DATA VISUALIZATION IN THE MEDICAL FIELD

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ABSTRACT

This paper discusses the increase in the data generated around the world, especially in the health care sector. Big data is becoming common with increased digital health data accumulation and accessibility to public data which was previously hidden to the commoners. At the same time, health data visualization applications have become popular over recent years. Peer-reviewed original research articles and review articles searched in Google Scholar and Pubmed databases that were indexed in the last ten years period, using the keywords “Big data” or “data visualization” or “Interactive visualization techniques.” Other related information in books, blogs, and published documents were searched in Google search engine using the same keywords. Contents from the downloaded documents were presented and discussed under three headings viz. (a) about the importance of data visualization in daily life (b) discussion about the advancement in visualization in the medical field (c) the advantages of using the visualization techniques in the medical field. The usage of different plots in public health is explained with suitable examples using the data from public health datasets. From the discussion, it can be understood that when big data is visualized well, it can identify implementation gaps and disparities and accelerate implementation strategies to reach the population groups in most need of interventions.

Introduction

Technology nowadays plays an important role in the development of human civilization. Technology has evolved over the last few years and provides innovative and smart ways of doing work. Electronic gadgets, appliances have added extra means of comfort to our lives.

Technology in the medical field has improved the life of medical professionals and students who are training to become experts. Access to medical records has also been easier and faster due to the advancements. Modern technology has allowed us and has given us the comfort of contacting doctors or medical experts from our homes and also getting the required test reports with just one click.

There are pros as well as cons in any kind of field. Even though technology has increased the productivity of various individuals and organizations, it hasn't increased the efficiency of machines. Management of machinery requires human-act and advancement of technology alone is not enough for progress as Technology is largely dependent on human intervention.

Modern Technology in the medical field has gained prominence and acceptance as the method of curing and identifying diseases. The advancements have made clear various physical and psychological causes behind various diseases.

Advancements in medicine have been made in every civilization, But, Today it is more researched and revised in the form of chemicals. These advancements in the medical field have opened up many possibilities beyond what doctors thought was possible many years ago. Modified techniques, surgeries, therapies, and drugs have decreased the overall death rates over the years. Medical advancements have shown wonders like achieving various tasks which were marked as impossible, Various complicated surgeries where they thought the patient's life would be at risk have been dealt with smoothly and successfully. Doctors have been more than successful in transplanting various parts of the body like the heart, liver, and kidney are were able to save the lives of many. Improvement and advancement in cosmetic surgeries have helped many acid attack victims or acid burn cases patients by providing them with new faces.

Physical disorders can also be overcome up to a certain extent and all this is happening due to the advancements in the field of medicine. Doctors are using modern robotic technology in complicated surgeries, which not only makes the job easier but improves the accuracy of procedures as well. Due to the advancement in a combination of drug therapies, the death rate due to diseases like HIV and various types of Cancer has come down in numbers.

There are many advantages of using Data Visualization in health care. Visualization can be used to interpret patient care data which will help the nurses with the required information about the

patient. It also allows health care professionals to access the data of their patients with similar symptoms to understand the timeline for recovery.

Some companies use visualization to illustrate an individual's health status which makes it easier to compare with others who have similar symptoms. These visualizations also help the individuals understand and educate them on areas where they need to improve their health, including the blood sugar and cholesterol levels and Body mass index values, Exercise habits, etc.

These visualizations are often used by media to depict health-related trends on a large scale, An example of this could be COVID 19 cases in the country state by state. The visualization shows a graph of the country with shading to illustrate which of these states have been affected most by the pandemic.

the advancement in the medical field and how Data visualization has been helpful to doctors in managing and maintaining the medical data which is growing tremendously.

Literature Review

These are some observations for the literature review.

Participants understand pictograms as icon arrays across a range of studies. The idea that people prefer icons provides researchers with a good starting place to conduct diverse studies that can more definitively show the effectiveness of icon arrays. Pictographs provide better results for small numerators and with participants with lower numeracy. They were also preferred when compared to other formats, as well as improving comprehension.

