Can J Anesth/J Can Anesth (2014) 61:959–962
DOI 10.1007/s12630-014-0146-5

SPECIAL ARTICLE

From the *Journal* archives: Improving patient outcomes in the era of Big Data

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Received: 26 November 2013 / Accepted: 10 March 2014 / Published online: 29 March 2014

Editors' Note: Classics Revisited

Key Articles from the *Canadian Journal of Anesthesia* Archives: 1954-2013

As part of the *Journal's* 60th anniversary Diamond Jubilee Celebration, a number of seminal articles from the *Journal* archives are highlighted in the *Journal's* 61st printed volume and online at: www.springer.com/12630. The following article was selected on the basis of its novelty at the time of publication, its scientific merit, and its overall importance to clinical practice: *Rose DK, Cohen MM, Wigglesworth DF, Yee DA.* Development of a computerized database for the study of anaesthesia care. Can J Anaesth 1992; 39: 716-23. Dr. Mark Ansermino provides expert commentary on the development and implementation of a large perioperative database, notable not only for its size (i.e., 17,000 patients) and the wealth of information that it provided, but also for the era in which it was developed (i.e., prior to the computerized anesthesia information systems that are rapidly being adopted today.)

Hilary P. Grocott MD, Editor-in-Chief
Donald R. Miller MD, Former Editor-in-Chief

Article summary

Source: Development of a computerized database for the study of anaesthesia care.

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Authors: *Rose DK, Cohen MM, Wigglesworth DF, Yee DA.*
Purpose: To describe the details and cost for the development of a computerized database of perioperative care.
Principal findings: The implementation of a computerized database comprising data from 17,000 patients over a 15-month period was described. Information from carbonless copies of handwritten intraoperative postanesthetic care records and postoperative visits was transcribed into a custom-designed database optimized for rapid data entry. Additional information was matched electronically to hospital administrative databases. Users were prompted to identify adverse events on the operative and postoperative records by a compulsory checkbox. All data were verified by a research nurse and anesthesiologist. A retrospective chart review revealed a low incidence of discrepancies. The estimated costs were $4.00 per patient.
Conclusions: An accurate record of patient characteristics, the process of care, and intraoperative and postoperative adverse events hold the potential to optimize patient outcomes, improve training, and improve allocation of resources.

This manuscript is a description of the development and implementation of a database system that preceded the availability of computers at every bedside.[1] With the aim of providing a comprehensive perioperative data collection, the system relied on manual recording and entry of data using handwritten records on structured forms. Validity was enforced with human checks and specific form constructs, and the forms were then aggregated following secondary entry into a computerized database. Integrating this perioperative information with administrative databases shows clear insight into the potential of integrating multiple sources of information (Big Data). Development of the system involved tools that are largely obsolete today due to the rapid advancement in technology and its uptake.

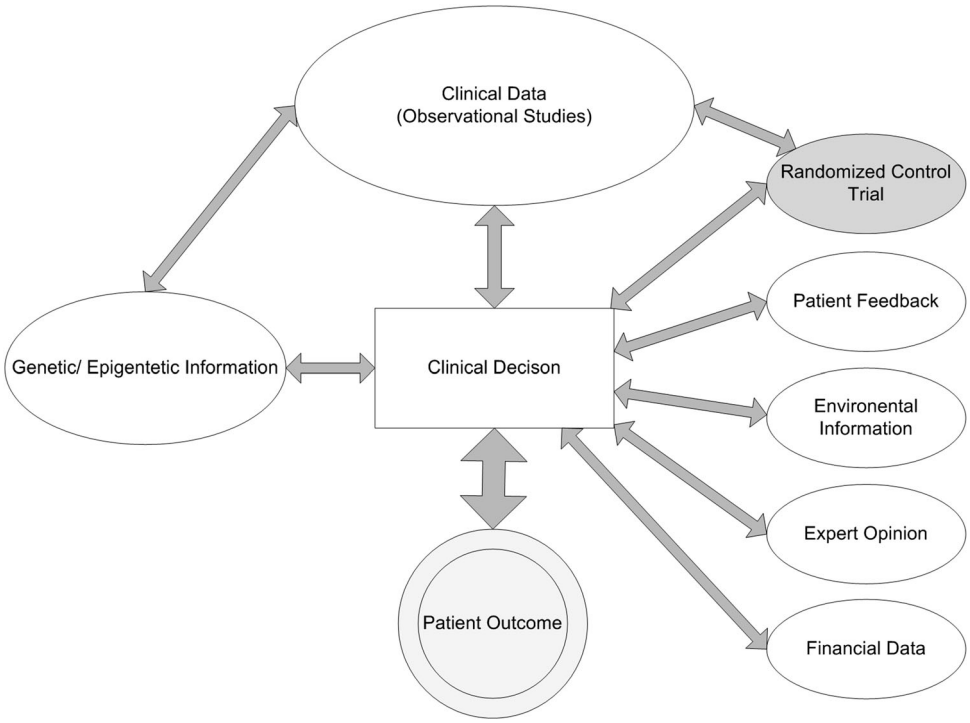

Figure Big Data facilities informed clinical decision-making based on measured patient outcomes. The randomized controlled trial retains an important but limited role that both informs and is informed from observation studies

Nevertheless, the manuscript highlights the importance of not only collecting the information but also using the data to reduce errors and improve outcomes. This is a lofty goal which is currently largely unrealized, even with the implementation of computerized anesthesia information systems. This method of data collection provided a robust set of data comparable with current anesthesia information systems but potentially at a lower cost.

