Data Driven Innovation

Agenda

- Precision Medicine
- Wearables
- Multi-Modal Mental Healthcare
- Four Dimensions of Research & Innovation
- Key Takeaways

Data Driven Path Breaking Solutions

How cancer patients are treated today ?

1. Surgery
2. Radiation therapy
3. Chemotherapy
4. Hormone therapy
5. Immunotherapy

With Chemotherapy, Cancer Patients are sure to have side-effects

THE TIMES OF INDIA, CHENNAI
WEDNESDAY, OCTOBER 6, 2021

Many opting for cancer cure minus chemo

Genetic Tests Now Help To Rule Out Chemo

Dr Seema Doshi was shocked and terrified when she found a lump in her breast that was eventually confirmed to be cancerous. "That rocked my world," said Doshi, a dermatologist in private practice in the Boston suburb of Franklin who was 46 at the time of her diagnosis. 'I thought, 'That's it. I will have to do chemotherapy.'"

She was wrong.

Doshi was the beneficiary of a quiet revolution in breast cancer treatment, a slow chipping away at the number of people for whom chemotherapy is recommended. Chemotherapy for decades was considered "the rule, the dogma," for treating breast cancer and other cancers, said Dr Gabriel Hortobagyi, a breast cancer specialist at MD Anderson Cancer Center in Houston. But data offers some confirmation of what many oncologists say anecdotally — the method is on the wane for many cancer patients.

Genetic tests can now reveal whether chemotherapy would be beneficial. For many there are better options with an ever-expanding array of drugs, including estrogen blockers and drugs that destroy cancers by attacking specific proteins on the surface of tumors. And there is a growing willingness among oncologists to scale back unhelpful treatments. The result spares thousands each year from the dreaded chemotherapy treatment, with its accompanying hair loss, nausea, fatigue, and potential to cause permanent damage to the heart and to nerves in the hands and feet.

Cheaper and faster genetic sequencing has played a major role in this change. The technology made it easier for doctors to test tumours to see if they will respond to targeted drugs

The diminution of chemotherapy treatment is happening for some other cancers, too, including lung cancer, the most common cause of cancer deaths in the US, killing more than 69,000 Americans each year. (Breast cancer is second, killing 43,000.)

Cheaper and faster genetic sequencing has played an important role in this change. The technology made it easier for doctors to test tumours to see if they would respond to targeted drugs. Genetic tests that looked at arrays of proteins on cancer cells accurately predicted who would benefit from chemotherapy and who would not. There are now at least 14 new targeted breast cancer drugs on the market, with dozens more in clinical trials and hundreds in initial development.

When Dr. Roy Herbst of Yale started in oncology about 25 years ago, nearly every lung cancer patient with advanced disease got chemotherapy.

With chemotherapy, he said, "patients would be sure to have one thing: side effects." Yet despite treatment, most tumors continued to grow and spread. Less than half his patients would be alive a year later. The five-year survival rate was just 5 to 10%. Those dismal statistics barely budged until 2010, when targeted therapies began to emerge.

There are now nine such drugs for lung cancer patients, three of which were approved since May of this year. About a quarter of lung cancer patients can be treated with these drugs, and more than half who began treatment with a targeted drug five years ago are still alive. The five-year survival rate for patients with lung cancer is now approaching 30%.