Bar graphs should be used to compare several data points. They are increasingly being used and recommended for communicating health and medical risks to the public. Bar graphs attract attention and they provide information. However, there were conflicting results about the use of bar graphs when directly compared to other types of visualizations such as icon arrays and line graphs. Participants with past experience with a certain data visualization type found that same visualization easiest to use and understand. Thus, while bar graphs can be beneficial, they need to be considered carefully in light of audience and purpose.

Keeping the visualizations as simple as possible is also important. Studies have found that excess information that is not key to the data visualization is not necessary. Moreover, the studies that looked at interactivity and animation found that these features did not significantly improve outcomes or comprehension and can actually decrease understanding for users. Simplicity was also found to be a key takeaway with the amount of data or the options given to participants. Keeping the data visualization focused on one specific takeaway or on one option seems to improve preference and understanding.

Care with design features Several studies found that the design features of data visualizations include things such as headings, titles, legends, captions, orientation and other features that can all impact the way participants read and comprehend the information. It is also important to include the actual numbers in the text or also in the visual to help with accuracy and comprehension.

Several visualization techniques are now available which can give composites of different visualizations through the use of cross filters, clicking on an element on any panel alters all the visualizations in the dashboard. Social media are opening remarkable possibilities for health and healthcare researchers. Using Network Analysis and Graph Theory for what we do online can be analyzed. Data from Twitter is especially interesting for public health analysts since it is publicly available to enable studies of how medical trends spread. Using clustering active communities of discussions for polio and measles have been identified

There are several databases in the public domain which offer huge volumes of data. The census, Ministry of Health and Family Welfare. Integrated Disease Surveillance Programme, National Vector Borne Disease Control Programme and the Open Government Data Programme offer such data in India. However, exploring these datasets and correlating between them to derive insights remains a challenge. But, data quality is also dependent on the local level. Therefore, there is a need for the development of analytical and interpretative skills at the lower level of the hierarchy.

Discussion

Data visualization is a process that makes the data readily available for use easily. This process helps us in minimizing operating costs by providing detailed data and information in understandable forms at the convenience of the doctors, nurses, and the administration on the spot.

The systems enable healthcare professionals to procure unique knowledge and information about the demographics and lifestyle preferences of their patients. This further helps them in tracking and healing the patients accordingly.

The first visualizations may have taken the form of drawings in sand or scratched on rock and it is possible that the famous Palaeolithic cave paintings in Lascaux, southern France, may have functioned as both hunting guides and directions to the spirit world. The ancient Babylonians, Egyptians, Greeks, and Chinese all developed sophisticated ways of representing information visually to plot the movements of the stars, produce maps to aid navigation, and develop plans for crop planting and city development. Many of these early visualizations would have been drawn on clay such as this very early Babylonian world map (600 BC). Later visualizations would be rendered onto papyrus, which had the benefit of enabling information to be more easily shared and annotated.

When you have loads and loads of data to share, you can never choose and pick only a few key points to illustrate. This is also the case when you are looking at state-by-state health information through a number of indicators. Still, to various members of your audience, some elements of the knowledge might be more important than others. If this describes the kind of data set you are working with, the best match for your content could be an interactive widget or a dashboard.

Interactivity enables the viewer to tailor the material or dataset to his or her needs and easily discover the knowledge without having to wade through a lot of content they just do not care about. This can save time and saves a lot of effort.

Companies like Cigna use data visualization to illustrate an individual’s health status compared with others in a similar demographic. Such illustrations can educate patients on areas where they need to improve, including cholesterol levels, body mass index, and exercise habits.

Through fields such as health data analysis and health informatics, medical organizations accrue large amounts of raw data. Examples of such data include patient diagnosis, outcome, and length of stay.

How can data analysts meet challenges in streamlining processes, better allocating resources, or improving patient care? Visualizing health data offers a solution. Medical organizations can synthesize raw data and convert it into graphics, charts, and dashboards. Visually displaying health data points helps identify trends and significant “data” clusters.

What’s more, it provides a way to share important findings with stakeholders who may not be data literate, such as hospital executives and administrators. Health data visualization can illuminate the general public and alert them to important developments in a crisis.

