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Diagnosis of the productive capacity of the IMSS for generation of health techonologies

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Abstract

Objective: *To quantify the production capacity and performance in research and technological developments of the Mexican Institute of Social Security (IMSS).* **Material and methods:** *We identified and analyzed information of the legislation, human and financial resources, and infrastructure addressed for research and technological development of IMSS. We analyzed whether the information on the legal framework contained key features to boost research and technological development. Information on the human, financial, and infrastructure resources were obtained from official sources. The research productivity was identified by a bibliometric analysis in 2014; productivity in technological developments was identified by intellectual property products.* **Results:** *The legal framework of the IMSS has several areas for improvement to boost research and technological development, especially the guidelines for technology transfer. The IMSS has 438 researchers, 39 research units, and a budget of US$ 37.4 million for research and technological development. The rate of articles published per 10 researchers was 4.8; while patents rate was 1.8.* **Conclusions:** *The IMSS has a great potential to translate research into technological developments, it is only necessary patents to make some changes to the legal framework.* (Gac Med Mex. 2016;152:591-7)

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Introduction

At global level, health systems are confronted with several challenges to fulfill their purpose of improving population health levels. On one hand, there is an increasing demand of health services, due to population aging and increase in chronic conditions, which forces health systems to produce more services. On the other hand, limited financial and human resources force health systems to be more efficient in the use of supplies[1-3]. Therefore, the provision of health services quickly, safely, with quality and at affordable price is ann imperative characteristic in health systems. Scientific literature suggests that health technology innovation (HTI) can contribute to achieve the above-mentioned characteristics[4,5]. HTIs generally include new products (e.g., new drugs or medical devices), new services and new organization forms, and are generally directed to improve therapeutic results in patients and to reduce the cost for health services provision[6,7].

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The development of a HTI depends on a long process where scientific research and technological development are intertwined[8]. This process is a cycle, the first step of which is scientific research (discovery stage); subsequently, the development of the HTI is carried out (development stage), which then arrives to the market (distribution stage), where, after some time, it loses novelty, and new health necessities start emerging; then the scientists start conducting new investigations to solve the new necessities, and the cycle starts again[9].

Developing countries produce a lower rate of HTI than developed countries[10], since most lack the scientific and technological infrastructure required for HTI development[11,12], including research centers, scientists specialized in health topics, equipment, funding and policies to foster and apply scientific research and technological development in the field of health[13].

In Mexico, only one study has been published on research production and HTI capacity. This study focuses on the National Health Institutes, which are high specialty hospitals administered by the Ministry of Health[14]. Although the Mexican Institute of Social Security (IMSS – *Instituto Mexicano del Seguro Social)* is the main social security institution in Mexico (it provides medical care to approximately 32.1% of the Mexican population[15]), its capacity of research and HTI production remains unknown. The present study has the purpose to quantify the IMSS capacity of production and yield on research and technological development, by means of a bibliometric analysis and a documentary review. The production capacity has been measured in terms of the legal framework, human resources, infrastructure and financial resources.

Material and methods

Design

Cross-sectional, retrospective, descriptive study based on a bibliometric analysis and review of key documents. All documents were analyzed with Excel® 2010.

Legal framework, human and financial resources and infrastructure

The information on legislation, human and financial resources and infrastructure was obtained from official documents; if several versions of the same document were found, the most recent was analyzed. The documents were searched in the Internet using the Google® search engine. Additionally, the websites of the National Council of Science and Technology (CONACyT – *Consejo Nacional de Ciencia y Tecnología),* the IMSS, the Health Ministry, the Scientific and Technological Consultative Forum, the Mexican Association of Directors of Applied Research and Technological Development and the Ministry of Economy were reviewed.

With regard to the legal framework, since the IMSS must follow the national legislation and other regulations issued by the Federal Government, information was obtained on regulations, both national and of the IMSS, related to research and technological development. Characteristics to promote technological development were searched in the collected legal documents, and were identified with a literature review[16,17]. If the collected document had at least one of the wanted characteristics, then it was analyzed in detail. Three levels were defined to characterize the strength of the characteristics' presence in the documents analyzed in detail. A score of 3 units was given to the document that explicitly mentioned the characteristic and described in detail the role and responsibility of the stakeholders (e.g., investigators, government, the industry, etc.). A score of 2 units was given to the documents that explicitly mentioned the characteristic and that included a general or brief description of the role and responsibility of the stakeholders. A score of 1 unit was given to the documents that mentioned in a general manner the characteristic. The characteristics for promoting technological development were searched in the documents by A. Figueroa-Lara and A. López-Domínguez or F.I. López-Fernández. When the presence or the strength of the presence of any characteristic was questioned, a third reviewer, G. Fajardo-Dolci, would analyze the document, and any discrepancy between the documentary reviewers was solved by consensus.