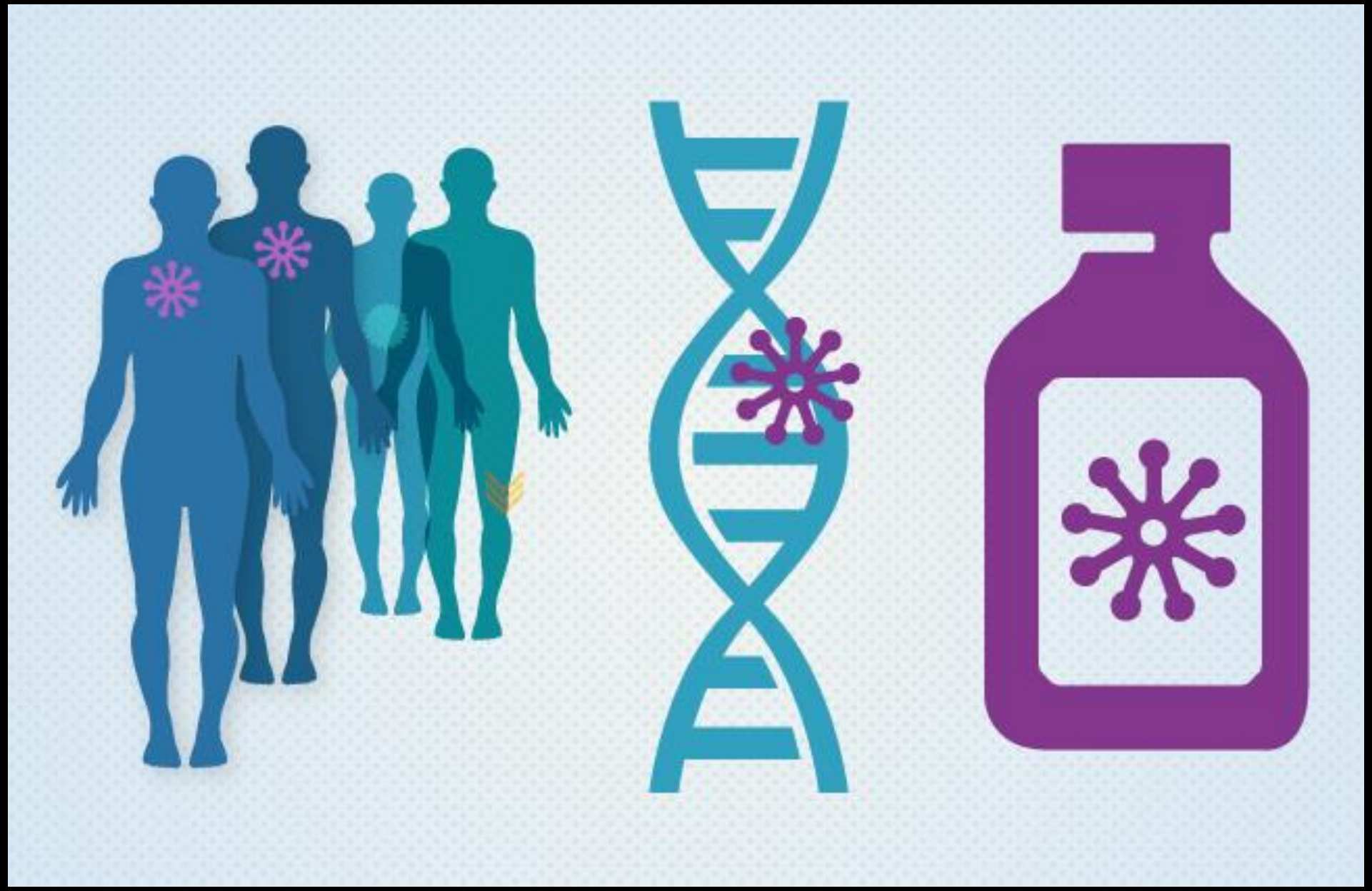
Another type of lung cancer treatment was developed about five years ago — immunotherapy, which uses drugs to help the immune system attack cancer. Immunotherapy is given for two years. With it, life expectancy has almost doubled, said Dr Charu Aggarwal, a lung cancer specialist at the University of Pennsylvania. NYT NEWS SERVICE

Any Alternative Treatment for Cancer ?

Gene-Driven

Precision Medicine

https://www.cancer.net/navigating-cancer-care/how-cancer-treated/personalized-and-targeted-therapies/understanding-targeted-therapy



Why Precision Medicine?

Side effects are minimal

Uses drugs designed to "target" cancer cells (only)

Precision Medicine also has applications in other diseases… Cardiovascular etc

Quick Refresh: genes and DNA

- Genes have DNA
  - DNA contains the code
    - …to synthesize a protein
- DNA tells the cell to do certain things
- Cancer cells typically have changes in their genes, thus different from normal cells
- Gene changes in cancer cells mean the cell will grow and divide rapidly (abnormal)

Precision Medicine ?

- Based on understanding of individual gene
- Applies genomics and protenomics
- Identifies biomarkers to specific diseases
  - BCR-ABL(Luk), EML4-ALK(Lung)
- Precise and individualized treatment to certain patients and diseases
- Select sensitive drugs, optimal dose and timing – least side effect

