Technology in Society 48 (2017) 1–10

Contents lists available at ScienceDirect

Technology in Society

journal homepage: www.elsevier.com/locate/techsoc

Some factors limiting transfer of biotechnology research for health care at Cinvestav: A Mexican scientific center

Nelly Medina-Molotla [a], Halla Thorsteinsdóttir [b, c], Eugenio Frixione [a, d, 1], Walid Kuri-Harcuch [a, d, *, 1]

[a] Program on Science and Technology Development for Society, Center for Research and Advanced Studies (Cinvestav), Mexico City, Mexico
[b] Small Globe Inc., Toronto, Canada
[c] Institute of Health Policy, Management and Evaluation, University of Toronto, Canada
[d] Department of Cell Biology, Center for Research and Advanced Studies (Cinvestav), Mexico City, Mexico

ARTICLE INFO

Article history:
Received 27 May 2016
Received in revised form
10 October 2016
Accepted 31 October 2016
Available online 2 November 2016

Keywords:
R&D for health care biotechnology
Technology transfer
Patenting
Commercialization
Developing countries

ABSTRACT

We investigated a number of factors that influence the transfer and commercialization of biotechnology for health care at Cinvestav, a leading Mexican research institute and major contributor to biomedical sciences in the country. Mixed methods were used, where we sent a survey to all the principal investigators (PIs) doing research in health-oriented biotechnology at Cinvestav that we could identify and asked them about their transfer of technologies activities, and interviews were carried out with those PIs who are currently pursuing projects for commercialization. Our results show that, despite a strong publishing record on the international front, most of these scientists lack a business-oriented focus. Further business expertise does not appear to be readily available or helpful at the institutional technology transfer office. Weak collaboration strategies reflected in a low number of key partnerships, together with a lack of private financing, also limit the capacity to transfer and commercialize the technologies being generated. The local scientific tradition and conditions do not seem to be amenable to these kinds of efforts, nor does the government pursue a coherent strategy to promote technology transfer and commercialization in health biotechnology. Consequently, promising projects take too long to develop and usually go to a limited extent through the consecutive patenting and licensing steps, both indicators of commercial activity in academia. The end result is a lack of success in making the results of new scientific knowledge beneficial for public health, a problem experienced not only by Mexico but shared by a number of low-and-middle income countries. We discuss the need for an urgent change in concerted vision by research institutions in developing countries, so as to engage their robust scientific infrastructure with the social and health demands of their populations.

1. Introduction

The development of biotechnology for health care in emergent countries has received considerable attention since the early years of this century, as it represents a potentially efficient way for addressing public health issues with locally generated means specifically aimed at their growing populations [1–5]. Research in health-related biotechnology is no longer only found in the United States and some leading members of the European Community, as a number of low-and-middle income countries also have become active knowledge producers in the field. Research has shown that the number of health biotechnology papers authored by researchers from low-and-middle income countries has increased extensively in the two last decades [6]. China, for instance, which occupied eighth place globally in terms of numbers of health biotechnology publications for the period 1998–2001, by 2006–2009 had already escalated up to second place just after the United States [6].

Following the time-tested approach of first copying products originated elsewhere [7,8], innovative biotechnological creations began to appear in a few of these emergent states [9,10]. Interestingly, some of those efforts include studies in stem cell research and other cutting-edge biotechnology fields where, due to the

* Corresponding author. Department of Cell Biology, CINVESTAV-IPN, Apdo Postal 14-740, Mexico City 07000, Mexico.
E-mail address: walidkuri@gmail.com (W. Kuri-Harcuch).
[1] These two senior co-authors contributed equally to this work.

http://dx.doi.org/10.1016/j.techsoc.2016.10.004
0160-791X/

immaturity of the field itself, the scope for copying is limited and there is a stronger emphasis on new-to-the world innovation [11–15].

Still, developing new and potentially useful biotechnology does not by itself result in new products on the market, even in leading economies [16,17]. Generating new health products, particularly therapeutics, is a risky endeavor with many products failing in clinical trials. It does require complex interactions among the actual technical developers, the policy makers, and the public and stakeholder groups necessarily involved in the process; also the input from the users of new health products has been found to be important for successful innovation [18,19]. Moreover, it is well known that having allies and private sector partners encourages innovation in universities [20]. Sharing facilities at universities and research centers with the biotechnology industry is indeed a constant factor for success in high-income nations and can be an important instrument for technology transfer [21]. The establishment of most biotechnology companies in these countries has so far occurred through the work of scientists who actively contribute to basic science research, as well as to the development of new technologies derived from that same research activity [16,22]. The pioneer firms in this sector were established in the United States, where firms such as Cetus, Genentech and Hybritech relied on scientific knowledge provided by the University of California San Francisco, Stanford University and CalTech, while in the Northeast, Biogen was supported by scientists from both Harvard University and the Massachusetts Institute of Technology (MIT) [16,23,24]. Similarly, increasing the biotechnology industry in other regions of the United States such as Texas, North Carolina, and Maryland, also involved mixing the essential requirements: basic scientific knowledge and entrepreneurial culture [23,24].

