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Review article

Data for orthopaedic surgeons – A review

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ABSTRACT

As we step into a technology powered era, where information is available everywhere, managing data forms an important part of professional and everyday life. With developments like online databases, high definition videos and images, social media, robotics, explosion of academic publications, telecommunication, artificial intelligence and internet of things, there is a variable amount of data that the orthopaedic surgeon is exposed to and has to deal with on a regular basis. It is imperative that the surgeon has a basic working knowledge on data and its applications in relation to the field of orthopaedic surgery. This review introduces the surgeon to data and its types, its sources, collection, Electronic Medical Records (EMR), management after collection, Big data and legal issues related to data. Data generators from megabytes to yottabytes are discussed along with options for their storage and analysis.

Knowledge on the types of data is important to decide on the type of statistical tests that may be used on them, for the options available for storage, analysis and legal issues. We discuss the different types of data, computer and cloud-based systems of Electronic Medical Records (EMRs) with their advantages and disadvantages as well as the differences between conventional and EMRs. Management of data after collection is discussed including storage and backup, archiving and sharing, organizing, tracking changes and analysis. High resolution images, videos, robotics and analytics are powering demand and production of data in Trauma and Orthopaedics. Issues like copyright, Privacy, security, encryption and legal issues related to data are highlighted as these are important as more and more data is being used online and involve issues of privacy and security. We also take a look into the future of data in orthopaedics as digitization of the world is occurring at a rapid pace.

1. Introduction

Data, which is defined as facts and statistics collected together for reference or analysis are essentially units of information collected through observation. The singular of data is datum which is a single value.

Although humans have used data in forms not labelled as data as such from time immemorial, the first recorded use of the word data in English language was in the 1640s. It was derived from Latin data which meant 'a fact given or granted'.[1]

Data is thought to go through six phases in its lifecycle.[2] From capture (thought of as birth) to maintenance, usage, publication, archiving and finally purging (death). Once data is generated, the process of active management of data through its lifecycle of interest and usefulness is called data curation.

Digitization of the world is occurring at a rapid pace and content is thought to be created mainly in three locations: the core (traditional and cloud datacenters), the edge (infrastructure like cell tower and branch offices) and the endpoints (PCs, smartphones and IoT). The data produced by all the above three is called a Global Datasphere (GD). The amount of data is expected to increase exponentially as we gallop through the technological era with one prediction of up to 175 zettabytes of data in the GD by 2025 from 33 zettabytes in 2018.[3]

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Among the industries using data like manufacturing, financial services, healthcare, and media and entertainment, healthcare currently consumes the least data. But it is expected to grow the fastest towards 2025 at the rate of 36% with demand for high resolution imaging, videos, robotics and analytics fuelling this growth.[3]

Data is usually in the raw form and often does not make sense. It becomes information which is comprehensible after processing and analysis.[4] It can be collected from persons or objects. Data is always present and depends on the researcher to ask appropriate questions to bring out the right answers.

Variables of data include type, size and origin or sources of data. It forms an integral part of engineering and technology, which are evolving at a rapid pace. Orthopaedics as a speciality, overlaps and depends on engineering sciences in a major way compared to other fields in medicine, especially in biomechanics, implantology, manufacturing and functioning of various prostheses and implants, gait analysis etc. It is imperative that orthopaedic surgeons understand the value of data in the field. This article gives a basic introduction of data to the orthopaedic surgeons.

2. Overview

This review about data is discussed under the following headings.

- Types of data
- Sources of data
- Collection of data
- Electronic Medical Records
- Managing data after collection
- Big Data
- Public Health and Medical Informatics
- Legal Issues with data

3. Types of data

To be meaningful for analysis, each unit of data should be of the same type before taking up for analysis. Different types of data cannot be clubbed together for analysis as each type requires a different strategy to handle. Data can be classified broadly as categorical or numerical. **Categorical** data is arranged in categories and further classified as Nominal or Ordinal.