NIH Definition

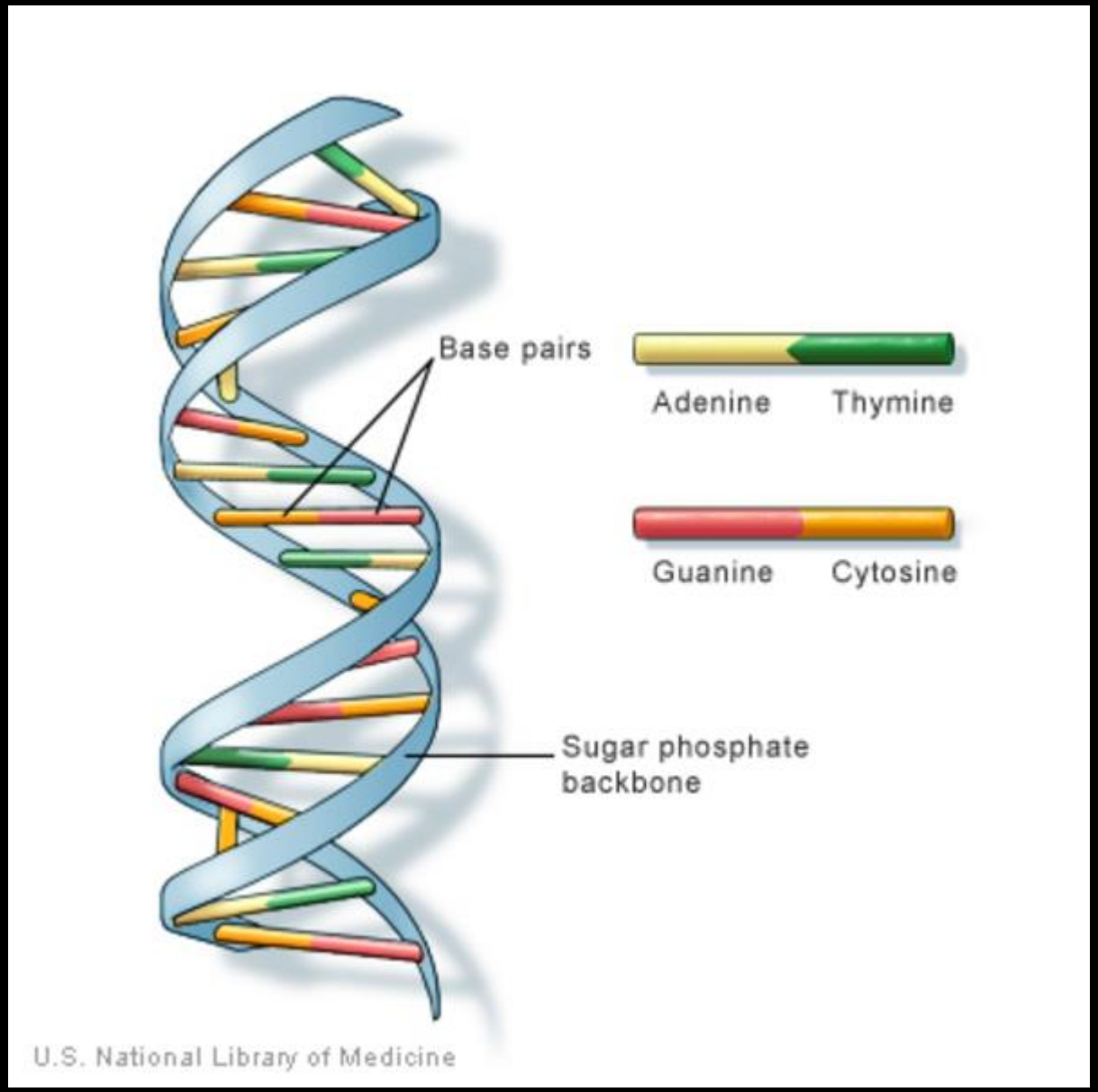
Imaging to find the Target

PET/CT imaging is able to identify active tumors at a very small size, based on the biological activity of the tumor

Obtain a sample of patient's tumor

Perform the DNA sequencing

Search for Cancer causing Mutations



DNA Sequencing

- Determine exact sequence of bases (lab procedure)
- This sequence has information on what a cell needs to assemble protein

Pharmacogenomics and DNA sequencing

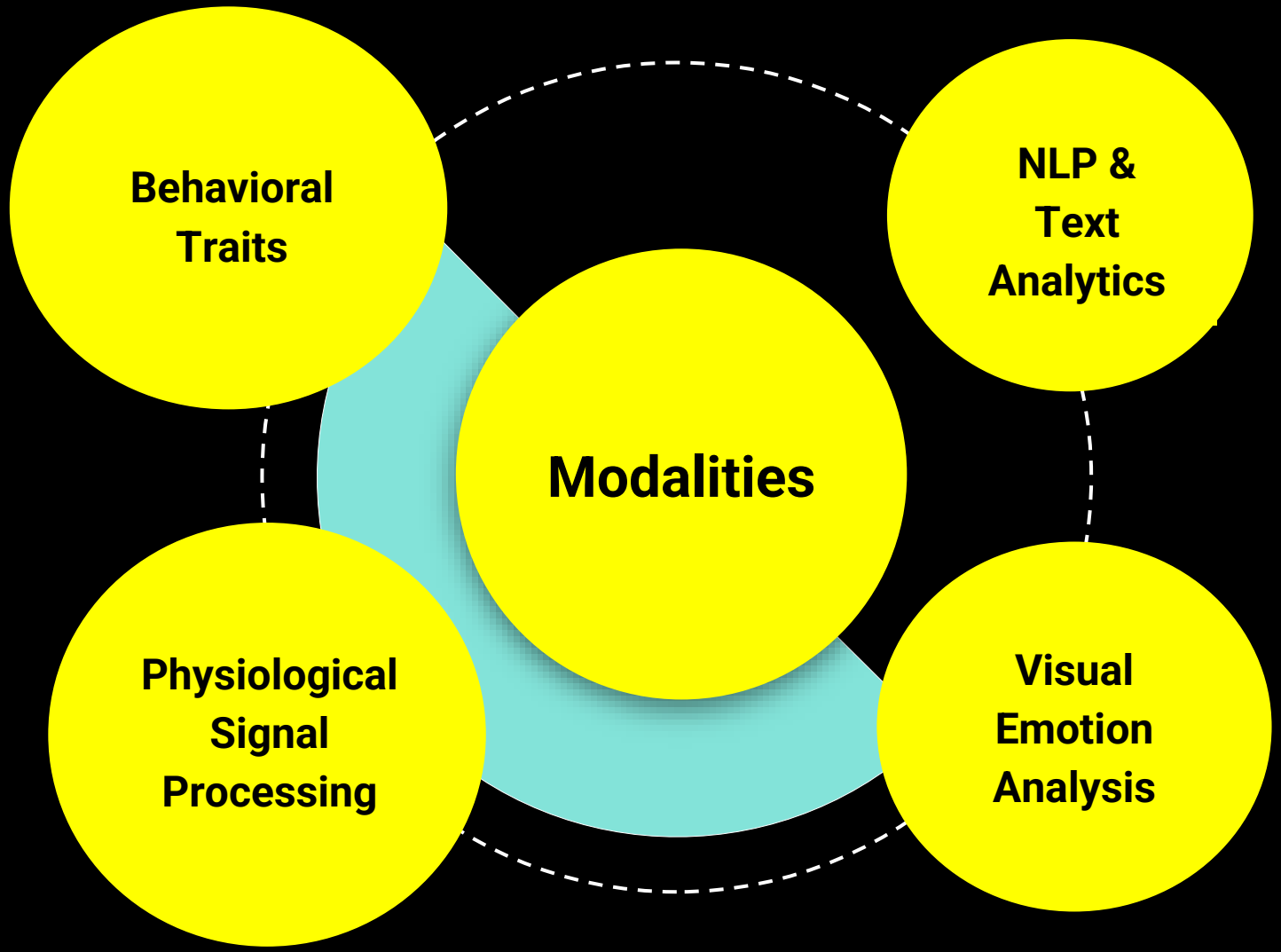
- Pharmacogenomics looks at how a person's individual genome variations affect their response to a drug.
- Such data is being used to determine which drug gives the best outcome in particular patients.
- Over 140 drugs approved by the FDA now include pharmacogenomic information in their labelling.