Today’s health organizations use a number of data collection points. For example, when doctors and nurses treat patients or conduct follow-up visits, they enter patient-specific data into electronic health records (EHRs).

As information is collected, data analysts use machine learning, artificial intelligence (AI) and other technical tools to export data and create visual presentations. We’ll highlight some specific tools later in this guide.

Data visualization often assumes the form of a “dashboard”: a set of interactive reports that allow decision-makers to quickly review metrics or scan trends. Several types of dashboards may be used in health care organizations:

- Operational dashboards. Operational dashboards show real-time data about what’s happening in the hospital. For example, they may display current information about hospital admissions that can be reviewed throughout the day.
- Strategic dashboards. Strategic dashboards show trends and changes over time. For example, a strategic dashboard allows hospital executives to review month-over-month changes in inpatient length of stay.
- Analytical dashboard. Analytical dashboards provide tools for extrapolating conclusions from broad datasets. One application is calling out specific trends from a large collection of patient medical records.

The most common types of visualization designs include the following:

- Infographics and mini-infographics
- Charts
- Tables
- Maps

- Timelines
- Scatter plots

Few of the visualizations used in the medical field

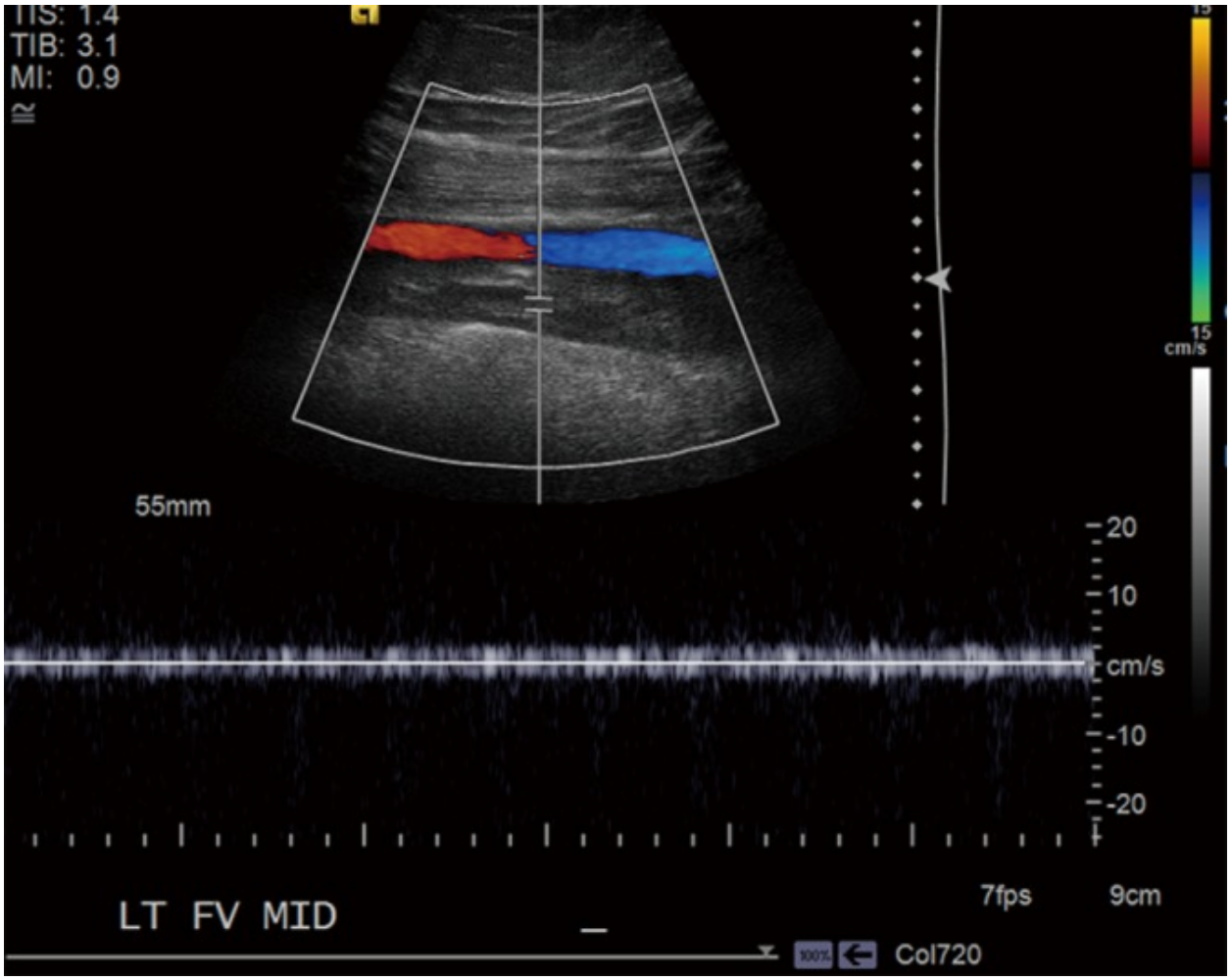

Figure 1

Venous color-flow Doppler. US Doppler imaging of the left femoral vein showing complete occlusion by a heterogeneous thrombus with dilatation of the vein at the site of thrombosis. No significant waveform is present. The adjacent artery is also shown for reference. US, ultrasound