The information on human and financial resources and infrastructure refers exclusively to the IMSS. The investigators affiliated to the National System of Investigators (SNI – *Sistema Nacional de Investigadores)* and their corresponding level (from candidates to level III) were identified through the SNI investigators catalogue[18]. The information about financial resources was obtained from an official report issued by the Ministry of Health[19]; the amounts were reported in US dollars (USD) and the exchange rate published by the International Monetary Fund

was used[20]. The information was analyzed by means of descriptive statistics.

Bibliometric analysis

Scientific articles were searched in the PubMed website, which is the United States National Library of Medicine search engine. The criteria for the inclusion of articles were the following: at least one author had to report being affiliated to the IMSS (research unit, hospital or administrative unit) and the article should have been published in English or Spanish between January and November 2014. Articles submitted in the form of editorial, letter or commentaries were rejected. The following key-terms were used to identify articles: (IMSS) AND ("2014" [Date-Publication]); (Social Security Mexican Institute) AND ("2014" [Date-Publication]); (Mexican Institute of Social Security) AND ("2014" [Date-Publication]).

Each article was extracted information on authors' names, their institutional affiliations (differentiating if it was national or foreign) and journal of publication. Subsequently, the most recent impact factor of the journal was searched with Google®. All the retrieved information was captured in a database designed using Excel® 2010. Descriptive statistics was used to analyze the information.

IMSS intellectual property

Information on IMSS patents was obtained from the IMSS own database, from the Mexican Institute of Industrial Property (IMPI – *Instituto Mexicano de Propiedad Industrial)* and from the World Intellectual Property Organization (WIPO). A patent was considered to be the IMSS property when this institution was its owner or co-owner and at least one of its inventors was the asignee or one of the asignees and an IMSS' employee. The following key-words were used to identify IMSS patents: (IMSS); (IMSS). All IMSS patents were retrieved regardless of the year of submission or granting; therefore, all patents up to November 2014 were considered. Other industrial property products, such as utility models, or industrial designs were searched and retrieved with the same criteria used for the patents.

The following information was obtained from each industrial property product: inventors' affiliation, asignee, title, date of submission, type of submission (national or Patent Cooperation Treaty [PCT]) and date of granting (when it applied). The information was captured in an Excel® database, and descriptive statistics was used for analysis.

Results

Six documents on research and technological development legislation were identified; 50% of the documents correspond to national-wide legislation, and the rest to IMSS-related legislation. With regard to national legislation, the Law of Science and Technology-CONACyT Organic Law and the National Innovation Program contain 100% of the characteristics looked for in the documents. The first document has a characteristics' description level of 83%, and the second, a description level of 78%. The 2013-2018 Innovative Development Program contains 50% of the characteristics of interest and a level of description thereof of 17%. On average, national-wide legislation documents have 83% of the characteristics of interest and a description level of 59%. Considering the quality of the description of characteristics that promote technological development, the more advanced involve the definition of an administrative unit exclusively in charge of technological development management, whereas the most laggard characteristic involves regulations and guidelines for technological transference.

With regard to IMSS legislation, the document with the highest percentage of the characteristics of interest (83%) is the Medical Services Directive Organizational Manual, with a characteristics' description level of 39%. The documents on the Rule that Establishes the Regulations for Health Research at the IMSS and on the Procedure for Application, Evaluation, Selection, Support Assignation and Follow-up of Research Protocols on Health and Technological Development have 33% of the searched characteristics and a characteristics' description level of 22%. On average, the documents on legislation at the level of the IMSS have 50% of the characteristics of interest and a description level of 28%. Considering the characteristics' description quality, the more advanced characteristics involve the definition of an administrative unit exclusively in charge of the management of technological development and the roles and obligations of the stakeholders. The characteristic with the most laggard involves rules and guidelines for technological transference (Table 1).

