CIR ESP. 2018;96(5):247–249

CIRUGÍA ESPAÑOLA

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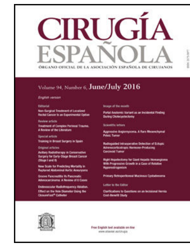

Editorial

Big Data and Surgery: The Digital Revolution Continues☆

Big data y *cirugía: la revolución digital continúa*

More than 30 years ago, at the beginning of the revolution sparked by the first laparoscopic cholecystectomy, an American surgeon and soldier, Col. Richard Satava, described the disruptive change that laparoscopic surgery represented, not merely as a purely technological innovation, but as another manifestation of the digital information era.[1] The irruption of the digital world in surgical practice has produced multiple advances, with the universal applicability of imaging-assisted surgery, development of robotic surgery, progress in the quality of imaging studies (HD, 3D, 4K) and also the possibility to manipulate, store and share the images obtained, as well as simulation models, virtual reality or 3D printing.[2,3] Simultaneously, the digital revolution has much more clearly impacted all aspects of our daily life, including medicine, obviously, and health care. The universal development of the Internet, e-commerce, social networks, new concepts of the Internet of Things (IoT) or the digitalization of business management resources has favored the exponential growth of the amount of digital information that is created and stored. It is believed that currently more than 96% of general information is stored digitally. The growth in the volume of health care data is growing at an astronomical speed: in 2013, 153 exabytes had been generated (1 exabyte=1 billion gigabytes), and it is estimated that the generation of information will exceed 2314 exabytes by 2020, which means an annual growth of more than 48%.[4–6]

Obtaining and storing this amount of information of all kinds (text, images, patient file data, signals generated by devices implanted in patients, unstructured files) has led to the development of a new concept and opened a new field of application and development of digital technology with an incalculable dimension and future, which is the concept of *big data*.[5] Technically, big data is defined as a set of data so large that traditional data processing applications are not enough to deal with them, nor are the procedures used to find repetitive data patterns.[5] The most interesting characteristic of big data is that it includes digital data obtainable from multiple sources (texts, databases, figures, medical records, registries, Internet of Things). This unstructured information can be analyzed with specific processing tools to obtain algorithms, behavior or correlation patterns, which involves a limitless source of potential information. This concept has been applied immediately in today's society, creating a very important new business model due to the important information that the results of these analyses can provide in multiple areas (banking, commerce, etc.). Logically, the next stage has been its application in medicine, although this process is at a very early stage.[7]

The new era of big data may have a significant impact on health care, while benefiting and empowering multiple stakeholders.[7] First of all, patients would benefit from a better and more precise use of technology. Also, clinicians would have real access to patients, which would improve decision making. Researchers would be able to develop better prediction models or algorithms. Pharmaceutical companies would be able to better evaluate the outcome of treatments and market control, and medical device companies would benefit from safer and more controllable implementation. Finally, financial administrators could develop more precise forms of payment, while the government, in order to reduce costs, could improve legislation and use the data to deal with social issues, and software developers would have the opportunity to improve their programs.

One concept of interest in healthcare management is known as *Business Intelligence*, in which the myriad of data obtainable from patient files, together with purely administrative hospital management information, can generate information with potentially enormous advantages in the optimization and management of resources.[8] Potentially, the most interesting model for applying big data in clinical

☆ Please cite this article as: Targarona EM, Balla A, Batista G. *Big data* y cirugía: la revolución digital continúa. Cir Esp. 2018;96:247–249.

practice is the concept of ''precision medicine''. The conjunction and analysis of large genomic and proteomic databases, together with the phenotypic characteristics of the population obtained by daily digital traces, and specific medical information obtained either through medical files or through data obtained by implantable medical devices (pacemaker, Holter, etc.), can hypothetically allow for information to be obtained that was not previously imaginable.[7] Logically, these concepts have been rapidly extended to other medical or medical-surgical specialties (cardiology, anesthesia, transplant medicine, plastic surgery).[9–12]

The application of the information obtainable from big data in surgery is in a very early stage of development, although several possible fields of application are visible on the horizon.[12,13] The most basic application of the big data concept is the successful experience initiated more than 15 years ago in the USA with the creation and exploitation of large clinical databases. These databases, developed initially in veterans' hospitals, are reliable and balanced in terms of risk, providing comparison of results among multiple hospitals, including thousands or millions of surgical procedures.[14] Their use enables benchmarking comparisons to be made, hospitals to be accredited, payment formulas modified, and is presently a new way to obtain practically immediate evidence in the real world.

