EDITORIAL VIEW   **PERIOPERATIVE MEDICINE**

Data science and its application in anesthesiology

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Abstract

Electronic health records have brought about vast improvement in all aspects of healthcare. 'Anesthesia Information Management System' is a specialized form of electronic health record system that is used to record all of the events taking place during the perioperative period, such as clinical procedures performed, physiologic changes that may happen and the medications administered. Based on anesthetic data many databases have been developed internationally for quality improvement in anesthesiology and to know the research outcomes. At an individual clinical level, big anesthesia data is not yet present, unless waveforms and continuous numerical data of intraoperative physiologic variables is recorded. Though the initiative for big data has taken up by some healthcare institutions in the health data management but our country is still far behind in this field. This editorial is aimed to highlight the necessity of this system and to draw the attention of the concerned authorities to plan provision of electronic record keeping in operating rooms.

Key words: Electronic Health Records; Data; Data Science; Anesthesiology

1. Introduction

In the age of digital tools, every aspect of life has been transformed. Health records require enormous paper work. The hard copies require considerable logistics. There is also loss and decay of important information during storage and transfer. These records are now being transformed to electronic systems, termed as 'Electronic Health Record Systems' (EHRS).[1] An EHRS is defined as a longitudinal collection of electronic health information about individual patients as well as the whole populations.[2]

EHRS have resulted in improvements of all aspects of healthcare. Wearable vital monitoring systems and subsequent management of the medical conditions are a simple example of physiologic data collection.[3] At an advanced level, there are examples of the National Health Service (NHS) of UK, that uses Deep-Mind health service (a subsidiary of Google) to warn physicians about acute kidney injuries of in-patients.[4]

Patient safety, clinical decisions, evidence-based guidelines, human resource management, cost containment and administrative policies have all been improved using these digital systems. Large healthcare data can also provide information on medical outcomes and rare medical conditions. Data management makes use of techniques from various scientific fields like mathematics, statistics, computer science and information science. It must be born in mind that data collection without an outcome plan is wastage of the resources.[5]

1.1. 'Anesthesia Information Management System' (AIMS)

AIMS is a specialized form of electronic health record system that records the events taking place during the perioperative phase such as clinical procedures, physiologic parameter changes, and medication administration. It has both hardware and software components. For information storage, modules are used and it is then stored in a relational database management system (RDBMS) which stores and provides inferential

data. It's an advanced data management system that makes gaining insights from data a lot easier. [6] Computational tools integrate data analysis with interactive visual interfaces.

AIMS interface usage starts with entry of patient demographics and medical history. Software system can suggest preoperative laboratory tests based on comorbidities or planned surgery. It can also provide risk stratification like risk of major adverse cardiac events using computational tools by following algorithms like the modified Lee-Goldman index. Vital signs are recorded continuously by automated software. Data can then be presented in the desired format like tables, figures, and pie charts etc. Information is kept confidential and can be accessed only by authorized competent authorities.[7] At Vanderbilt University, USA, interface has been switched from bigger machines to wireless handheld devices.[8]

There are many vendors of AIMS like Drager, GE Healthcare, and Philips Medical Systems etc. They supply both the hardware and software components. Vendor selection for a facility depends upon the scope for which AIMS is intended to be installed.[9]

AIMS has enabled enhanced intraoperative record keeping and detection of controlled substances misuse, e.g., narcotics. It has also helped in improvement of patient safety, facilitated clinical decisions, formulation of evidence-based anesthetic guidelines, cost containment of anesthetic procedures, facilitation of clinical research and improvement of administrative processes and policies related to operating rooms. [9,10] It provides better accuracy than manual records.

The major obstacle to AIMS adoption at any healthcare facility is the financial barrier. It can cost up to 700,000 – 1,600,000 Pakistani rupees (PKR) per operating room, 500,000 – 1,300,000 PKR per anesthesia location and 2,300,000 – 7,600,000 PKR for AIMS server. Twenty percent of initial costs is likely to be spent on maintenance support per year in addition.[11]

1.2. Anesthesia Databases

Several anesthetic databases have been developed internationally. Their aim is to collect data for quality improvement in anesthesiology and to know the research outcomes. Few examples of population level databases include 'Pediatric Regional Anesthesia Network', 'Multicenter Perioperative Outcomes Group' (MPOG), and 'Society for Ambulatory Anesthesia' database. Countries like USA and UK have developed national health databases to collect health data for research and development in anesthesiology and other allied disciplines.[12]

1.3. Big Data

Big data is defined as data that contains greater variety, arriving in increasing volumes and with more velocity. There are some attributes of big data, which are called '5V's'; these are;

1. Volume: There must be terabytes or more of new data each day. A terabyte is a unit of information equal to one million million (10^{12}) or, strictly, 2^{40} bytes.

2. Velocity: Data must be generated at high speed.

3. Variety: Data must be heterogeneous, which means that it ought to be from different and diverse sources

4. Veracity: Data must be true. If not all of the collected data is correct, it will compromise the true results of the analysis.

5. Value: The data obtained must have at least some importance for future usage. This is the most important aspect of the data.[13]

At an individual clinical level, big anesthesia data is not yet present, unless waveforms and continuous numerical data of intraoperative physiologic variables is recorded. However, there is increasing velocity of anesthetic data in the current era. Volume of data is yet not large enough to account for big data. Considering the advancement in technology, it is not far enough to reach the big data destiny in anesthesiology. Currently the emerging data in anesthesiology is the genetic data. [14]

There are certain limitations of big data. For example: there may be accumulation of false or irrelevant data or absence of important data. There may be measurement errors and unfamiliarity with computer science concepts that can lead to inaccurate results in interpretation of the information. The most important limitation to mention is the requirement of a firm clinical approach to interpret results which require extensive training of the personnel. Few critical aspects of data management in anesthesiology which need to be looked at include its meaningful use, strict maintenance of confidentiality and use of standardized tools for interpretation of data.[14,15]

Two methods to overcome problems of big data are machine learning and data mining. Machine learning is a branch of 'Artificial Intelligence' which enables computer system to learn from available data via computer algorithms. Data mining is a process of turning raw data into useful information by finding useful patterns in data by sophisticated mathematical algorithms. It requires human supervision.[15]

The health data management is yet novel in our country. There are some healthcare institutions in Pakistan who have started this journey like Indus Hospital Karachi which is country's first paperless hospital.[16] Its electronic medical system links all the hospital operations and is focused on volume, costs, and efficiency of the resources

and to some extent they target patient health outcomes. However, anesthesia details are recorded manually by the personnel and not all anesthesia work units are linked to the central hub. Shaukat Khanum Memorial Cancer Hospital's (SKMH&RC, Lahore) electronic health record system was also developed on a patient-centered approach. Its electronic health records regarding anesthesia and postoperative care unit are completely automated.[17] At Aga Khan University Hospital, Karachi, all administrative and patient records are online but all health units are not integrated. The electronic health record system exist but AIMS is yet to be adopted.

2. Conclusion

Automated information systems are the future of medicine. They are destined to replace the paper based health records. AIMS is the essential component of modern anesthesiology. There are associated shortfalls and current commercial systems are just an entry into the digital technology. This technology has to be embraced someday, the earlier the better. Costs are high, but rewards are worth it.

3. Conflict of interest

None declared by the authors.

4. Authors' Contribution

SA: Manuscript writing and proof reading
UA: Conceived the idea, did literature search, manuscript editing
FAK: Proof reading and approval of final draft

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