BIOSTATISTICS IN CANADA: OPPORTUNITIES AND CHALLENGES

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1. Introduction

Biostatistical methods play a critical role in diverse areas of public health and medical research including clinical trials, epidemiologic and etiologic research, and many areas of basic science. Historically, as new scientific questions arose in these areas, new methodological challenges arose. Biostatisticians have worked in parallel with these fellow scientists, developing innovative statistical techniques which were used to help answer the scientific questions through collaboration and application. Technical and computational advances in recent years have lead to improvements in our ability to collect and store massive amounts of data and many health scientists aim to exploit this information to answer clinical or public health questions. The need for innovative and rigorous biostatistical methods with a solid foundation in theory is greater than ever, and their development will ensure we can maximize the use of this information to the advantage of Canadian society. The Canadian and international health research communities recognize the acute shortage of highly trained biostatisticians as a major barrier to optimal use of available health data [1].

In this position paper, some of the opportunities and challenges facing biostatisticians in the current Canadian context are outlined. Scientific opportunities are discussed first, followed by challenges that arise with regard to research funding and training. Remarks are also made on the interaction between biostatisticians and the mathematics institutes.

2. Science

Biostatistics is a sub-specialty of statistics, in which theoretical and methodological research is motivated by problems in health, medicine, and biology. The methods we develop are highly driven by current challenges in health and biology, but our research is, in essence, one of methodological development that is technical in nature. Hence, biostatistics is inherently a branch of the statistical sciences. In biostatistics there is an added *opportunity* that biostatistical methods can be immediately applied to advance our understanding of issues in health and biological research.

Thus, biostatistical researchers belong within the statistical researcher community, but in addition need strong links to collaborators in health research. Biostatistics is inherently cross-disciplinary, and this cross-disciplinarity highlights some of the current challenges in biostatistical research, including:

- Methods for causal inference in randomized and observational studies
- Methods for complex longitudinal and life history data

- Statistical methods for genetic and genomic research.

These represent areas requiring considerable development over the next five to ten years. These typify areas of growth in biostatistics, but there are numerous other research opportunities in areas where increased computing power and access to health data are important. In all of these areas (and others), there is the potential for significant advancement by Canadian scientists, many of whom are world leaders. It is expected that this work will influence epidemiologic, clinical, and other health research by bringing better methods to practice. The cycle of research development is rapid and the scope of collaboration broad; typically, challenges in analysis or design for health research studies give rise to methodological developments in biostatistics, which can feed back directly into health research.

3. Research Funding

Investigators leading biostatistical research programs, with their natural and necessary interdisciplinary aspects, face unique challenges when seeking research funding. The ideal setting for biostatistical research is at the interface between statistical methods and health research, with collaborative substantive research in health driving methods development. The collaborative, substantive work is and should be funded by health sciences funding agencies like CIHR, while the methodologic research is fundamentally research in statistics and is naturally funded by NSERC.

Several examples of this model have been successful in the Canadian context. For example, NIDA funded HIV/AIDS research conducted at the Universitiy of Waterloo in collaboration with researchers from Berkeley and Columbia (U.S.) and Tubigen (Germany). The Promotion of Breastfeeding Intervention Trial, run by researchers at McGill University and funded by CIHR, gave rise to NSERC-funded research in causal inference in biostatistics. And at UBC, a CIHR-funded observational study of beta-interferon treatment for Multiple Sclerosis is spawning methodological research in the Department of Statistics.

The danger of such a model is that biostatisticians face tensions between funding agencies; sometimes, it is not clear whether a project fits into the NSERC or CIHR remit, and there is at least the potential for important research at the interface of methods and applications to fall through the cracks between agencies. It is very plausible that a project would be considered simultaneously "too theoretical" by the CIHR community, and "too applied" by the NSERC community. More collaborative programs between CIHR and NSERC should be developed.

Funding mechanisms and research infrastructure need to adjust to support biostatistics research. Substantive collaborative work must be supported by CIHR and related agencies, and career paths developed for those biostatisticians who engage in this work. Methods development research must be supported by NSERC. Finally, individual statisticians need to have the flexibility to work in both models. The merging of mathematics and statistics in the NSERC conference model raises concerns for biostatisticians. While it is clear that the statistics community recognizes interdisciplinarity and the synergistic relationship between theory and methods and applications, it is not clear that the mathematics community recognizes this fact.

