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Editorial

Technological Transfer of Knowledge in Pulmonology☆

Transferencia tecnológica del conocimiento en neumología

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The dictionary of the *Real Academia Española* (Royal Academy of the Spanish Language) defines technology as "*theories and techniques that enable the practical use of scientific knowledge*" or as "*a group of industrial procedures and tools for a specific sector or product*". Likewise, the word "transfer" comes from the Latin word *transferre*, meaning to take or carry something from one place to another, or rather to cede one's right to or domain over something to another person. Such transference of technology is a mechanism to propagate capabilities, usually among countries with different levels of development. The transfer may be of technical objects, devices or knowledge. It is an open door for making contacts and initiating collaboration between research centers, companies and financial entities. The transfer of technology has become institutionalized by means of collaboration agreements or accords between the different entities mentioned.

According to Friedman,[1] in this decade technology will not be able to meet the needs of the population derived from aging; its possibilities will be used to the maximum, but with no introduction of new procedures. Furthermore, due to the economic crisis which began between 2008 and 2010 and the reduction of capital dedicated to research, investment in developing innovative technologies is a high risk for companies. Thus, these companies will decide to invest their capital in low-risk projects based on previous technologies. It is therefore the government that will have more resources for promoting basic research and for absorbing its expense.

In Spain, the health-care system is predominantly public (socialized), and it is the main customer for companies in this sector, which are mainly distributors.[2] As they are distributors and not producers, this means that the technological production (measured by the number of patents, licenses or commercialized systems) is very low. But, why the private sector does not invest in innovation? The introduction of a new product in the market is the result of a long process that begins with the birth of an idea based on the previous experience of the researcher who tries to respond to a specific need of the population. In this process, various entities may intervene, such as universities, foundations and other institutions that provide the necessary technical personnel from other specialties, as well as administrative aid. The moment that a company approves a project, it is taking a risk: the idea may reach the market in the form of an industrial prototype that will later be commercialized, but most ideas do not come to fruition. In most cases, the problem is economic. Our country, which is ranked ninth worldwide in scientific research (based on the number of papers published, not on cited articles), only contributes 0.6% of the worldwide business in advanced technology. Although efforts have been made in order to reduce the differential compared with other neighboring countries, we are still very far from being competitive. In Spain, the technological deficit (difference between what is imported and exported in technology) in the year 2008 was 20 billion Euros. In order to partially palliate this state of things, Congress has recently and unanimously passed the Science, Technology and Innovation Law (in Spanish, *LCTI*). This law includes the term "innovation", which recognizes the fundamental role of markets. Innovation means creating value. Along these lines, the National Innovation Strategy (E2I) will reduce the gap between the regulations and the market. It is a tool with multiple initiatives, such as promoting public purchasing of innovative products, the introduction of companies in the stock market or measures aimed at the participation of companies in European R+D+i subsidies. Meanwhile, the reality is that, with the economic crisis, the government has cut back 30% of the budget for Public Research Organisms, and only 60.8% of the funds earmarked for business loans in the Department of Science and Innovation have actually reached companies. The crisis therefore conditions businesses applying for loans. In spite of this, universities promote technology-based spin-off companies, which have even greater difficulties to find financing. But, currently only 15% of university students aspire to start their own company when they graduate. In other words, although there is public money available in science and innovation, business administrators are not willing to take risks. It is not just an economic problem; it is also cultural. There is a lack of entrepreneurs. Given this situation, the Government of Catalonia has recently approved an entrepreneur plan for schools: it will be implemented in preschool and primary education to offer children knowledge of basic economic concepts, and in secondary school students will be introduced to the subject of "Professional orientation and entrepreneur initiatives".

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In pulmonology, there have been great advances in diagnostic imaging techniques, specifically bronchoscopy and CT scans. Optical coherence tomography (OCT) is a new bronchoscopic technique that provides visualization of structures smaller than 3 mm, including the small airway.[3] It is based on the application of low-coherence near-infrared light that interacts with the adjacent tissues depending on their depth, creating a sectional image. The spatial information is determined by the time delay of the reflected light. The superficial layers of the tissues are referenced, and in them neoplasms of the airway can be identified.[4] It can also give information about the remodeling phenomenon in COPD. Electromagnetic navigation bronchoscopy (ENB)[5] uses several technologies at the same time, such as DICOM conversion of CT images, creating images in 3D (virtual bronchoscopy) and electromagnetic navigation together with a sensor that allows for navigation throughout the airway. Video-assisted bronchoscopy with autofluorescence imaging (AFI) provides greater safety in diagnosing lung cancer extension than conventional video-assisted bronchoscopy.[6] Ultrasound-guided bronchoscopy has demonstrated its effectiveness in the location of mediastinal lymph nodes, masses and peripheral lung nodules.[7] Nevertheless, efforts should be taken to improve the image offered to the bronchoscopist, as it includes the noise of the reflex of the structures themselves produced by the ultrasounds. A clearer vision of the field to be biopsied would provide greater safety in the extraction of samples.