Nominal data are named categories and examples include sex, blood type, eye colour, race etc. Nominal data do not have a natural ascending or descending order and each sub-category carries its own importance. Examples of nominal data include use of particular type of implant used for particular fracture (plate, intramedullary nail, arthroplasty), gender distribution for epidemiological studies, type of investigatory modalities used to confirm a particular type of fracture (radiograph, CT scan, MRI scan) etc. While **Ordinal** data can be arranged in ascending or descending orders of categories e.g. High/middle/Low, Income levels etc. Orthopaedic relevant examples include stratification of open fractures based on Gustilo Anderson classification (Open grade I to IIIC), Garden's classification for intracapsular fracture neck of femur (I to IV) etc. In both the above examples, the severity of injury worsens as the grade of the injury increases.

Numerical data as the name suggests is arranged in numbers. They are further classified as discrete or continuous types. **Discrete** numerical data is qualitative type of data and examples include number of people in a group, days of hospitalization after hip arthroplasty etc. This type of data cannot be subjected to all types of mathematical treatment but can only be counted as a non-negative whole numbers.

Continuous data can be integers and also include numbers with decimal values. Examples include the physical component of Short Form 12 (SF-12 PCS), the mental component of Short Form 12 (SF-12 MCS), the Liverpool Elbow Score etc.

The importance of this classification is that only certain statistical tests may be done for each type. Nominal data may be analysed using frequencies, proportions or percentages, Ordinal data may be analysed using all the above and may be presented visually using pie or bar charts, median, mode and percentile values. Continuous data may be analysed using percentiles, mean, median, mode, Standard deviation, interquartile range, range and visually presented using histograms and box plots.

Data is said to be distributed symmetrically when all three: median and mean lie in the center of the bell shaped curve. It may be positively skewed when the mode is to the right of the center (median) while the mean to the left or negatively skewed when the mode is to the left of the center and mean the opposite of the previous. Kolmogorov Smirnov test, Shapiro Wilk test and review of bell shaped curve superimposed on a histogram can be used to ascertain the nature of data distribution. For normality, Anderson-Darling test may be used.

4. Sources of data

The main types of data include numbers, text, pictures, video and audio files. Pictures and video files need bigger storage spaces as the sizes of these files are large. The challenges for these types of data are organization and storage while those for numbers and text include accuracy of collection and analysis. In addition to clinical data, Radiographs, CT scans, MR images are used relatively more than other specialities. Video files are also increasingly being used by arthroscopy surgeons. Computer assisted surgery, 3D printing, robotics, the approaching use of IoT technologies in orthopaedics introduce the challenge of handling big data and Artificial Intelligence.

Sources of data in orthopaedics may be classified into clinical and non-clinical sources.

Fig. 1a classifies the clinical and non-clinical sources of data. Laboratory studies include basic science studies. A list of all the common sources of clinical and non-clinical data is also included in Fig. 1b. This list is non exhaustive.

Hospital records would include administrative data like financial inflows and outflows, data on staff, employees, logistics, billing etc. Electronic Medical Records (EMR) may be used by a single hospital or a chain of hospitals. The quality of outputs from these databases would depend on the quality of data that is entered into the database.

Primary and secondary data: Primary data refers to data that has been collected by the researcher(s) directly from original sources (for example, from patients in a clinical study) while the term secondary data refers to data which has already been collected from primary sources and made readily available for researchers(for example, in published articles) to use for their own research. Systematic reviews and meta-analysis work on secondary data.

