new application stand out and become successful?

Things to Know

- What does mHealth mean?
  - What are the segments and types of mhealth or some of the uses of mHealth?
  - What are the benefits and drawbacks?
  - How should quality be ensured?

Next session

- Health communications and social media
- Read: Social Media and its Impact on Public Health
  - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9925030/
- Homework assignment #3: Search the web for a health app that you like and write a 2 page assessment of the tool. Describe their product, users, pros and cons, ethical issues or their future.