https://www.whatisbiotechnology.org/index.php/science/summary/sequencing/dna-sequencing-determines-the-order-of-dna-building-blocks

- Labelling is not only important in terms of matching patients to their most appropriate drug, but also for working out what their drug dose should be and what side effects are
- Drug developers are also using pharmacogenomic data to design drugs

Data Driven Interventions in Mental Healthcare

- A Wristband
- A Vision System
- An EEG Headband


Behavioral Traits
NLP & Text Analytics
Modalities
Physiological Signal Processing
Visual Emotion Analysis

A Wristband to Measure the Stress Level

Uses Biochemical mechanism to measure the level of Cortisol in sweat of a person.

ML model figures out the stress level.

Being tested for early prediction of Diabetes

alexithymia

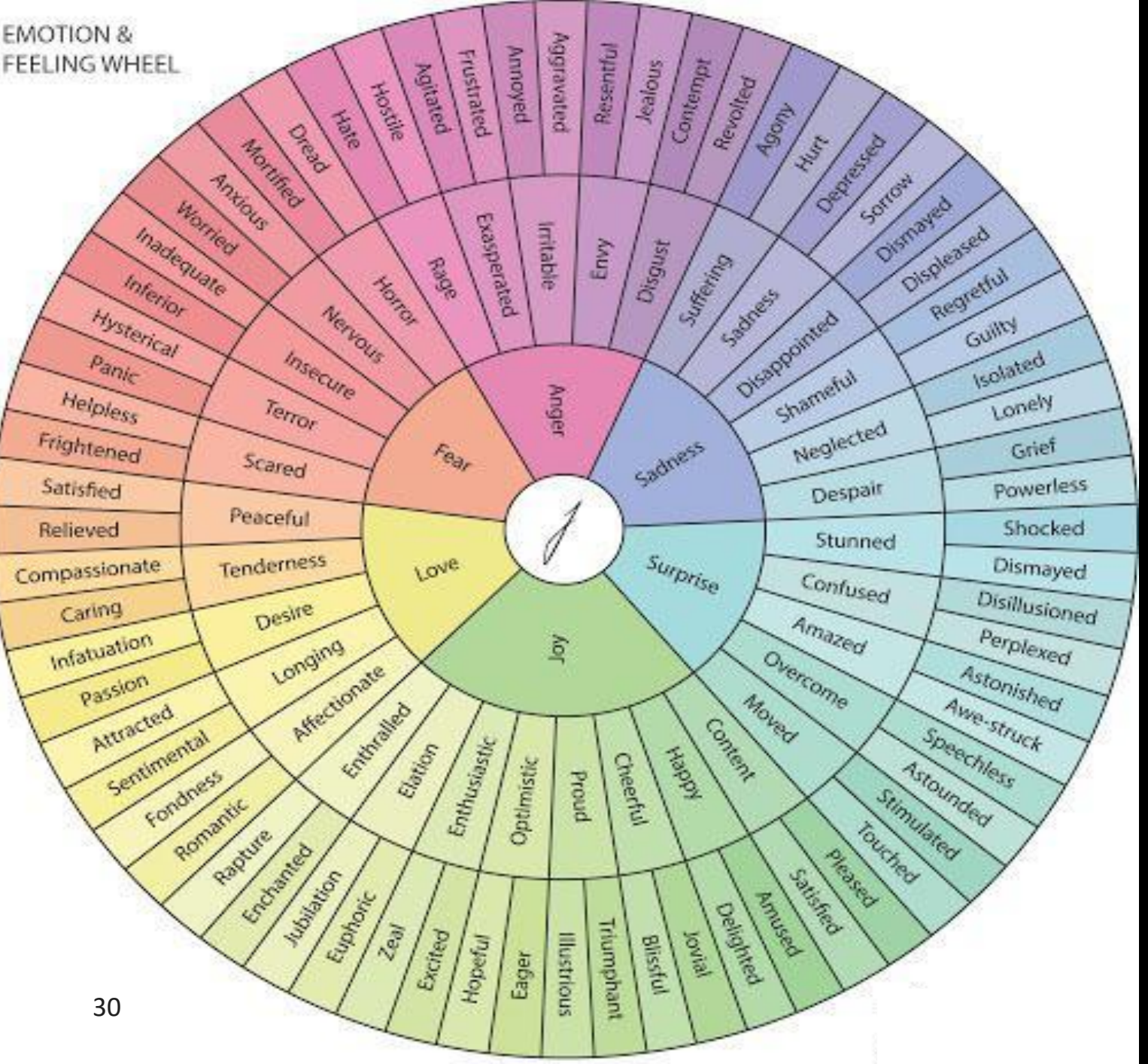
/əˌlɛksɪˈθʌɪmɪə/

noun

the inability to recognize or describe one's own emotions.

Nearly 10% of the population suffers from this condition

Understanding one’s own emotions as well as others’ emotions is vital for wellbeing - Emotional Intelligence

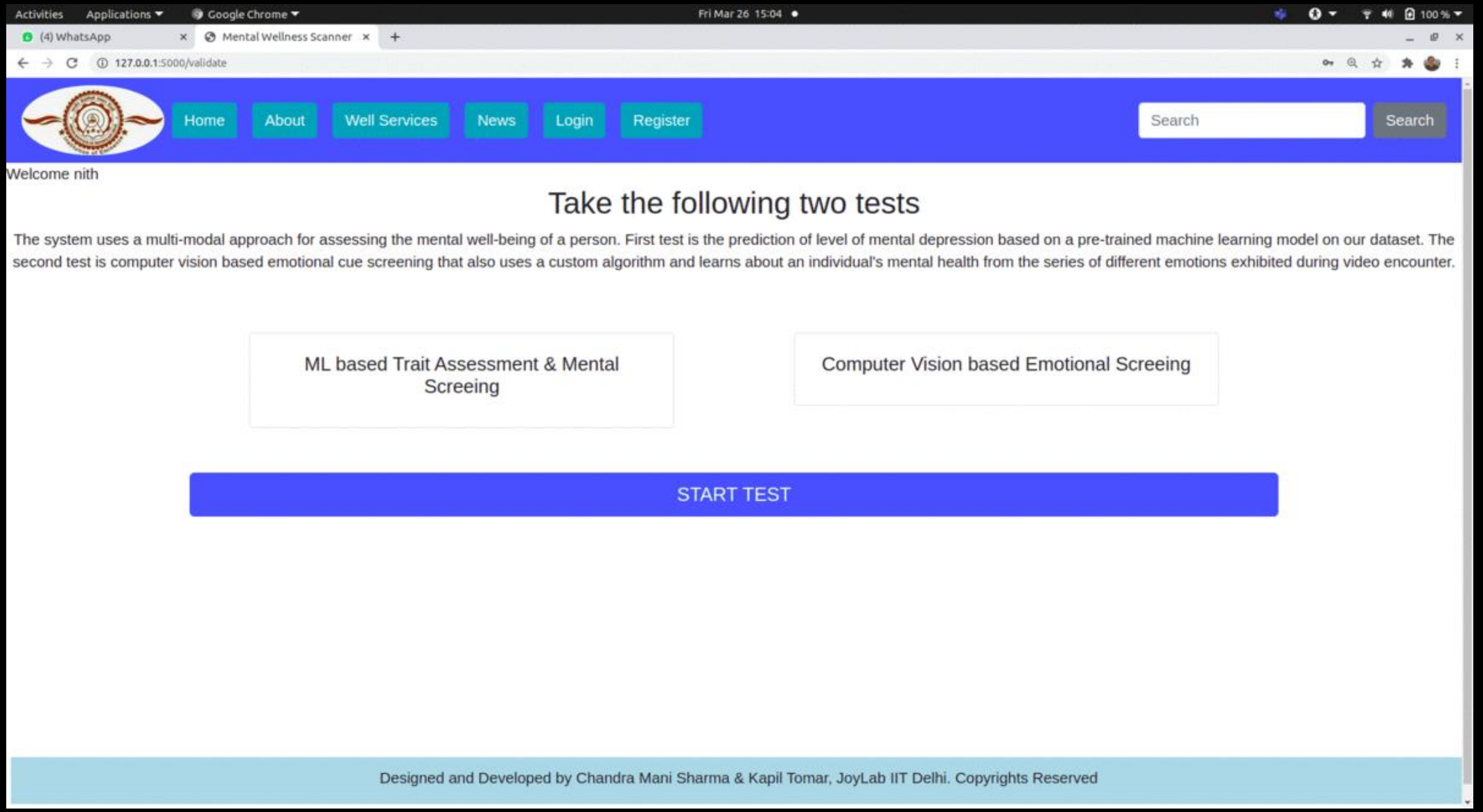


Emotion is a Complex Thing!