Collection of data: Data may be collected either manually or digitally using electronic devices. Manually collected data is usually entered into digital format to make analysis easier. Hence devising a database to collect data into digital format would save time in transfer of data between these two forms. It is important that rules are laid down to collect data that is homogenous. Otherwise, analysts will be spending a lot of time to make the data homogenous, a process called sanitizing data to make it analyzable. This would include uniformity in spelling, removing errors, making sure right data is entered into the right cells. Newer systems in excel and

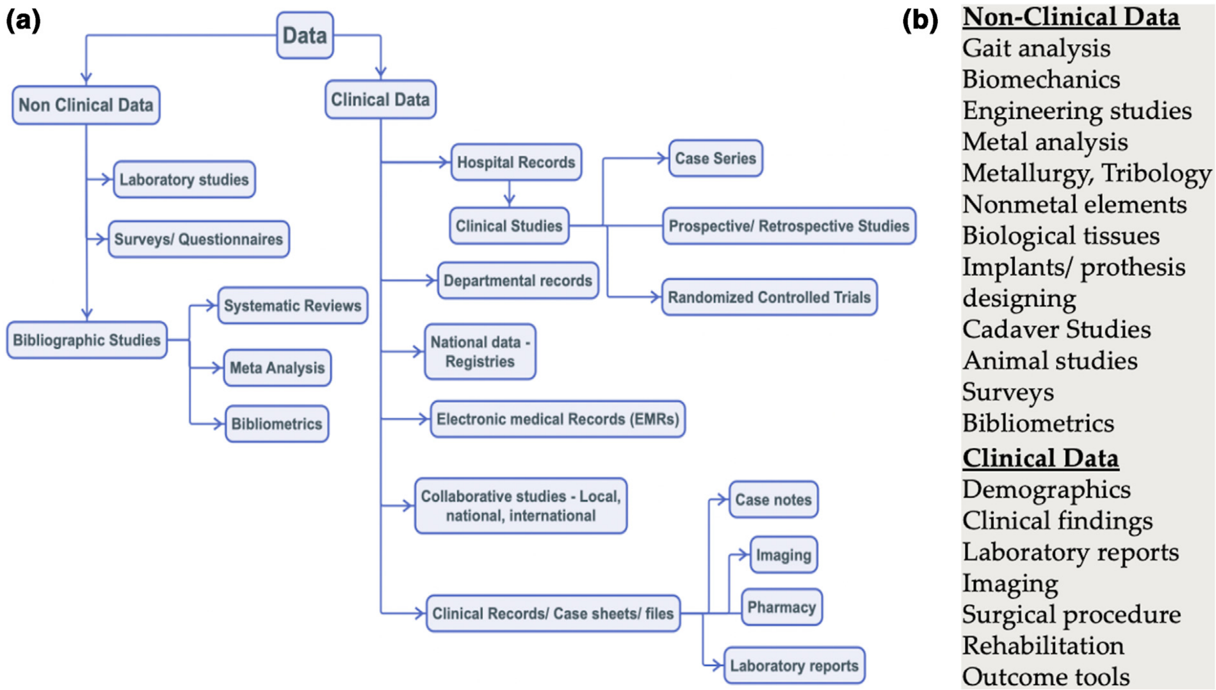

Fig. 1. a: Classification of clinical and non clinical data. b: Sources of Clinical and Non Clinical data.

access and other forms of databases have techniques to standardize inputs into each field so that it saves times to input data into each cell as well as avoids spelling mistakes and errors of entry of datum into each cell. MS Access is an example of a database whereas MS Excel just gives spreadsheets. Appropriate training may be required for the user to reduce incidence of these errors. If multiple users are recruited to input data, it is important that they understand the rules of entry of data.

5. Electronic Medical Records (EMR)

EMR is an electronic collection of medical information about a person that is stored in a computer. It includes information about the health history of a patient including clinical history, examination, diagnosis, medicines, allergies, imaging and laboratory test results as well as treatment plans. They can be accessed by all the medical and nursing staff involved in the care of the patient. They can range from a simple database used by an individual surgeon to a complex database used by a chain of hospitals. Hence, they can be used at level of the surgeon, a small-scale hospital, a large-scale hospital or a chain of hospitals ranging from a few to as complex as all hospitals within a nation. Based on the amount of money invested, needs of the establishment, the databases have different features. They could be offline/server based (i.e. limited to just one computer or a network of computers but not connected to the internet/cloud based storage) or online/cloud based where the data storage occurs in the cloud and requires an internet connection. Each type has its own advantages or disadvantages (Table 1). Some would argue that offline data storage is more secure as the data does not leave the premises of the hospital. Online systems have the advantage of access from anywhere. Handheld devices and smartphones could also include these datasets. Both the types of databases may be used in handheld devices but the amount of storage in offline databases and the functionality in cloud based systems would be limited in these systems compared to desktop based systems as the storage and processing power of desktop devices are superior to handheld devices.

