Commentary

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Methods of measuring translational science

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Introduction

The National Institutes of Health (NIH) Roadmap places special emphasis on "bench-to-bedside" research, or the "translation" of basic science research into practical clinical applications. The Clinical and Translational Science Awards (CTSA) Consortium is one example of the large investments being made to develop a national infrastructure to support translational science, which involves reducing regulatory burdens, launching new educational initiatives, and forming partnerships between academia and industry. However, while numerous definitions have been suggested for translational science, including the qualitative T1-T4 classification, a consensus has not yet been reached. This makes it challenging to tract the impact of these major policy changes.

In this study, we use a bibliometric approach to map PubMed articles onto a graph, called the Triangle of Biomedicine. The corners of the triangle represent research related to animals, cells and molecules, and humans; and, the position of a publication on the graph is based on its topics, as determined by its Medical Subject Headings (MeSH). We define translation as movement of a collection of articles, or the articles that cite those articles, towards the human corner. The Triangle of Biomedicine provides a quantitative way of determining if an individual scientist, research organization, funding agency, or scientific field is producing results that are relevant to clinical medicine. We validate our technique using examples that have been previously described in the literature and by comparing it to prior methods of measuring translational science. Science Translational Medicine, a new companion publication to Science, represents the crystallization of several undercurrents that have been rocking biological research over the past few years. First is the uneasy sense that our approaches to the transformation of 50 years' worth of remarkable advances in biomedical research into better cures, treatments, and preventative measures have not been as effective as they need to be to better serve society. Other worrisome symptoms include a growing avoidance of clinical research by promising young scientists and a decreased productivity in pharmaceutical and biotechnology companies. Fundamental research conducted with in vitro and in vivo models and assays has been enormously successful, in part because shared evolutionary pathways from the inception of life often dictate that seminal discoveries in one model system apply to all life forms, a reflection of the profound unity of biology. Yet direct translation is not the rule when it comes to applying knowledge gained from any one model to human disease biology. Often, promising approaches to disease characterization or treatment established in vitro or in animal models prove ineffectual in patients. This paradox illustrates the daunting intricacy and diversity of biological systems. Indeed, species-specific properties emerge from the intricate and still poorly understood mechanisms by which basic molecules interact to form molecular assemblies, organelles, cells, tissues, organs, and organisms.

Our country needs more and better translational research, both for the sake of our patients and because much of the research funding in the United States comes from the primary expectation of the American public that such scientific investigations will reduce the burden of disease. This is not to say, as many fear, that we should reduce our focus on basic research. On the contrary, I believe the opposite to be true, because one cannot effectively translate a language that is not understood in its primary form, and we are still a long way from achieving such mastery at the basic level. On the other hand, we cannot, as some argue, focus exclusively on basic research, because efforts to translate knowledge gained from experimental organisms will simply waste resources if scientists have not achieved a rich understanding of the fundamental properties of human physiology and pathophysiology. If we had used only a basic science approach, vaccines would still be a distant dream. The deciphering of complex systems requires a diversity of balanced approaches, the avoidance of dogmas, and the creation of varied opportunities for scientists to self-assemble freely and address these difficult problems as they see fit. Furthermore, insights gained in translational and clinical research often can help refine hypotheses at fundamental levels.