EEG Headband to Regulate Emotions

ML and CV in Affective State Screening

ML & CV for Affective State Assessment



Swallowable

Ingestion Tracking System

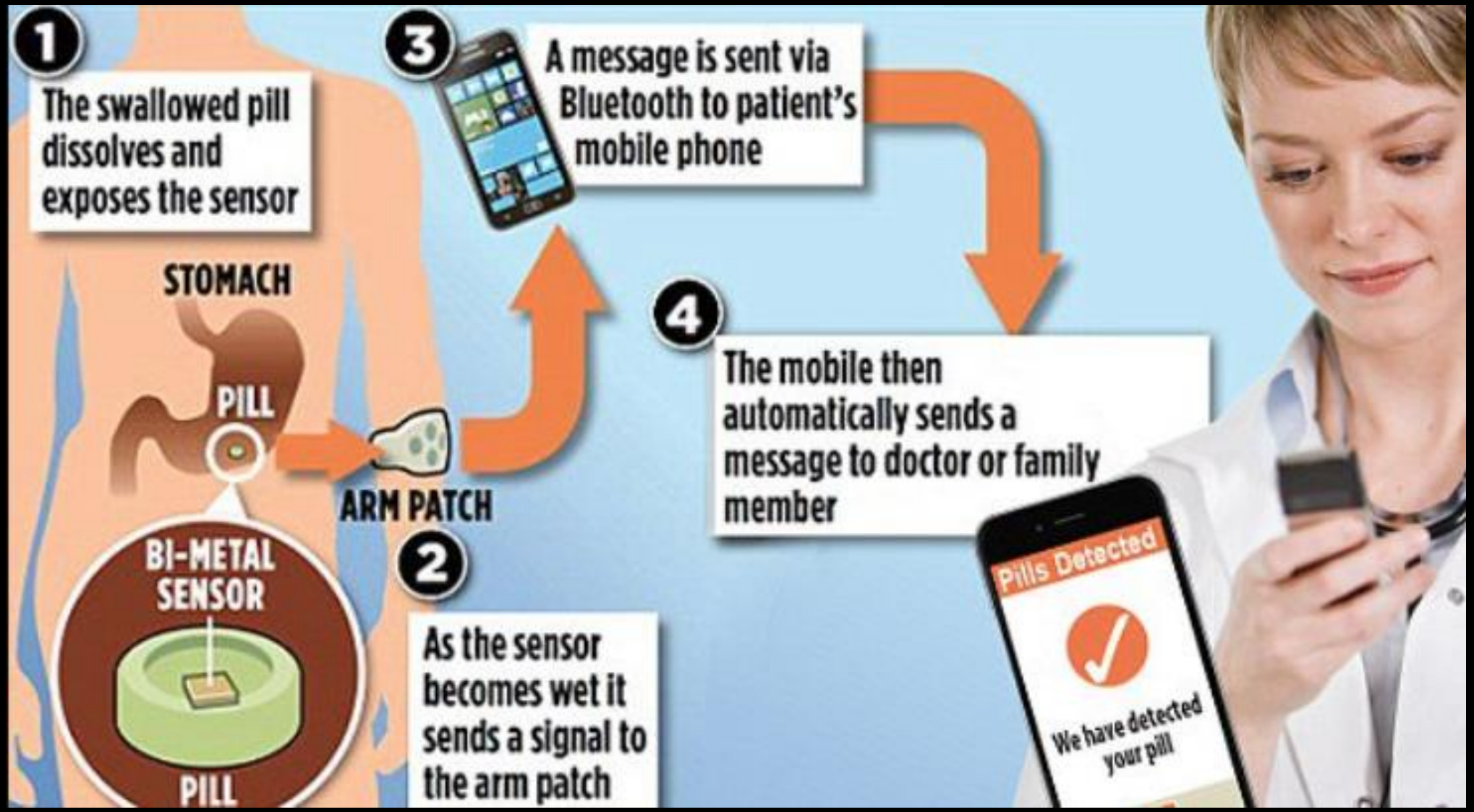
- **Aripiprazole** tablets has an ingestible sensor embedded in the pill that records that the medication was taken.

- The tablet is approved for the treatment of schizophrenia, acute treatment of manic and mixed episodes associated with bipolar I disorder and for use as an add-on treatment for depression in adults.

Aripiprazole

- The tablets that contain a small sensor come with a patch (a wearable sensor) that detects a signal from the tablet and a smartphone application (app) to display information about how you are taking the medication.

- The app must be downloaded onto your smartphone before you start the medication.


1
The swallowed pill dissolves and exposes the sensor
STOMACH
PILL
ARM PATCH
BI-METAL SENSOR
PILL
2
As the sensor becomes wet it sends a signal to the arm patch
3
A message is sent via Bluetooth to patient's mobile phone
4
The mobile then automatically sends a message to doctor or family member
Pills Detected
We have detected your pill

FDA approval

The U.S. Food and Drug Administration approved the first drug in the U.S. with a digital ingestion tracking system.