The disadvantages of EMRs include: expensive software, need maintenance and knowledge to operate, security concerns regarding confidentiality, data integrity and access by the right people as well as security from the wrong people.

Differences between conventional medical records and EMRs are given in Table 2 and disadvantages of EMRs are given in.

Managing data after collection:

Issues in data management include.

a) Storage and Backup
b) Archiving and sharing
c) Analysis, citing and handling data
d) Organizing and tracking changes
e) Data Copyright, Privacy and intellectual property
f) Security and Encryption

Table 1
Differences between Computer based and Cloud based storage systems.

Computer based	Cloud Based
• Data is secure, does not leave the premises • Origin and storage same place • Does not need internet connection • Needs backing up physically	• Data is stored in cloud • Origin and storage are different • Needs internet connectivity • ? Security concerns • Stored in the cloud and automatically backs up in the cloud

Table 2
Differences between conventional and electronic medical records.

	Conventional records	Electronic records
Handwriting	Physicians Handwriting illegible sometimes	Standard format of text by the computer
Interactivity	Not interactive or intuitively designed	Is interactive
Reminders & cautions	Printed reminders and cautions can be overlooked	Reminders can be flashed and even made to acknowledge by user
Special features	None	Special applications: Patient specific and real time feedback possible
Transfer	While transferring – requires huge volumes of multiple records to be transferred	Does not take space to transfer. Can be done in seconds if online
Offshore storage	Can only be done after discharge	Can be backed up offshore periodically
Storage space	Takes space to store	Comparatively far less space required to store
Sharing	No sharing of data, copies need to be made for each user	Data can be shared with multiple users at single time
Disaster in office	Destroys records	If backed up online, all records can be preserved
Ecology	Not eco friendly	Eco friendly
Collaborations	Cumbersome	Between departments, between doctor and patient possible. Can track care

6. Data storage & backup

The data collected from clinical or non-clinical work must be stored in order to handle or analyse. This data takes some memory within the computers or systems that store the data. Higher amounts of storage are named in multiples of thousands of bytes. These include Kilobytes (1000), Megabytes (1000^2), Gigabytes (1000^3), Terabytes (1000^4), Petabytes (1000^5), Exabytes(1000^6), Zettabytes(1000^7) and Yottabytes(1000^8). One zettabyte is a trillion Gigabytes. Most domestic systems have storage of the order of Gigabytes (GB). This can be extended to 1–4 Terabytes in upcoming systems. Surgeons who regularly use HD videos and high quality digital images would require storage capacities in Terabytes. To give an example, a high definition (HD) video from a single arthroscopy of one to 2 h would typically generate between 4 and 10GB of HD video data. High resolution MR images require about 100 MB storage while 2D/3D CT reconstruction images require around 1–2GB storage. Most surgeons can manage less than terabytes even in busy practices if HD data is not being routinely used. Organizations managing Big Data would require storage capacities between Petabytes and Yottabytes. Big data will be discussed in detail in the following text.