The large surgical databases from different projects, such as the NSQIP or NSI, may be too small (although they include several million patients) to be considered big data, and perhaps they are only the tip of the iceberg for the potential of this concept. But three examples illustrate the potential interest of this idea in the use of information. First of all, an analysis was recently published of a series of 52 868 gastric bands implanted in France between 2007 and 2013, indicating that the need for reoperation for the withdrawal of the band was 6% per year, which progressively increased, calling into question the practical utility of this technical option.[15] Another recent study presents the results of a series of 189 477 sleeve gastrectomies performed by 1634 surgeons in 720 patients in two years (from 2012 to 2014). The results question multiple aspects related to this intervention obtained from consensus conferences or initiatives with a smaller number of patients.[16] Finally, a recent analysis of more than 325 000 patients (appendectomy 46 688; colectomy 152 114; inguinal hernia 59 066; hysterectomy 59 066; prostatectomy 10 802), paired using a propensity score model, demonstrated significant advantages of the minimally invasive approach for all of them in terms of complications classified according to Clavien, readmissions and hospital stay, except for appendectomy.[17] Although caution is necessary when accepting the information obtained from the analysis of these large databases,[18] its immediate utility is evident, either for benchmarking and identifying clinical variability and care improvements among collaborating hospitals, or for obtaining information that is difficult to obtain with conventional evidence-based studies. The analysis of these large databases provides multiple types of information. Specifically, in minimally invasive surgery, it provides a better understanding of the results from the application of these techniques, comparisons between techniques, detailed analysis of the postoperative evolution and analysis of infrequent diseases, procedures or patterns of applicability in the population.[13] Some authors have proposed that the analysis of these data could be an alternative to methodologies for obtaining evidence, as obtaining reliable information is sometimes extremely difficult in time and resources.[19] Undoubtedly, obtaining truthful information from large samples that is reliable, and practically in real time, means an additional way of obtaining evidence and evaluating the applicability and the results of multiple surgical procedures or their results.

Inevitably, surgical indication and treatment are options to be included in algorithms and decision-making analyses in multiple clinical situations. Undoubtedly, the surgeon should know his/her role and actions to be taken when posing an intervention determined by analysis or treatment algorithms based on multiple data regarding a specific disease, in the context of ''personalized surgery''.

The current surgical environment, which is becoming widely technified, opens options for the use of big data technology, and we have been given a glimpse of different areas of interest. The operating room is a technological environment capable of generating a large number of data to possibly obtain information. Intraoperative monitoring of surgical patients, the data obtained during the laparoscopic approach (image, pressure, energy use), or potential new applications based on imaging (fluorescence and indocyanine green, augmented reality) and, inevitably, robotic surgery are potential sources of raw information, which may be of interest once analyzed. The concept of precision surgery is easily intuitive through the use of fluorescent contrasts. Robotic surgery has an immense potential for obtaining information (ergonomics, precision of movements, etc.). Big data is inevitably linked to more advanced concepts, such as artificial intelligence or *machine learning*.[20,21] There is already a project underway to analyze hundreds of surgical videos, which, when analyzed with AI models, can lead to the creation of intraoperative support or correction tools for laparoscopic interventions.[21]

The digital revolution in surgery did not end with the performance of a minimally invasive esophagectomy or a POEM. It continues, but with perspectives that are difficult to imagine or predict. However, surgeons should be aware of new support options for conducting surgery while participating in the development of these concepts and determining their applicability. As already considered in extra-sanitary environments, and increasingly in healthcare management, information is power. The type, form of obtaining and exploiting information is in the midst of a dizzying transformation, and surgeons should understand the concepts, their advantages and disadvantages and collaborate in protocols for obtaining and exploitation information. If not, other medical professionals will do it for us.