30 tablets
Rx only
NDC 59148-030-85
AbilifyMyCite®
(aripiprazole tablets with sensor)
Dispense the accompanying Medication Guide to each patient.
Needs a compatible mobile device.
Please see U.S. FULL PRESCRIBING INFORMATION including Boxed WARNING enclosed.
Keep Abilify MyCite® components out of the reach of children.
5 m
Verizon
4:21 PM
22%
Tablet
Registered!
Congratulations... Your first tablet has registered in the MyCite system!
NOW IT'S TIME TO START USING THE APP
Return to MyCite
30 Tablets
NDC 59148-030-13
AbilifyMyCite
(aripiprazole tablets with sensor)
Dispense with accompanying Medication Guide to each patient
Rx only
5mg

MIT researchers built an ingestible sensor equipped with genetically engineered bacteria that can diagnose bleeding in the stomach, and possibly other gastrointestinal ailments.

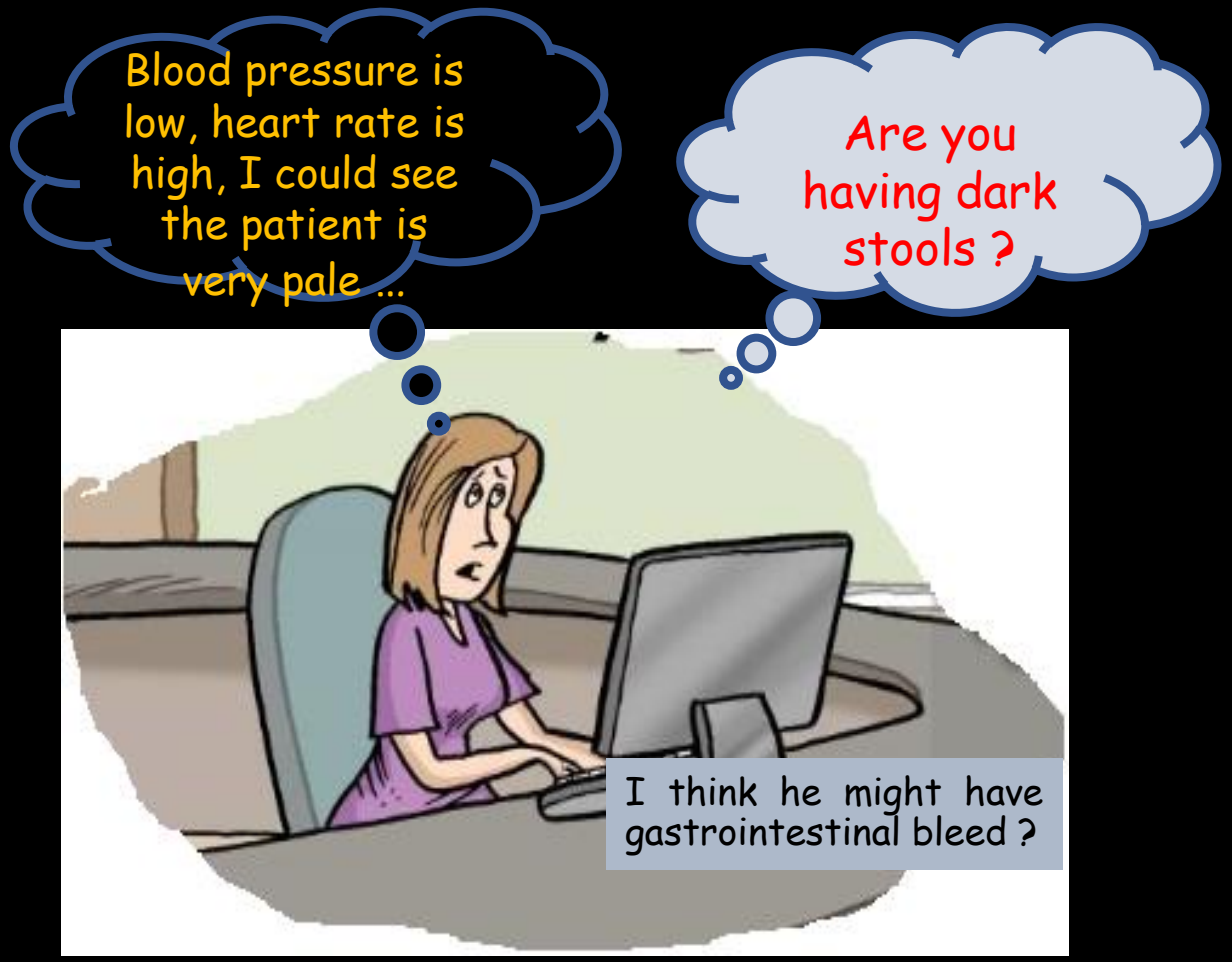
Remote Patient Monitoring

- Remote monitoring, enables medical professionals to monitor a patient or @risk patient remotely through connected devices such as smart phones and wearables

- Such interventions will reduce number of patients rushing to emergency – highly stressful

- This method is primarily used for managing chronic diseases or specific conditions, such as heart disease, diabetes, or asthma.

- These services can provide comparable health outcomes to traditional in-person patient encounters, supply greater satisfaction to patients, and may be cost-effective


Blood pressure is low, heart rate is high, I could see the patient is very pale ...
Are you having dark stools ?
I think he might have gastrointestinal bleed ?