7. Data handling, processing and analysis

Once storage needs are taken care of, the next requirement is processing speeds of the systems. Regular computers with processing speeds available in the market would suffice for individual use or for small scale and even large scale hospitals. When the data outputs reach Big Data, the processing speeds of the computers may need to be increased. More specifically, the software used to store and process or analyse the data need to be efficient to handle Big Data as routinely available software cannot handle big Data sets. In most cases, the specifications of the computer (RAM or Random Access Memory) is the main limitation in handling big Data. In addition to using a compatible software, the computer should possess the required processing speeds to handle big data. Examples of software that handle small data include Microsft Excel and Access and Google spreadsheets. Software that can handle statistics and big data include SPSS, R, EpiInfo, MedCalc, Statsdirect, Power-Excel. Exclusive big data handling softwares include SQL, IBM, SQLite and Oracle.

8. Big data

Big data is defined as extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions. These data sets will contain billions of fields. Typically, multiple users upload the data into a centralized database where the data is stored and analysed. As seen previously, they require storage capacities between Peta and Yottabytes. Big data can be structured, semi structured or unstructured. Most orthopaedic systems use structured data which makes analysis easier. The data is collected using forms.

In orthopaedics, the use of big data has been increasing in the last two decades. It is possible to store and process big data sets as the storage and processing speeds of available computers increase. Big data may be found in National Registries like the Joint registry, the National Hip Fracture Database (NHFD), trauma registry (TARN) or ligament registry used in the UK and multiple other countries.[5,6] It has applications even during the current pandemic.[7] Administrative data may also be used by orthopaedic surgeons. These include admission and discharge and readmission data from Medicare, US Census data from the USA. High quality studies with such large data is not possible. Hence, most of these are observational studies. The advantages and disadvantages of big data are listed in Table 3.

For a population of approximately 7 crores, the NHS in the UK generates data on 1 million patients over 36 h and has around 55 million patients' data in different databases.[8] For a population of 130 crores, India could potentially generate at least 15 times that number. The value of big data is in predictive analytics, especially in healthcare i.e. by data mining, analysis of the data, predictive modelling, and machine learning, current and historical data are analysed to make predictions about future or otherwise unknown events. Use of Artificial Intelligence (AI) is invaluable in analysing big data. So far, data is fed into the internet by humans. With Internet of Things (IoT), data will be fed at an exponential rate into the internet directly from devices which will increase the value of AI analytical tools to make sense of the collected data.

9. Public Health and Medical Informatics

Public Health Informatics (PHI) is defined as the systematic application of information and computer science and technology to public health practice research and learning.[9] The primary focus of PHI is to prevent disease, injury or disability in populations of risk by use of information. It includes, in addition to governmental frameworks consisting of legislative, regulatory and policy directives since care of the whole community is the focus here. Disease Surveillance Systems are used to systematically collect, analyse and interpret data of communities in epidemics to track and respond to them. National Registries may be considered part of

Table 3
Advantages and disadvantages of big data.

Advantages of big data
• Application in public health in predicting epidemics and hotspots. Monitoring evolution of epidemics and pandemics
• Preventing medical problems using genomics
• Predicting and preventing vehicular trauma by improving traffic management by studying patterns of accidents and traffic hotspots
• Personalized healthcare plans and rehabilitation protocols using algorithms
• Designing and manufacturing of implants based on outcomes and feedback from users of current trauma and implant surgeries
• Rare disease databases, National Registry data for Arthroplasty, Trauma (TARN), Hip fracture and Ligament Registries have given valuable insight into big data and its uses in monitoring of implants as well as surgeons' performances and outcomes of these procedures/conditions at a community level.
Disadvantages of using big data[3,6]
• Selection bias, Lack of hypothesis
• Measurement errors, processing errors
• Inaccurate entries in upto 16.6% cases
• Lack of standardization between datasets
• Missing data
• Cost of developing and maintaining
• Privacy

PHI since these are databases that are used to track large groups of patients with a particular disease, an exposure to a risk factor or those who have had a procedure.

Medical Informatics (MI) deals with the systematic processing of data, information and knowledge in medicine and healthcare.[10] It involves studying data, information and knowledge and to provide solutions related to problems in these domains in medicine and healthcare. Both these disciplines involve application of knowledge from various fields like management, information & computer science, law & political sciences, epidemiology and medical specialities to name a few.

