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. 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. 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%. 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. 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. 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.

The new era of big data may have a significant impact on health care, while benefiting and empowering multiple stakeholders. 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. Potentially, the most interesting model for applying big data in clinical...
practice is the concept of “precision medicine”. The conjunc-
tion and analysis of large genomic and proteomic databases,
together with the phenotypic characteristics of the population
obtained by daily digital traces, and specific medical informa-
tion 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. Logically, these concepts
have been rapidly extended to other medical or medical-
surgical specialties (cardiology, anesthesia, transplant med-
icine, 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 append-
dectomy.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 envi-
ronments, and increasingly in healthcare management,
information is power. The type, form of obtaining and
exploiting information is in the midst of a dizzying transfor-
mation, 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.

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