In 2013, the IMSS had 438 investigators, 271 (62%) belonging to the SNI; out of them, 5% were candidates, 38% belonged to level I, 13% to level II and the rest to level III. On that same year, at the IMSS there were 13,550 family doctors, 22,940 physicians with any

Table 1. Documents about national and IMSS legislation that contain characteristics for technological development (most recent version)

Document title	Characteristics							
	Definition of an administrative unit for technological development management and promotion	Rules and relationships between stakeholders	Guidelines to grant support to research and technological development	Incentives to inventors	Technological developments diffusion and implementation	Rules and guidelines for technological transference	Number of searched characteristics (%)	Description level
Mexico								
Law of Science and Technology and CONACyT Organic Law	3	3	2	2	3	2	6 (100%)	83%
National Innovation Program	3	2	2	2	3	2	6 (100%)	78%
2013-2018 Innovative Development Program	1	1	0	0	1	0	3 (50%)	17%
Average	2.3	2.0	1.3	1.3	2.3	1.3	5 (83%)	59%
IMSS								
Medical Services Directive Organizational Manual	3	1	1	1	1	0	5 (83%)	39%
Rule that Establishes the Regulations for Health Research at the IMSS	2	2	0	0	0	0	2 (33%)	22%
Procedure for Application, Evaluation, Selection, Support Assignment and Follow-up of Health and Technological Development Research Protocols about Health Critical Issues Contesting for Financial Support from the IMSS	0	2	2	0	0	0	2 (33%)	22%
Average	1.7	1.7	1.0	0.3	0.3	0.0	3 (50%)	28%

Table 2. Human resources and infrastructure for research, technological development and health services provision, and financial resources for research and technological development at the IMSS (most recent data)

Variable	Value
Human resources dedicated to research and technological development, 2013	
Number of investigators*	438
Investigators belonging to the SNI†	271 (62%)
Candidates†	23 (5%)
Level I†	165 (38%)
Level II†	59 (13%)
Level III†	24 (5%)
Human resources dedicated to medical attention, 2013*	
Family doctors	13,550
Doctors with any other specialty	22,940
Nurses	104,463
Research units, 2014	
Research units‡	39
Animal housing facility‡	1
Medical units, 2013§	
Family Medicine Unit	1,502
Hospital	233
High Specialty Hospital	28
Financial resources directed to research and technological development, 2014 (USD)§	37,475,701

*Source: IMSS, Memoria estadística 2013. Ciudad de México, 2013.
†Source: *CONACyT. Investigadores vigentes del SNI 2013. Ciudad de México: CONACyT; 2013.*
‡Source: *IMSS. Informe al Ejecutivo Federal y al Congreso de la Unión sobre la situación financiera y los riesgos del Instituto Mexicano del Seguro Social 2013-2013. Ciudad de México: IMSS; 2014.*
§Source*: Secretaría de Salud de México. Boletín de información estadística, recursos financieros. Ciudad de México: SS; 2014.* [online] Downloaded on December 5, 2014. Available at: http://www.sinais.salud.gob.mx/publicaciones/p_bie.html.

other specialty and 104,463 nurses. In 2014, there were 39 research units and an animal housing facility. In 2013, the IMSS had 1,502 family medicine units, 233 hospitals and 28 specialty hospitals. In 2014, the IMSS had a budget of USD 37.4 million for research and technological development (Table 2).

With regard to the IMSS research productivity, during the year 2014, employees of this institution published 320 scientific articles, out of which 211 (66%) were published in some journal with an impact factor > 0.5; therefore, the rate of published articles for every 10 investigators was 4.8. Of those 211 articles, 138 (43%) were published by investigators belonging to the SNI; 163 (77%) papers were published in collaboration with another institution and 59 (28%), in collaboration with any foreign institution. With regard to productivity on technological developments, from 1998 to 2014, the IMSS had 58 patent applications and 21 (36%) were granted; of the totality of applications, 6 (10%) were filed under the PCT modality. The rate of patent applications for each 10 investigators was 1.32. Of all 58 patent applications, 38 (66%) were filed by investigators belonging to the SNI, 14 (24%) were developed in collaboration with another institution and 3 (5%), in collaboration with a foreign institution (Table 3).