Likewise in Europe, companies were founded around prestigious scientific institutions, such as the University of Cambridge, UK, which provided the academic background to establish biotech startups and spinoffs engaging researchers as founders [25–27]. Germany followed the lead of the US and UK by implementing a research and entrepreneurship environment to foster biotechnology, initially based around the University of Mannheim and the University of Heidelberg. Later on, the European Molecular Biology Laboratory (EMBL)—which clusters the German Cancer Research Center (DKFZ), the Center of Molecular Biology at the University of Heidelberg, and the Max Planck Institute for Medical Research (MPI)—strongly contributed to the scientific base in health care biotechnology [27,28]. Thus, technology transfer and commercialization in health biotechnology have been largely dependent on universities and public research centers.

Bozeman (2000) has reviewed and analyzed the massive literature published on technology transfer and developed a model he calls the Contingent Effectiveness Model [21]. Since around 1980 the United States and other high-income countries started to place an emphasis on domestic technology transfer and have developed a number of policy initiatives to promote such technology transfer. The Contingent Effectiveness Model presents a conceptual analysis of the effectiveness of technology transfer and assumes that those involved in and promoting technology transfer, have multiple goals and diverse effectiveness criteria. The model has five dimensions, which shape the effectiveness of the technology transfer: characteristics of the transfer agent, the transfer media, the transfer object and the recipient as well as the demand environment. It argues that the effectiveness of technology transfer can reflect various meanings, such as market impacts, political impacts, impacts on personnel involved as well as impacts on the resources that are available for alternative purposes and other scientific and technical goals. The Contingent Effectiveness Model therefore focuses the attention on multiple dimensions of technology transfer to understand the various approaches that have been followed in carrying out and promoting the transfer.

In the case of biomedical science, the creation of spin-off firms has been a commonly used transfer medium for technology transfer in countries such as the United States and the United Kingdom [16,29]. Research on biomedical innovation in developing countries, including in Brazil, Cuba, Egypt, India, Iran, and Nigeria has shown less reliance on spin-off formation and rather the use of several other kinds of pathways for developing a domestic biomedical industry, including a strong reliance on public research institutions [9,30]. Póvoa and Rapini [31] analyzed the technology transfer process in Brazil and highlighted transfer channels similar to those used in high-income countries, e.g. publications and reports, informal information exchange, training and consulting as well as patents [31].

While technology transfer has been analyzed around the world there is still lack of empirical knowledge on this topic in Mexico, including in the biomedical sciences. Mexico, began to prepare young scientists in biotechnology for both medical and agricultural applications already at the birth of this new science in the late 1970s [32–35]. With a population of over 120 million, Mexico is presently the 11th-largest economy in the world and a powerhouse in selected exports, both commodities as well as manufactured goods [36]. Since the mid-1990s Mexico is one of three partners (with Canada and the United States) of the North American Free Trade Agreement (NAFTA) and, along with Chile, also one of only two Latin American members in the exclusive Organization for Economic Co-operation and Development (OECD). Yet, although currently ranked as number 71 [37] and therefore within the High Human Development bracket of the United Nations Development Programme (2014), the country also shows one of the broadest breaches in wealth distribution in the world [38]. In fact, it is afflicted by a shocking level of poverty in certain rural regions, and it consistently holds the poorest grades in the periodic assessment of public education systems among the OECD members [39].

A similar odd pattern is observed in Mexican effectiveness regarding science and technology. The number of officially recognized researchers throughout all areas of knowledge now exceeds 21,000 [40], who are distributed in over 388 universities and other academic institutions, with a pooled current output of 11,000 scientific publications in international peer-reviewed journals [41]. Nevertheless, Mexican investment in science and technology has stayed stagnant over the years at less than 0.5% of the Gross Domestic Product [42], as has the meager yield of Mexican patents in use [43]. Only a few Mexican scientists have succeeded in effectively linking their work with industry [44–51].

Such failure in producing solutions related to its needs is particularly disappointing in the public health area [52]. An increasing prevalence of serious disorders like diabetes and heart disease, combined with steady growth in both the total size and the mean age of the population, will soon demand substantial hikes in expenditure for health care. The latter is still remarkably low in Mexico, at only US $664 per capita [53], in comparison with figures for other countries: US $9146 in USA; US $5718 in Canada; US $1085 in Brazil; US $1074 in Argentina [53]. Yet the nation's economic system is ill prepared to meet this challenge. Hence, contributions from biotechnology and other biomedical advances would be highly welcome to address this situation. But unfortunately few concrete solutions have materialized so far [1,32,45], despite sustained efforts towards the development of medications, treatments, vaccines, devices, and programs for combating infectious and degenerative diseases. Effective action is, thus, urgently needed.

At present time the Mexican health biotechnology industry is composed of 210 companies, according to a recent official survey [54]. Yet, independent studies on this subject have found that most