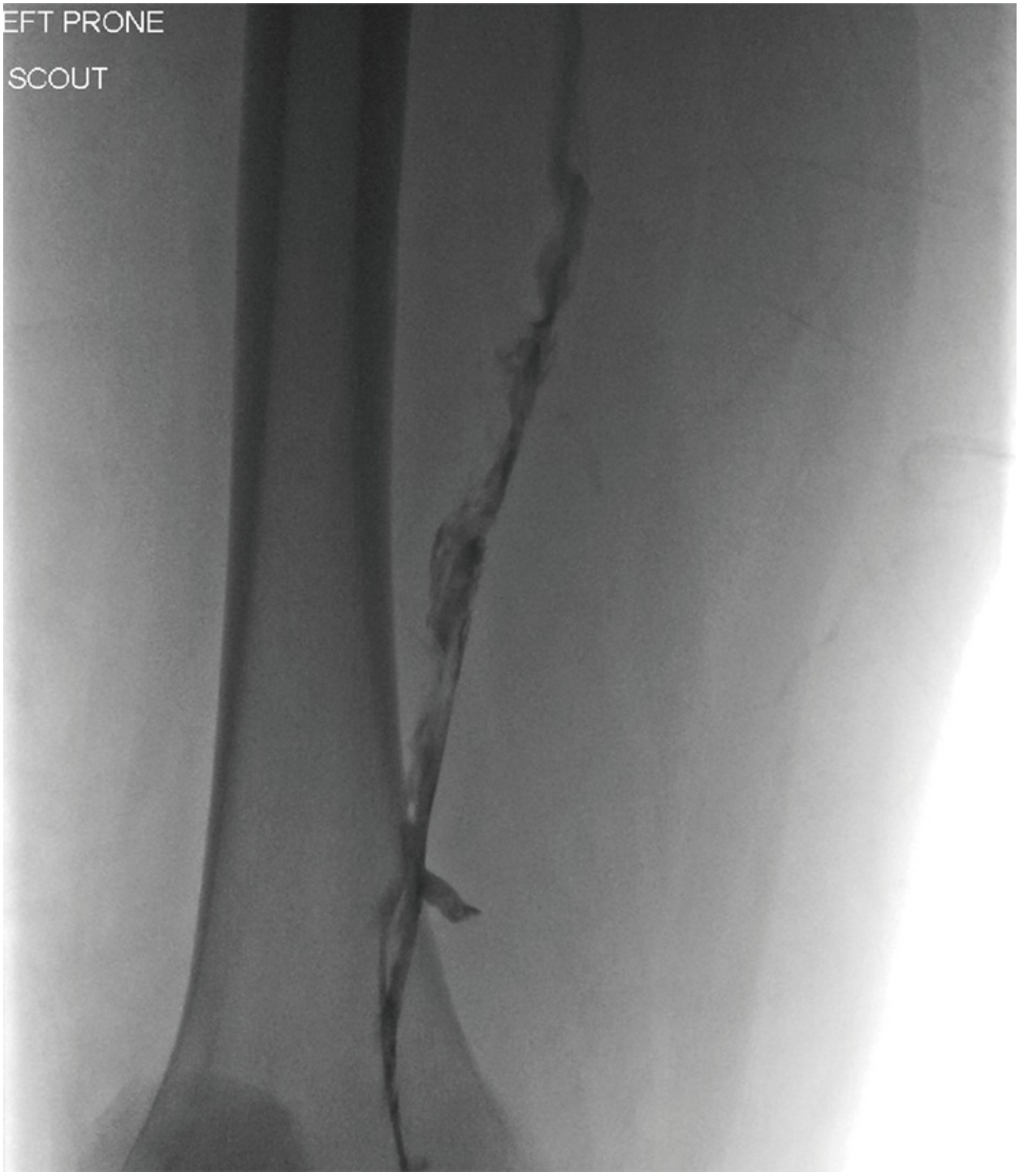

Figure 2

Contrast venography. Angiogram imaging of the left popliteal vein demonstrated a partially occlusive thrombus with irregular margins and diminished contrast flow. This thrombus was subsequently treated with catheter-directed therapy.