10. Security and encryption

Data security means protection of data from unauthorised access, use, change, disclosure or destruction while data encryption is encoding of data to protect confidentiality of data from unauthorised access.

Security may be maintained at multiple levels: at the level of the location, computer access, network and online. Threats could occur from different sources, and these include software viruses and malware, physical access, and destruction by unauthorised persons. It is important to keep the systems free of viruses by an up-to-date anti-virus software and limit physical access to unauthorised persons by using passwords to the system, files and folders, software, network and online databases. It is best to keep confidential information off the internet and not import any software that is not secure into one's computer. Very sensitive information should be kept in computers that are not connected to the internet. Physically restraining access to rooms and buildings to people who are not authorised improves security. Confidential data is best avoided sending by email or sent by using encryption to protect the data.

11. Legal issues of electronic data

There are three parties involved in data that is collected and stored. The patient, whose data is being collected, the surgeon/staff who is employed by an organization who enters the data and who pays for the software purchase and maintenance, and the software company who has created the software. The data that is being collected is personal data of patients and is bound by medicolegal laws guiding the collection, handling and use of the data.

Legal Issues related to data include Data copyright and ownership, Privacy and intellectual property, security and encryption. Ownership of data entered into the software would be by the organization or the surgeon who enters the data. They have the responsibility to maintain privacy, security and encryption required to maintain confidentiality of the information provided by the patient. If the security is doubtful, it is best not to include personal identifying data in these software and just restrict it to an ID that does not reveal the identity of a patient. When submitting for publication of results of big data, the submitted data should not identify patients since it may be accessed by a third party.

In India, a specific legislation on data protection has not yet been enacted. Information Technology Act (2000) was amended in October 2009 to include Section 43A and Section 72A, which provided a right to compensation in the event of improper disclosure of personal information. Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011 under Section 43A of the IT Act were also issued subsequently. In August 2017 the Supreme Court of India recognised the right to privacy as a fundamental right.[11,12] Protection of privacy is also necessary in relation to right to information. The personal data protection bill 2019(in process) is likely to be India's first law on the protection of personal data.

The laws that deal with handling and usage of data include the laws given in Table 4. International IT and social media companies dealing with data in India are bound by the laws in their country of origin (most commonly USA, UK and EU countries) as well as the local and national legislation in the area of operation. Social media also collect data in large amounts from users and will be regulated by the IT act. It is advisable to not use social media apps for consultations routinely. Adequate care should be taken before using these apps in terms of legal issues. Elaborate guidelines have been provided by the Ministry of Health and Family Welfare, Government of India regarding the use of teleconsultation.[13]

12. The future

As we move into a technologically powered future, more applications will be available to perform increasingly complex and accurate functions in everyday life as well as professionally. As computation and processing speeds become faster and storage gets larger and cheaper, applications with complex features become available to store and analyse data. More and more surgeons may be expected to use increasing amounts of mobile, cloud and computer based data into the future. Increasing requirements for higher resolutions for imaging in radiography, CT and MRI for 3D imaging, 3D printing, robotics and computer guided surgeries would drive higher storage requirements and processing speeds.

Organizations and care providers will be using increasingly complex and larger databases carrying big data. We could see new AI applications and improvements in existing ones as well as improvements in the methods of analysing big data in the future. New

Table 4
Acts of Law in relation to data in India, UK, EU and USA.

India	UK & EU	USA
• Information Technology Act, 2000[12] • Personal Data Protection Bill, 2019[13] • Information Technology Rules, 2021[14]	• Data Protection Act 1998[15] • Data Protection Act 2018[16] • General Data Protection Regulation (GDPR) - EU[17]	• Health Insurance Portability and Accountability Act (HIPAA)[18]

techniques to secure and encrypt personal data as well as new legislations to prevent misuse of data and to cover loopholes allowing misuse may also be expected. The following quote form IDC sums up the future of data aptly. "The data driven world could be expected to be always on, always tracking, always monitoring, always listening as well as watching because it will be always learning".[3] Trauma and Orthopaedics may be expected to lead this world as there is more engineering, commercial and cost involvement related to data in this speciality more than any other speciality in medicine.