Yes


His blood pressure probably spiked most evenings, but no one knew this.
I checked my Daddy's blood pressure this morning, it was fine. Why did he have a stroke in the evening ?

Who ?


vivifyhealth

RPM devices

- Dexco: Continuous glucose monitors (Dexcom)
- Philips: eCareCoordinator (a clinical dashboard for ambulatory health) and eCareCompanion (a user-friendly patient app)
- Bio Button: records an individual's temperature, respiration, heart rate at rest, sleep activity, etc. Using its patented biosensor technology and advanced analytics

Value of RPM ?

- Remote patient monitoring increases the capacity for physicians to treat more patients

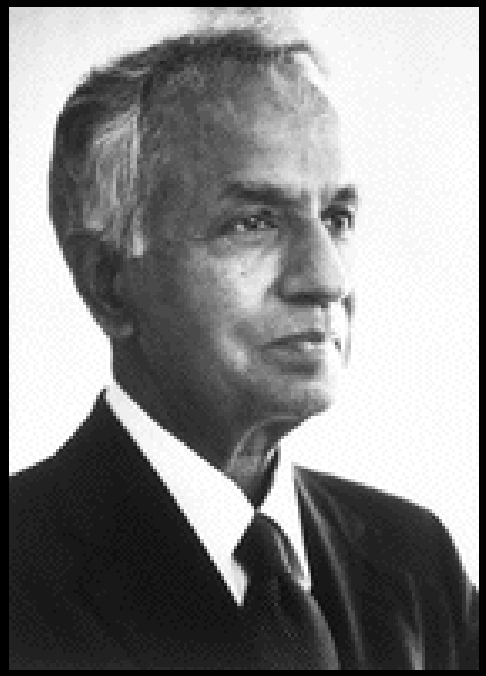
- Better engaged patients have a tendency to take control of their health

- Current efforts are being invested in developing implantable diabetes sensors that use **Bluetooth Technology** to transmit health data to a monitoring device or smartphone.

Innovation : Four Dimensions of R& D

First Dimension

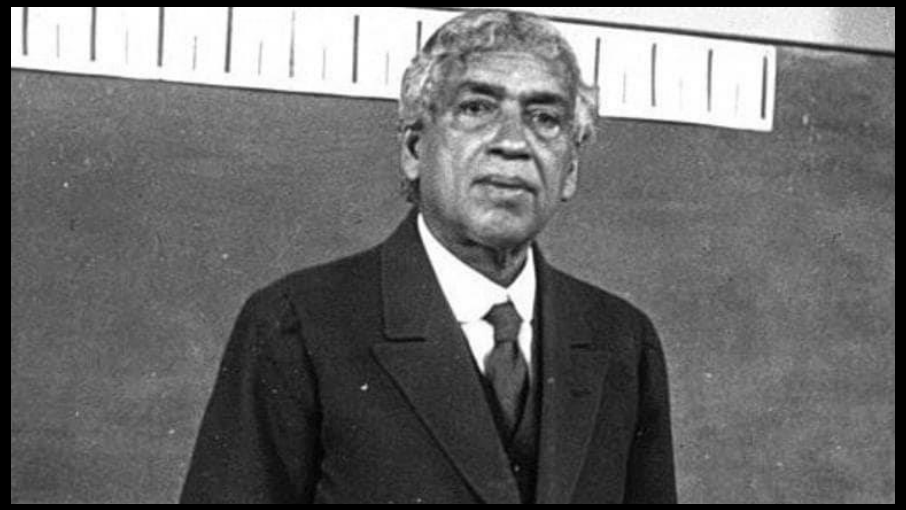
Theoretical



Research with Pen and Paper

Second Dimension

Experimental



Path Breaking Discoveries in the Laboratory

Third Dimension
Modeling/Simulation

Research using Massively Parallel Supercomputers

Now Data provides the key insights, leading to innovation

The Fourth Dimension

The Data Driven Innovation

Key Takeaways

- Currently AI and Computer Vision are contributing to Data Driven Innovation in a major way.
- Doctors, Lawyers, Farmers, Retailers and Engineers have also started harnessing the power of AI for solving real-world challenges.
- Data Scientists' first and foremost responsibility should be protecting the Privacy and Human rights of individuals.

References

1. https://www.wadhwaniai.org/
2. Automatic Pest Counting from Pheromone Trap Images Using Deep Learning Object Detectors for Matsucoccus thunbergianae Monitoring Suk-Ju Hong
3. https://www.startus-insights.com/innovators-guide/5-top-computer-vision-startups-impacting-the-healthcare-industry

Gratitude !

One-size-fits-all ?

PET/CT, is able to identify active tumors at a very small size, based on the biological activity of the tumor

PET/CT uses a harmless radioactive isotope that is bound to a sugar molecule

Precision Medicine - is made to precisely send substances like monoclonal antibodies to antigens attached to the cancer cells

…these targets can be different even when people have the same type of cancer.

monoclonal antibodies is a general term

There are different types of monoclonal antibodies

Precision Medicine Plan

- Deep understanding of genetic and genomic information
- Select sensitive drugs, Optimal Dose and timing - least side effects