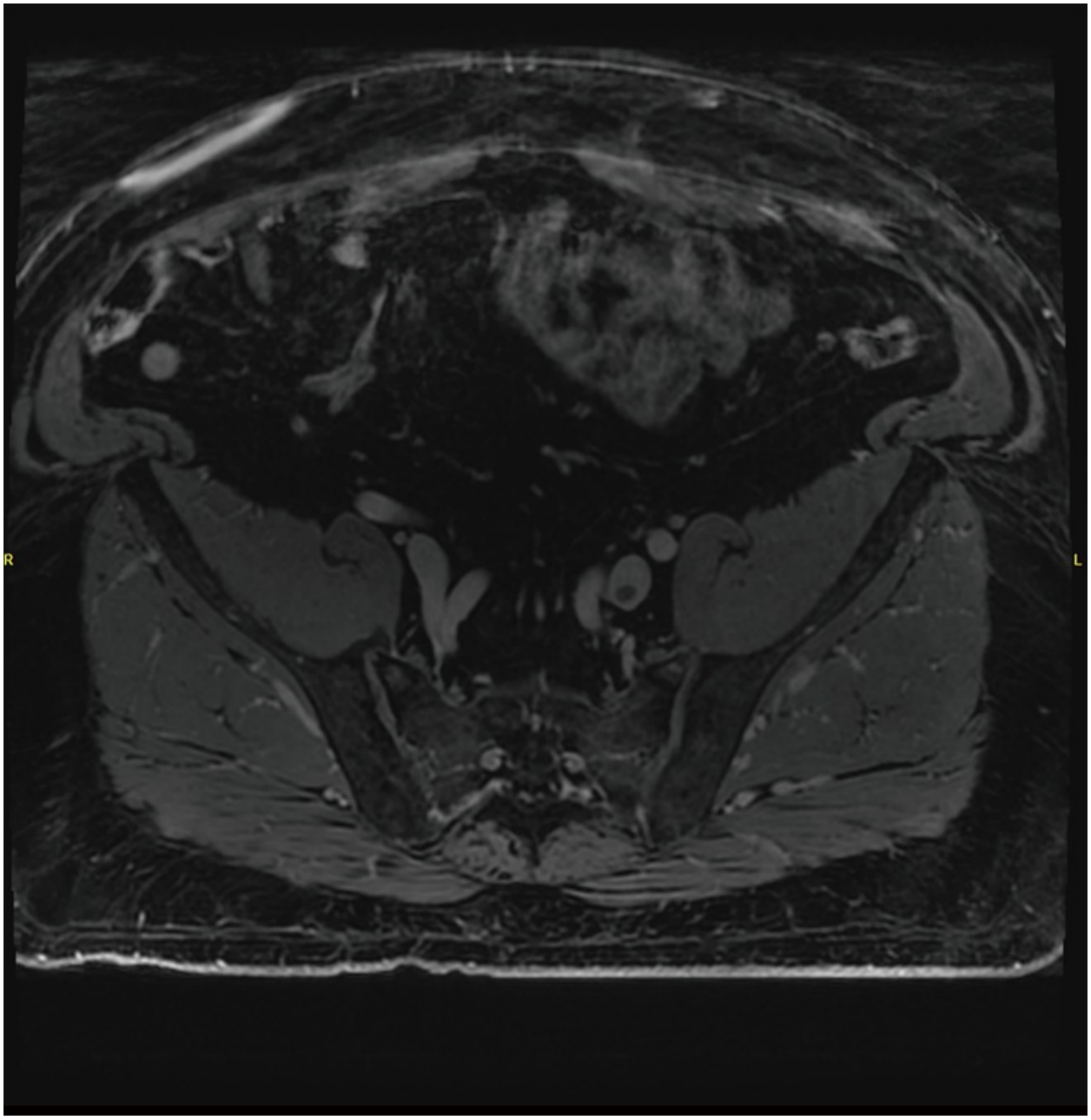

Figure 4

MR venography. MR imaging demonstrated a focal thrombus in the left common iliac vein that was seen extending superiorly to the inferior vena cava. No thrombus is seen on the contralateral side. MR, magnetic resonance