13. Conclusions

Data forms an important part of everyday life as we move into the technological era. It is important that orthopaedic surgeons equip themselves with a basic understanding of the different types of data, its collection, storage, analysis, security and legal aspects since they have to deal with data in various forms on a regular basis. As technology improves, the rules and methods used to deal with the above aspects also change and one needs to get updated with the advances on a regular basis. To analyse such large storages of data, applications involving Artificial Intelligence would be increasingly used in the future.

References

1. The history of data. ThinkAutomation. Published February 13, 2020 https://www.thinkautomation.com/histories/the-history-of-data/. Accessed July 3, 2021.
2. The data lifecycle: explained. *ThinkAutomation*. 2020;6. Published January https://www.thinkautomation.com/eli5/the-data-lifecycle-explained/. Accessed July 3, 2021.
3. Reinsel D, Gantz J, Rydning J. *IDC Report: The Digitization of the World from Edge to Core*; 2018. Published https://resources.moredirect.com/white-papers/idc-report-the-digitization-of-the-world-from-edge-to-core. Accessed July 3, 2021.
4. Shaha SH, Sayeed Z, Anoushiravani AA, El-Othmani MM, Saleh KJ. Big data, big problems: incorporating mission, values, and culture in provider affiliations. *Orthop Clin N Am*. 2016;47(4):725–732. https://doi.org/10.1016/j.ocl.2016.05.009.
5. Slobogean GP, Giannoudis PV, Frihagen F, Forte ML, Morshed S, Bhandari M. Bigger data, bigger problems. *J Orthop Trauma*. 2015;29(Suppl 12):S43–S46. https://doi.org/10.1097/BOT.0000000000000463.
6. Haleem A, Javaid M, Khan I, Vaishya R. Big data applications in orthopaedics. *J Orthop Spine*. 2020;8(1):46–47. https://www.joas.org.in/article.asp?issn=2666-7150;year=2020;volume=8;issue=1;spage=46;epage=47;aulast=Haleem.
7. Haleem A, Mohd Javaid, Khan IH, Vaishya R. Significant applications of big data in COVID-19 pandemic. *Indian J Orthop*. 2020;54(4):526–528. https://doi.org/10.1007/s43465-020-00129-z.
8. Koziara M, Gaukroger A, Hing C, Eardley W. Introduction to big data in trauma and orthopaedics. *Orthop Traumatol*. 2021;35(2):84–89.
9. Yasnoff WA, O'Carroll PW, Koo D, Linkins RW, Kilbourne EM. Public health informatics: improving and transforming public health in the information age. *J Public Health Manag Pract JPHMP*. 2000;6(6):67–75. https://doi.org/10.1097/00124784-200006060-00010.
10. Greenes RA, Shortliffe EH. Medical informatics. An emerging academic discipline and institutional priority. *J Am Med Assoc*. 1990;263(8):1114–1120. https://doi.org/10.1001/jama.263.8.1114.
11. Prasad MD, Menon CS. The Personal Data Protection Bill, 2018: India's regulatory journey towards a comprehensive data protection law. *Int J Law Info Technol*. 2020;28(1):1–19. https://doi.org/10.1093/ijlit/eaaa003.
12. Justice KS. Puttaswamy(Retd) … Vs union of India and ors. On 24 august. https://indiankanoon.org/doc/91938676/; 2017. Accessed June 10, 2021.
13. Board of Governors. Indian medical council: telemedicine practice guidelines; enabling registered medical practitioners to provide healthcare using telemedicine. Published March 25 https://www.mohfw.gov.in/pdf/Telemedicine.pdf; 2020. Accessed June 8, 2021.