Discussion

In the present investigation, the research and technological development production capacity and their corresponding productivity have been examined by means of a documentary and bibliometric analysis. At the national level, research and technological development-related legislation contains 83% of characteristics that promote technological development. However, the characteristics' description level is 59%. The IMSS legislation has only 50% of characteristics that promote technological development, and their description level is 28%. In 2013, the IMSS had 438 investigators and 39 research units. In 2014, this institution had a budget of USD 37.4 million for research and technological development. That same year, IMSS employees published 211 scientific articles in journals with an impact

Table 3. Level of scientific and technological production by the IMSS (most recent data)

Scientific productivity	Value (%)	Productivity on technological development	Value (%)
Articles published during 2014	320	Patent applications filed by IMSS employees, 1998-2014	58
		Granted patents	21 (36%)
Articles published during 2014 in journals with an impact factor > 0.5	211 (66%)	Patent applications under the PCT modality	6 (10%)
Rate of articles published in journals with an impact factor > 0.5 for every 10 investigators	4.8	Rate of patent applications for every 10 investigators	1.32
Articles published by SNI investigators in journals with an impact factor > 0.5	138 (43%)	Patent applications filed by SNI investigators	38 (66%)
Articles published in journals with an impact factor > 0.5 in collaboration with another institution	163 (77%)	Patent applications developed with another institution	14 (24%)
Articles published in journals with an impact factor > 0.5 in collaboration with a foreign institution	59 (28%)	Patent applications developed with a foreign institution	3 (5%)
		Industrial designs, 1999-2014	1

factor > 0.5. The rate of published articles was 4.8 for every 10 investigators. When the information was contrasted on internal databases by one of the authors (F.I. López Fernández), the number of publications in 2014 was found to be 405; i.e., 9.2 articles for every 10 investigators. This rate considers all criteria used on this research, except for the time period (January to December 2014). From 1998 to 2014, the IMSS had 58 patent applications, and 38 (66%) were filed by investigators belonging to the SNI. The rate of patents was 1.32 for every 10 investigators.

The legal framework on research and technological development is a key aspect to promote HTIs, since without it, the production, dissemination, implementation and communication of HTIs outside the institutional framework become inefficient, since there are no rules or regulations articulating the stakeholders, which makes the process to become inefficient[21]. The analyzed documents on research and technological development-related national legislation contain most characteristics necessary to promote HTIs. In addition, there is an intermediate level in the description of the roles and responsibilities of stakeholders. However, legislation at the level of the IMSS has important gaps, especially in the rules and guidelines for technological transference, incentives for inventors and innovations' dissemination and implementation. This may be due to the fact that, historically, the IMSS has been seen as a provider of health services[22]. Therefore, the IMSS authorities have considerable oportunity for improvement in legislation.Using the information of all Organization for Economic Co-operation and Development (OECD) member countries, the conclusion is drawn that total investigators in the OECD for every 1,000 employees is 7.6, while at the IMSS it is 1.1 (data not shown in the tables)[23]. This comparison suggests that the number of investigators at the IMSS is low with regard to the OECD member countries and thus, the IMSS could try to increase the number of researcher job positions. Another possible solution to the low number of investigators is to promote that the remaining 38% of IMSS researchers who don't belong to the SNI obtain this qualification, since investigators belonging to the SNI are reported to be more productive and to generate higher quality research[24].

Based on official statistics of the Mexican health system[25], the IMSS has approximately 14% of doctors, 33% of nurses and 20% of total hospitals available in Mexico. Every day, the IMSS grants 489,549 medical appointments, records 5,552 hospital discharges, performs 4,171 surgeries, looks after 1,261 deliveries and carries out 752,080 laboratory tests[26]. Therefore, it has great knowledge on health conditions, unmet necessities and health priorities of the Mexican population. The IMSS should take advantage of this knowledge on the health necessities of the Mexican

population in the generation of HTIs. The increase in the number of HTIs will benefit the health of the population[27,28] and might generate financial resources for the IMSS if HTIs were transferred to the industry.

An important limitation of this study is that the most recent information on human resources dedicated to research and on the SNI is of the year 2013. Since the bibliometric study was performed for 2014, the list of SNI investigators for 2014 is likely to be different to that for 2013, and there may be a slight error in the calculation of the percentage of articles published by SNI investigators. However, it is considered to be a small error that would not substantially alter the results, since the national number of SNI investigators varied around 6% between 2012 and 2013[29].The IMSS has sufficient productive capacity, in terms of human resources, infrastructure and financial resources, to generate research and technological developments, but the legislation has to be modified in order to articulate the above-mentioned resources. The IMSS has to see technological developments as an opportunity to improve the health of its population, and not as an extra workload. A key step to boost technological development is the generation and approval of rules and guidelines for HTI technological transference.

To our knowledge, this is the first study that has quantified the productive capacity in research and technological development of the IMSS and, therefore, following on this line of investigation is suggested.

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