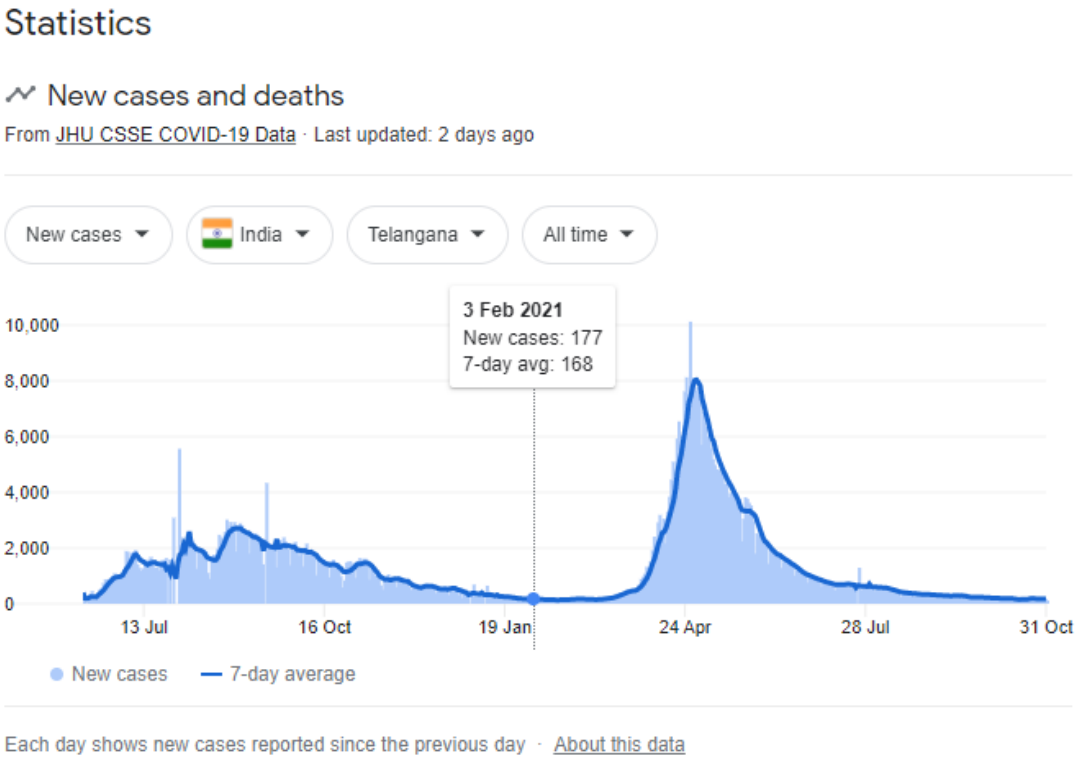

Figure 5

Google used a line graph to track covid 19 cases every day since the pandemic started, it helped commoners understand the live situation although they were quarantined.

