Changing times

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We wish you happy reading!

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Big databases and their contribution to dental research

Most dental medical activity takes place in private clinics. This setting makes it difficult to execute high-quality research and gain insight on treatment outcome and healing processes in dentistry.

The increased volume of information stored in the information systems creating computer-generated data, alongside an increase in computation capabilities to extract and analyze this data, has created a new science named big data science (BD).

Several treatment modalities in dentistry require long-term follow-up and scanning of large populations to verify the actual influence of treatment. For example, the influence of fluoridation of drinking water or the resistance of composite vs amalgam fillings. Analysis of big databases might offer such a longitudinal point of view on treatment outcomes in large populations.

Data from information systems of dental chains composed of several dental clinics operating under the same guidelines will enable data collection that will produce a large database.

Dental medicine is perceived nowadays as a separate branch in medicine, and, as a result, is excluded from medical centers such as hospitals, medical organizations, and from medical schools around the world.[1] This setting makes it difficult to execute high-quality research and gain insight on treatment outcome and healing processes in dentistry.[2]

In recent decades, general medicine has become an evidence-based medicine (EBM), which bases clinical guidelines on systematic reviews.[3] These reviews are based on a series of randomized prospective controlled trials. Clinical studies should be regulated and supervised by ethical committees. Therefore, due to the nature of the dental profession, conducting such randomized prospective controlled trials is difficult and limited to medical institutes and academic dental departments.

The limited ability to establish clinical principles in dental medicine on empirical paradigms forces the field to be based

on theoretical paradigms. These paradigms are supported by the world views of opinion leaders in clinical dentistry, limited clinical research, and basic scientific research. In the 1980s, information systems emerged and became widely accessible. It was the "opening shot" for an almost unlimited race to gather information in all fields of life, including medicine. The exponential development of information systems creates big databases.

BD, being a new and evolving field of research, is still challenged with self-definition. For example, what is the required size of a database for it to be referred to as BD? What are the inherent possibilities and limitations of analyzing big databases? What are the required skills from a data scientist? How should teams be built to properly analyze BD? How do we address ethical and privacy issues related to data extraction?

As for any new scientific method, BD engenders not only supporters but also opponents, especially when it comes to research that invades existing traditional research areas. In medicine the "gold standard" research method is randomized, controlled, pre-planned trials (RCTs).[3] BD studies are nonrandomized observational analyses of large electronic patients' databases. Data analysis derived from computed codes and records should be addressed with caution to prevent misinterpretation of data. In a systematic review challenging the new applications of BD,[4] several ethical issues were mentioned in relation to database analysis: privacy, anonymity, and the required attention to the security of data.

Despite all this, the enormous power of BD studies derives from the ability to screen a large number of patients. This might highlight abnormal trends or rare effects that will not be reflected in RCT studies that are limited in number of participants. For example: the damage to muscle tissue as a side effect of statin use or the use of aspirin to prevent unnecessary cardiovascular disease were discovered only following multiple data studies that included a large scale of information.

It should be mentioned that insurance companies have large databases on dental care. However, they do not share any of the data in their possession, for business and economic reasons. One of the ethical problems mentioned in relation to BD studies has been attributed to commercialization bias.[4]

For BD analysis the method for data extrapolation is structured at the most basic level: the "raw data" is extrapolated from the existing database, the "data." In the second step, the data is refined to obtain only the data relevant to the research topic and deal with the core research question: the "information." In the final stage, dedicated information must be established so that in combination with data from additional databases and information contained in the literature it will be possible to obtain "knowledge." The insights following BD analysis may provoke questions and require going back to the "raw data" for further refining questions and data extraction.

These analyses and insights should be published as scientific publications for the execution of operative decisions. As for other types of studies, BD studies should pose additional questions that need to be further evaluated using the various scientific methods available (for example, what are the dynamics of returning to a regular treatment routine?).

BD is an emerging field of science in medicine and dentistry that should be carefully addressed. Alongside the inherent process limitations, the extrapolation of data from big databases holds tremendous scientific power derived from the size of the scanned group. Dental research teams should recognize the power of analyzing big databases and establish working groups to correctly extrapolate data and establish old and new clinical paradigms in different fields of dentistry. Jim Gray, database researcher and recipient of the Turing Award (1998), claims that science nowadays changes due to the influence of information technology. He suggests adding "data science" as the fourth paradigm of science: empirical, theoretical, computational, and now data based.[5]

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