AAIM Perspectives

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Impact of an Interdisciplinary Computational Research Section in a Department of Medicine: An 8-Year Perspective

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INTRODUCTION

The evolving opportunities in biomedical research require that medical schools and departments continually review their respective organizational structures to optimize discovery and training. The traditional discipline-based organizations are not sufficient to stimulate the full range of new and interdisciplinary approaches to successfully address medically important questions.[1] Consequently, institutions have developed centers, institutes, cross-disciplinary departments, and programs aimed at promoting convergence in biomedical science through partnerships within the academic community and with industry.[2,3] The International Campaign to Revitalize Academic Medicine called for reinvention of academic medicine, in part, by developing emerging technology across disciplines.[4]

Departments of internal medicine have a major stake in the success of interdisciplinary research programs and are uniquely positioned to accelerate the application of new research technology targeted at human biology and disease. Importantly, the application of "personalized medicine" to diagnosis and treatment of a broad range of human diseases increasingly requires that academic clinical departments develop expertise in the application of computational and analytical methods to large "omic" datasets. The acceleration of new methods to generate and analyze genomic datasets created an important opportunity to assemble a critical mass of investigators with computational, analytical, and clinical expertise. Moreover, existing organizational structures within and outside the department did not sufficiently integrate the scientific and training opportunities with clinical medicine. Therefore, in 2009, the department of medicine at Boston University School of Medicine created the Section of Computational Biomedicine.[5]

We report herein on the 8-year follow-up of the impact of the computational biomedicine section. We will describe the scientific and translational deliverables, the challenges faced in sustaining this initiative, the factors that contributed to its success, and the impact on the broader university. On the basis of our experience, we believe that clinical departments, especially departments of internal medicine, have a vital role in catalyzing application of computational methods to medical problems and in addressing new opportunities for inter-

Funding: None.

Conflict of Interest: None.

Authorship: All authors had a role in writing the manuscript.

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0002-9343/$ - see front matter
https://doi.org/10.1016/j.amjmed.2018.03.008

disciplinary biomedical research in the modern research university.

FOUNDING AND EVOLUTION OF THE SECTION OF COMPUTATIONAL BIOMEDICINE

The Department of Medicine at Boston University and Boston Medical Center has a long-standing tradition of creating research sections to address emerging research opportunities, including clinical epidemiology, preventive medicine, biomedical genetics, and vascular biology. In 2009 the accelerating growth of high-throughput molecular profiling technology, the opportunity to better understand diagnostic and disease pathways through the delineation of new biomarkers, and the emergence of an extraordinary interdisciplinary research team with computational analytic expertise converged to create a unique opportunity for a new interdisciplinary section in the department of medicine—the section of computational biomedicine.

PERSPECTIVES VIEWPOINTS

- Given the recent emergence of high-throughput molecular technologies and their application to clinical samples, there is an urgent need for clinical departments to develop computational infrastructure and educational programs to accelerate the translation of precision genomic medicine approaches into the clinic.
- Our experience developing a section of Computational Biomedicine can serve as a roadmap for other academic medical centers that wish to accelerate development of personalized approaches to disease detection and treatment.

The goals of the computational biomedicine section were to provide a rich training environment and academic home for an interdisciplinary research group of MD and PhD faculty with expertise in bioinformatics, biostatistics, computational biology, and clinical medicine, with special emphasis on the analysis of whole-genome gene expression data. The concentration of expertise and equipment necessary to undertake these studies was intended to catalyze approaches to the identification of targets for prevention, diagnosis, and therapy. The initial focus of the group was on the characterization of gene expression signatures in cancer and precancerous conditions. The department invested $4.1 million to recruit faculty and learners, as well as support critical capital investments in sequencing and computational facilities. Boston University also awarded an endowed professorship to the section chief. In 2014 the space for the section was renovated by the school of medicine to facilitate interactions between computational and biologic investigators.

The interdisciplinary group of computational biomedicine faculty provides a remarkable training and collaborative environment. The section includes 12 faculty and 20 pre- and postdoctoral fellows. The faculty include 2 MDs and 10 PhDs who come from diverse academic backgrounds: bioinformatics, artificial intelligence, pulmonary medicine, biostatistics, genetic epidemiology, biology, and computer science. Five faculty were recruited from outside the institution and 7 from within the university. The fellows come from sections in the department of medicine as well as the bioinformatics, pathology, and biostatistics departments.

The computational biomedicine section faculty have rapidly responded to important opportunities for discovery and extramural funding. For example, the section has secured $26.2 million in federal grant support since 2009. Importantly, the section has developed productive ties to industry that have led to $16.2 million in sponsored research agreements. The section also has strong collaborative interactions, including joint grants, with 25 faculty from sections within and outside the department of medicine. The section's research findings have led to 11 provisional patent filings and issuing of 4 patents. To translate the discoveries made by the section into the clinic, investigators within the section have founded 4 companies that have collectively raised more than $20 million in financing.

The training mission of the computational biomedicine section has been a particularly important goal. A total of 65 pre- and postdoctoral fellows have received their primary research training in the section since 2009. Because learners must be prepared for interdisciplinary research teams in the future, the section encouraged the involvement of learners in all projects. In addition to the influence on pre- and postdoctoral students, medical residents and fellows participated in the training opportunities offered by the computational biomedicine section. The enthusiasm of the residents and fellows for computational training led to the formation of a genomic medicine research pathway in the department's internal medicine residency training program.

As Boston University and Boston Medical Center evaluated the direction and leadership of their joint cancer center, the emerging contributions of the computational biomedicine section were believed to be remarkably well aligned with the university's strategic goal to use bioinformatics to map gene expression and other molecular signatures to develop precision medicine approaches to prevent, intercept, and treat cancer. Therefore, the computational biomedicine section chief was appointed director of the Boston University-Boston Medical Center Cancer Center—a cross-campus collaboration to lead integration of the interdisciplinary expertise developed within the section with the cancer center's