Figure 6

Google used an area graph to track covid 19 cases in each country, all over the world, to maintain a proper track of the world situation of the pandemic.

Location	Total cases ↓	New cases (1 day*)	New cases (last 60 days)	Cases per 1 million people	Deaths
Worldwide	**21,94,56,675**	*No data*		**28,223**	**45,47,782**
United States	4,59,34,095	18,883		1,39,382	7,45,535
India	3,42,85,814	12,514		25,200	4,58,437
Brazil	2,18,10,855	6,761		1,03,204	6,07,824
United Kingdom	90,57,629	37,667		1,36,337	1,40,632
Russia	83,77,984	39,931		57,092	2,34,194
Turkey	80,32,958	23,948		96,602	70,611
France	69,88,705	6,329		1,04,191	1,15,294
Iran	59,24,638	8,427		71,098	1,26,303
Argentina	52,88,807	548		1,17,689	1,15,950

Figure 7

The number of new cases reported for the most recent day of complete data, within the last three days

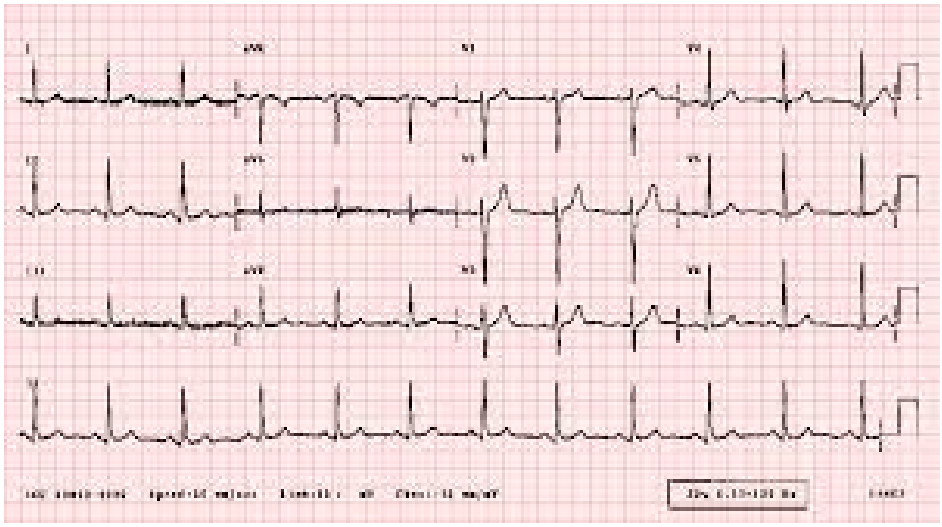

Figure 8

An electrocardiogram (ECG) is a simple test that can be used to check your heart's rhythm and electrical activity