Telemedicine and telemonitoring are terms that describe the use of technology to control patients at a distance while they are in their homes.[8] In patients with COPD, the transmission of spirometric data detects 73% of recurring exacerbations.[9] In asthma, the peak flow and symptoms are monitored.[10] In general, videoconferencing can reduce the number of physician visits in rural settings.[11] The problem with this technology is that not all patients are connected to the internet, and therefore its generalized use is subject to the increased expansion of the web.

The use of simulators can improve teaching interventionist techniques such as bronchoscopy or mechanical ventilation.[12]

The developments in robotics in coming years are sure to be spectacular. In thoracic surgery, the Da Vinci robot has been recently been applied in video-assisted thoracoscopy (VATS).[13]

Current acoustic technology is able to study respiratory sounds more objectively than what is offered by conventional auscultation.[14] The acoustic intensity can be measured by means of vibration response imaging (VRIxp).[15] Measurements of acoustic asymmetry can be used to monitor the evolution of different respiratory processes.

When the size of a particle is less than or equal to 100 nm, it is considered a nanoparticle.[16] Quantic dust is a type of nanoparticle that is used in diagnostic imaging. They are semi-conductor nanocrystals that have a wide spectrum of absorption and a narrow spectrum of emission. As they have an elevated surface area, they can be associated with peptides of antibodies that act like targets, increasing the specificity of functional images. These products can offer numerous therapeutic applications for respiratory diseases. The majority of the studies done are based on the treatment of respiratory infections, such as respiratory syncytial virus, by means of chitosan/DNA nanospheres or small interfering RNA (siRNA) through nasal inhalation, invasive pulmonary aspergillosis or anti-tuberculous drug vehicles. Although currently biodegradable products are used, their potential effects on the lungs are unknown.

In Spain, some research groups have been able to reach the preindustrial production and marketing phase. The following is a description of some of the projects that have transferred or are in the process of transferring technology. The group at the Hospital del Mar de Barcelona (IMIM) has developed a training device for the respiratory muscles that uses resistive loads (ORYGEN DUAL VALVE, Forumed, Spain). The device is the result of more than 15 years of research in respiratory muscle function.[17,18] Electrical impedance tomography (EIT) has been successfully introduced by the group at Hospital de San Pablo in Barcelona (TIEsys-4, Barcelona, Spain).[19,20] EIT offers thoracic images that give quantitative parameters of the pulmonary ventilation. EIT does not require ionizing radiation and gives results similar to those offered by perfusion gammagraphy. The group constituted by the Hospital del Río Ortega in Valladolid and the Hospital Clínico de Santiago de Compostela has studied pulse-oximeter signals and heart rate for 10 years.[21] By means of spectral and central tendency analyses, they have been able to discriminate patients affected by SAHS. The "Disavoz" Project by the group at the Hospital Arnau de Vilanova in Lérida is trying to identify patients affected by AHS by means of voice analysis based on previous studies (SEPAR grant, 2009). The analysis of snoring using the "Snorizer" system (in process of being commercialized by Sibel SA, IBEC, Hospital Universitari Germans Trias i Pujol, Badalona, Barcelona, Spain) can differentiate between the different degrees of severity in patients with SAHS.[22] At the same time, important advances are being made in the field of telemedicine applied to home CPAP titration.[23]

Finally, we must emphasize the efforts made by our respiratory society since 2001, the year in which the Respira Research Center (in Spanish, *CRI*) was created, which led to the creation of the Respira Network (2003–2006) and CibeRes, part of the Carlos III Health Institute in 2007.[24] SEPAR, through its work areas and integrated research programs (*PII*), includes several lines of basic research, technological innovation among them.

To summarize, in spite of the economic crisis, we can say that different institutions are doing everything possible to promote and develop the transfer of technology and produce innovation. Thanks to this fact, several Spanish pulmonological research groups are creating lines that in the near future will provide economic benefits.

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