REFERENCES

1. Satava R. Innovative technologies. The information age and the biointelligence age. Surg Endosc. 2000;14:417–8.
2. Marescaux J, Diana M. Looking at the future of surgery with the augmented eye. Ann Laparosc Endosc Surg. 2016;1: 36–43.

3. Diana M. Cirugía guiada por fluorescencia aplicada al aparato digestivo: el ojo cibernético permite ver lo invisible. Cir Esp. 2017. Available from: https://doi.org/10.1016/j.ciresp [accessed 06.07.17]
4. Available from: https://med.stanford.edu/content/dam/sm/sm-news/documents/StanfordMedicineHealthTrendsWhitePaper2017.pdf.
5. Chen M, Mao LY. Big data: a survey. Mobile Netw Appl. 2014;19:171–209.
6. Hilbert M, López P. The world's technological capacity to store communicate, and compute information. Science. 2011;332:60–5.
7. Kruse CS, Goswamy R, Raval Y, Marawi S. Challenges and opportunities of big data in health care: a systematic review. JMIR Med Inform. 2016;21:e38.
8. Ashrafi N, Kelleher L, Kuilboer JP. The impact of business intelligence on healthcare delivery in the USA. Interdiscip JInf Knowl Manage. 2014;9:117–30.
9. Rumsfeld JS, Joynt KE, Maddox TM. Big data analytics to improve cardiovascular care: promise and challenges. Nat Rev Cardiol. 2016;13:350–9.
10. Pendry K. The use of big data in transfusion medicine. Transfus Med. 2015;25:129–37.
11. Kanevsky J, Corban J, Gaster R, Kanevsky A, Lin S, Gilardino M. Big data and machine learning in plastic surgery: a new frontier in surgical innovation. Plast Reconstr Surg. 2016;137:890e–7e.
12. Mathias B, Lipori G, Moldawer LL, Efron PA. Integrating ''big data'' into surgical practice. Surgery. 2016;59:371–4.
13. Balla A, Batista Rodríguez G, Corradetti S, Balagué C, Fernández-Ananín S, Targarona EM. Outcomes after bariatric surgery according to large databases: a systematic review. Langenbecks Arch Surg. 2017. http://dx.doi.org/10.1007/s00423-017-1613-6.
14. Hall BL, Hamilton BH, Richards K, Bilimoria KY, Cohen ME, Ko CY. Does surgical quality improve in the American College of Surgeons National Surgical Quality Improvement Program: an evaluation of all participating hospitals. Ann Surg. 2009;250:363–76.
15. Lazzati A, de Antonio M, Paolino L, Martini F, Azoulay D, Iannelli A, et al. Natural history of adjustable gastric banding: lifespan and revisional rate: a nationwide study on administrative data on 53.000 patients. Ann Surg. 2017;265:439–45.
16. Berger ER, Clements RH, Morton JM, Huffman KM, Wolfe BM, Nguyen NT, et al. The impact of different surgical techniques on outcomes in laparoscopic sleeve gastrectomies: the first report from the metabolic and bariatric surgery accreditation and quality improvement program (MBSAQIP). Ann Surg. 2016;264:464–73.
17. Sood A, Meyer CP, Abdollah F, Sammon JD, Sun M, Lipsitz SR, et al. Minimally invasive surgery and its impact on 30-day postoperative complications, unplanned readmissions and mortality. Br J Surg. 2017;104:1372–81.
18. Cook JA, Collins GS. The rise of big clinical databases. Br J Surg. 2015;102:e93–101.
19. Frieden TR. Evidence for health decision making – beyond randomized, controlled trials. N Engl J Med. 2017;377:465–75.
20. Kassahun Y, Yu B, Tibebu AT, Stoyanov D, Giannarou S, Metzen JH, et al. Surgical robotics beyond enhanced dexterity instrumentation: a survey of machine learning techniques and their role in intelligent and autonomous surgical actions. Int J Comput Assist Radiol Surg. 2016;11:553–68.
21. Twinanda AP, Shehata S, Mutter D, Marescaux J, de Mathelin M, Padoy N. EndoNet: a deep architecture for recognition tasks on endoscopic videos. IEEE Trans Med Imaging. 2017;36:86–97.

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2173-5077/