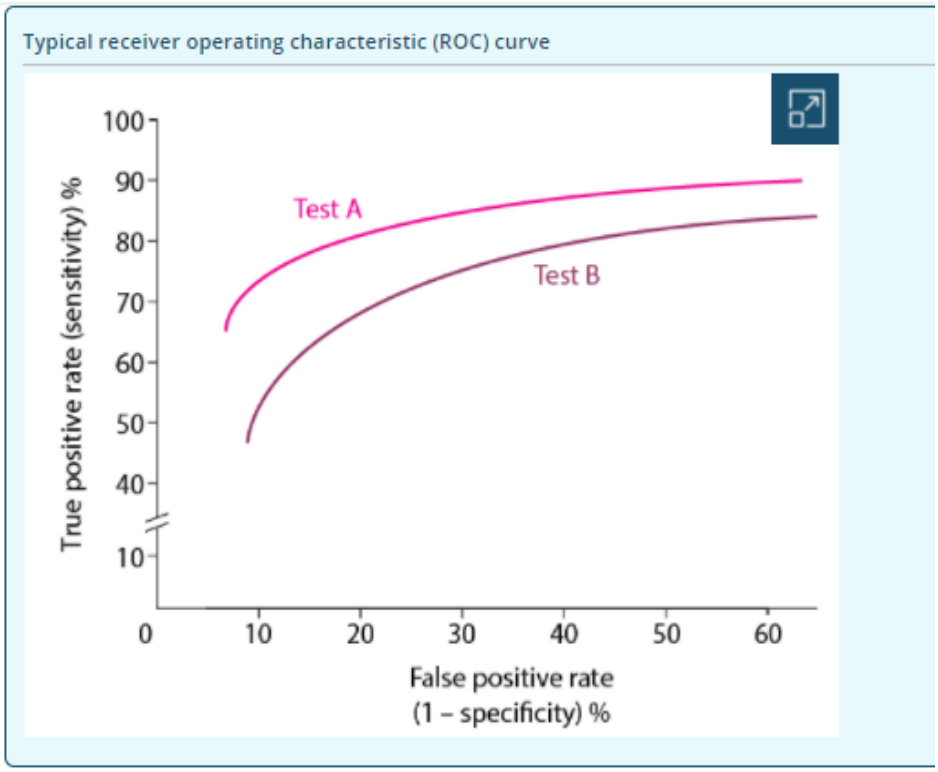

Figure 9

Receiver operating characteristic (ROC) curves

Graphing the fraction of true-positive results (number of true positives/number with disease) against the fraction of false-positive results (number of false positives/number without disease) for a series of cutoff points generates what is known as an ROC curve.

The visualizations that are still current and how they have evolved further: Visualization techniques or quantitative graphics developed from time to time, based on the need and innovative efforts of different scientists since the 16th century. Time series charts, Pie charts, and bar diagrams continue to be the most popular data visualizations since the olden days.[13] The bar chart has seen several practical variations in the course of time such as percentage bar, three-dimensional bar, horizontal bar, side by sidebar, negative–positive bar, etc.

During the process of development of quantitative graphics, five key concepts evolved in modern-day visualization.[15] The first is that it is computer-based, the second is using visual representations and the third representing underlying data, which is mainly an abstraction rather than a true representation such as the image of a skull in X-ray. The challenge, therefore, is to choose the appropriate visualization. The fourth concept is that data could be made interactive.

Especially with large data the user could interact with the data to control or modify the visualization so that they can change not only what is visualized but also how it is done. The last concept is that the goal is to amplify cognition. This means the end-user can solve problems better by observing and understanding invisible patterns of data when it is tabular form. For this, we can use “cognitive artefacts” – tools such as pivot tables, filters, and slicers, through which the end-user can better understand the visualization and make their own interpretations

Conclusion

The distribution and adoption of various data visualization tools are limited because of various reasons. In the increasingly complex clinical environment, the dependence upon data visualization to distill important information in a real-time fashion is likely to increase in the next few years. To facilitate movement towards improving our ability to compare the effectiveness of data visualization techniques, We have summarized best practices in design and evaluation while calling for the standardization of usability testing methodology.
These visualization techniques will definitely help in the betterment of understanding various health-related issues or trends in the field of medicine.

The emergence of the Internet in the latter part of the 20th century, the availability of new software tools such as Flash, Google Earth, and Processing, and the increase in publicly available data, have seen a huge increase in types of data visualization. Whereas in the past, various graphical aids for interpreting data have mainly been produced by specialist statisticians and scientists, in this new era we see an increasing appetite amongst members of the general public to produce their own.

In the age of big data, public health impact and implementation needs can be assessed in different ways using different interactive visualization techniques. When visualized well, big data can identify implementation gaps and disparities and accelerate implementation strategies to reach population groups in most need for interventions. For precision public health to succeed, advances in predictive analytics, and practical tools for data integration and visualization are needed.As Health Administrators may come from diverse specialties and most, including those from public health, will not be well versed in big data science, robust training and career development for big data in public health is the need of the hour.

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