4. Institutes

The three mathematics institutes have achieved remarkable growth since their inception and now constitute a considerable strength in Canada for mathematical research. However, biostatistics in particular, and the statistical sciences as a whole, in Canada have benefitted only marginally from the institutes. There have been workshops and small programs of interest to statistical researchers, but these are relatively rare. Most institute programs are geared towards researchers in pure mathematics. Moreover, many statisticians who have worked with the institutes have found the relationship difficult, with complex requirements for matching funding and little transparency. For example, the institutes fund post-doctoral fellowships extensively; it is very difficult to achieve a level playing field for post-docs, because statistics and biostatistics fellows spend less time in postdoctoral positions and therefore appear less experienced than their mathematics counterparts (because jobs are so readily available). Another limitation with the current institute structure is that it really only makes sense to have mathematicians appointed in leadership roles, since most of the activities are in mathematics. Consequently, capacity is created for the long-term planning and development of mathematics research in Canada. No such capacity exists for statistical science generally, or biostatistics specifically. These communities struggle with being small, and being without a mechanism to free up capacity from home university duties in order to galvanize the discipline.

The infrastructure and personnel resources of the institutes are now extensive and they will play an important role in the discussion of the long-range planning exercise. Since there is no statistics institute, and the current institutes' mandate is to support mathematical sciences, with de facto emphasis on pure mathematics, this situation puts statistics and biostatistics at a significant disadvantage. If the institutes are to be maintained, this must include formal leadership by statisticians. This could be accomplished either by revisiting the idea of a statistics institute (like the proposed National Institute for Complex Data Structures) or by including formal mechanisms for statistical leadership within the existing institutes. This could achieve broad support within the biostatistics community.

5. Training

Biostatistics is an exciting, fast moving discipline with increasing need of trainees from the public and private sector. Training programs for biostatistics are desperately needed; the supply of qualified graduates does not meet current demand. A recent survey by the Division of High Impact Clinical Trials of the Ontario Institute for Cancer Research found that 82% of respondents indicated that the shortage of biostatisticians was a limiting factor in their ability to conduct their research. We believe that training specific to biostatistics (i.e., including training in statistics and methodology, but also some training distinct from statistics and mathematics) is necessary to build the needed national capacity in biostatistics. Biostatistics programs (e.g., McGill's graduate program, the Waterloo Biostatistics Program with its specialized Oncology Research and Methods Training Program funded by the Ontario Institute for Cancer Research and the joint M.Sc. program between the UBC department of Statistics and the School of Population and Public Health),

require students to develop skills in both statistics as well as obtaining specialized training in epidemiology or clinical research methods to ensure they can work effectively in collaboration.

One of the co-authors participated in a series of applications for training programs to CIHR and NSERC over the past two years, with the goal of developing a biostatistics collaborative program among several universities. These programs were well received (scoring >4.0 at CIHR, for example), but not funded. These programs would allow systematic training opportunities for biostatistics students across the country.

6. International

Canada has a small but active biostatistics community. Resources for biostatistical research are considerably greater in the U.S., and establishment of international programs to foster collaborations between Canadian researchers and their counterparts in the U.S. would offer a welcome opportunity for engagement. Specialized programs with other countries may also prove useful, based on priority areas. There are examples of productive international collaborations which have addressed important problems in paediatrics, infectious disease, cancer and transplantation research.

7. Conclusions

Biostatistics is an area of significant growth in the mathematical sciences. Our role, in developing statistical methods that can respond to health research challenges, is a core sub-specialty of statistics. There are, however, a number of important challenges facing the biostatistics community, mainly related to funding and support:

- Innovative application-motivated research in biostatistics and other areas of statistics should be considered a core component of NSERC's funding mandate.
- There should be no external pressure to compel biostatisticians to interact with the mathematics institutes. These are two quite different cultures of researchers and mechanisms are not in place to ensure this would be a balanced relationship. Serious consideration should be given to a statistics institute.
- Training programs in biostatistics should be strengthened. Biostatistics is a significant growth area for M.Sc. and Ph.D. graduates and mechanisms to encourage students to enter the field need support.

Canada has a small but growing and vibrant biostatistics community, with strong foundations in the natural sciences and excellent links to the health research community. Funding for, and recognition of, interdisciplinary work in methods development and collaboration is essential to the growth of the biostatistics community in Canada, and of biostatistics in health research.

References

[1] DeMets, D., Stormo, G., Boehnke, M., Louis, T. A., Taylor, J., Dixon, D. (2006). *Training of the next generation of biostatisticians: a call to action in the U.S.* Statistics in Medicine, 25(20), 3415-3429.