Editor’s Perspective

The Promise of Big Data
Opportunities and Challenges

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Medicine is on the cusp of a remarkable transformative change fueled by the prospect of an acceleration and augmentation in knowledge generation and application. Medicine improved as it transitioned from being based on belief to becoming anchored in science. We were limited, however, in our ability to learn from clinical practice, even though natural experiments were occurring every day. Our methods tended to be reductionist, our data crude, our samples constrained, and our inferences speculative. This inability to learn quickly, easily, and meaningfully from everyday clinical practice is yielding to new capabilities and opportunities.

The shift is occurring as a result of advances in computational power and mathematical applications in concert with a rapid growth in the availability of data. Even changes in the last 5 years have produced breathtaking capabilities. We now have the computational heft to handle large, complex, high-dimensional data. We have mathematical applications that enable us to avoid the need to reduce the complexity of the data, maximizing the relevance of the data to patients seen in practice. And we have just experienced a remarkable advance in data availability through transformation of medical data and documentation into digital format.

A precision medicine future, with the generation of personalized estimates of risk of outcomes and response to various therapies, paradoxically depends on being able to analyze data from massive numbers of people. Only with such numbers can the heterogeneity of risk and response be revealed—and can each individual be understood in the context of the experience of people like them who have preceded them in the situation they are in. The knowledge of individual differences—and similarities—will provide opportunities for truly informed choices based on information that is more relevant, accurate, and meaningful.

To fully leverage this opportunity will require several key steps.
still abound in coalescing data from different sources. Although there are common data standards for many data types, adherence to the standards vary. Moreover, data holders, independent of concerns for privacy, have often seen data as assets to be hoarded rather than shared, even among those participating in research consortia and public health initiatives. There will be a need for continuing efforts to combine data, with attention to privacy and security, to fulfill their promise to produce knowledge that will help the next person who needs assistance.

Funding

Funders are not accustomed to applications that focus on big data as a means of knowledge generation. These projects require infrastructure to make data available, method development to produce tools customized to the particular challenges in medicine, and support for empirical work that may not be hypothesis driven, but is just as capable of producing valuable insights. In addition, funders need reviewers who transcend traditional medical research paradigms if this work is to get the support it needs.

Collaboration

Finally, and perhaps most importantly, this work will require new collaboration for clinical research. Advances in medicine are likely to derive from work with mathematicians, statisticians, and computer scientists. Such teams will bring together data scientists and clinical scientists. The recognition that medicine is an information science will begin to spread. These teams will need to invest in learning each other’s culture, language, and capabilities to forge collaborative activities where the whole is truly larger than the sum of its parts.

Medicine already lags behind so many fields in use of digital data. Our research and research funding is largely anchored in a model that has been stable for decades. Our meetings and journals largely remain bastions of traditional research and their presentation. Our practices on the wards are moving slowly toward the adoption of truly learning health system approaches.

And yet, we are at one of those amazing junctures in medicine that will define a new future as profoundly different from today as the pre-microbiology era was from what preceded it. We may have the chance to see what was formerly indecipherable. But the hazards of change are also great, and our ability to tackle these challenges is far from guaranteed. We will need ways to prove the value of these new approaches and tools—and they should be subjected to the same scrutiny as any new diagnostic or therapeutic intervention.

In this issue, we feature an array of insightful articles that address different facets and applications with respect to big data methods.2–11

The studies are not just about data size, but about approaching the data in new ways. The publication of these contributions signals a receptivity by Circulation: Cardiovascular Quality and Outcomes to research done with massive data analyzed in creative ways with important implications for practice and policy. We are all hopeful that these new directions will yield benefits for our patients and the public and inspire many of our readers to consider similar approaches in their own work. Be assured, research and clinical care are about to join the digital, mobile, mathematical, personalized revolution. We all need to ensure that the changes produce progress for people and society.

Acknowledgments

I thank Sharon-Lise Normand for her partnership in coediting this issue.

Disclosures

Dr Krumholz is a recipient of research agreements from Medtronic and from Johnson & Johnson (Janssen), through Yale University, to develop methods of clinical trial data sharing; is the recipient of a grant from the Food and Drug Administration and Medtronic to develop methods for postmarket surveillance of medical devices; works under contract with the Centers for Medicare & Medicaid Services to develop and maintain performance measures; chairs a cardiac scientific advisory board for UnitedHealth; and is the founder of Hugo, a personal health information platform.

References

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Circ Cardiovasc Qual Outcomes. published online November 8, 2016;
Circulation: Cardiovascular Quality and Outcomes is published by the American Heart Association, 7272
Greenville Avenue, Dallas, TX 75231
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Print ISSN: 1941-7705. Online ISSN: 1941-7713

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://circoutcomes.ahajournals.org/content/early/2016/11/08/CIRCOUTCOMES.116.003366.citation

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