Evidenced-based medicine (EBM) is currently anchored at the top of the hierarchy of evidence quality with the prospective blinded randomized controlled trial (RCT). While RCTs are considered to be the gold standard for the potential efficacy (Can it work?) of an intervention, they may not address the effectiveness (Does it work?) or safety of wider adoption or the critical question of efficiency (Is it worth it? Can we afford it?). The use of observational studies of large cohorts of subjects is increasingly being promoted as complementary to RCTs in directing treatment options in a heterogeneous population (Figure). The RCT remains an important cornerstone to providing clinical evidence, but it can be enhanced with improved data collection systems that provide better data at a lower cost and facilitate more focused clinical questions based on large observational data sets. The key question in this comparative effectiveness research (CER) is: Which treatment is optimal, for whom, in which context, and under what circumstances?

Contrary to previous opinions that the conduct of anesthesia had very little impact on the long-term outcomes of patients, it has become increasingly clear that anesthesiologists' perioperative decisions and interventions may produce measurable long-term effects on patient outcomes, including perioperative cardiac adverse events,[2] surgical site infections,[3] acute renal failure,[4] tumour recurrence,[5] and stroke.[6] These associations with rare clinical events are not possible when relying on the memory of individual practitioners or even institutions. The use of Big Data and CER is essential.

Big Data is the collection of large and complex stores of data made possible by rapid growth in the capacity of computerized systems to store large amounts of information at costs lower than ever. The challenges of extracting meaningful information from these large data sets require new tools and techniques that optimize the capture, curation, validation, storage, search, sharing, transfer, analysis, and visualization of this information. The trend to larger data sets is due to the additional information derivable from analysis of a single large set of related data *vs* separate smaller sets with the same total amount of data. The introduction of electronic health records, anesthesia information systems, operating room and supplies management systems, order entry systems, and administrative databases have catapulted anesthesiologists into the world of Big Data. This trend will grow with the integration of systems for video data, geotracking, genetic testing, patient feedback, environmental data, and home monitoring.

To capitalize on the potential of Big Data, we need to engage stakeholders in order to ensure optimized and accurate data collection and dissemination, invest in building both human and technical capacity, and promote a culture of stewardship in our healthcare and research organizations

which reassures our patients that the benefits of Big Data outweigh the risks.[7] Initiatives such as Privacy by Design developed by the Information and Privacy Commissioner of Ontario, Canada[A] are an important step toward balancing privacy with improvements in health outcomes.

The transformation of anesthesia practice with new knowledge from Big Data will require a shift in focus to embrace not only technical development but also new ways of thinking about individual, social, economic, and cultural expression and behaviour. Innovative information and communication technologies are enabling the transformation of every aspect of society itself as data become the new currency for research, education, government, and commerce.[B]

The increasing adoption of anesthesia information systems provides a source of detailed structured information of the perioperative period. This information can be combined to help predict patient outcomes for quality improvement on a large scale. A pioneering example is the Multicenter Perioperative Outcomes Group (MPOG) consortium,[8] which was founded in 2008 and is coordinated by the University of Michigan. The consortium involves more than thirty anesthesiology departments, mainly based in the USA, but with an increasing number of international sites. The consortium has grappled with the regulatory, procedural, political, and technical hurdles to enable the sharing of data for research.[8] Over one million operative episodes from anesthesia information systems have been extracted into a single MPOG database structure which has been mapped to predefined and consistent MPOG concepts for use in observational outcomes research.

Anesthesia information systems should not be viewed in isolation. The true value of the perioperative record can only be unlocked with links to outcomes and cost to compare effectiveness and efficiency. Local, provincial, national, and international standardization of data collection and validation are prerequisites for realizing the value of Big Data. The challenges of realizing this goal should not be underestimated. As anesthesiologists, we operate in highly complex clinical environments with many political, social, technical, and financial limitations. Poor-quality data will severely limit the advantageous impact of Big Data. We must individually and collectively embrace every possible opportunity to be engaged in the acquisition, implementation, and optimization of data collection and utilization. This is very likely to involve incremental changes with continuous improvement in the technologies and the quality and scope of data utilization. A collective culture that encourages accurate and comprehensive reporting of clinical activities will progress from small isolated success stories in the use of CER to optimal care for every patient.

The ultimate goal should be to retain high-resolution real-time data for every interaction of every patient within the health system. While optimal care continues to be provided for each patient during each episode of care, the objective should be to collect this information seamlessly with minimum demand of the healthcare provider or patient and intelligently integrate the data to ensure that the outcome of each episode will later be utilized to optimize the outcomes of future patients. This is the promise of Big Data - to transform data into insight (wisdom).

This key article by Rose *et al.* presented a practical example of the potential for information to impact patient outcomes. While the technology has significantly advanced, the possibilities expressed in this forward-thinking article have not been as widely implemented in the clinical setting as initially envisioned. Nevertheless, as technology continues to advance at an increasingly rapid pace, we should continue to strive to embrace and integrate information from Big Data to improve the outcomes of the patients in our care.

Key points

- The increased use of information technology can be harnessed as a tool to help drive improvement in patient outcomes.
- The importance of collecting health information is weakened if data are not used to modify practice in order to improve patient outcomes.
- Using the health information in a meaningful manner presents a greater challenge than collecting the information.
- More data from more sources provide an enhanced opportunity to change outcomes.
- Outcome enhancement can occur only when healthcare providers and patients are committed to leverage the use of Big Data.

Funding sources Not applicable.

Conflicts of interest None declared.

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