

Patents as a Source for the History of Medicine: The Example of the Japanese Medical Instrument Industry, 1885–1937*

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Abstract: This paper focuses on the development of the Japanese medical instrument industry from the 1880s to the beginning of the war against China (1937). Using patents registered for innovations in this industry during this period as a basis, it offers a business history approach and aims at a better understanding of how the Japanese health system changed to a market basis in the first third of the 20th century. Patents appear as a unique source for approaching the development of new medical technologies. They include both quantitative and qualitative (name and location of inventors) information, and make it possible to flag the major trends in the formation of this industry. In particular, this survey highlights the coexistence of two major kinds of innovators: artisans and mechanics, clustered in Tōkyō city, on the one hand; and big enterprises, specialized in X-ray equipment and electro-medical machines, from the 1920s onwards.

Key words: patent, medical instruments; X-ray equipments; innovation; R&D

Introduction

While health was transformed during the 20th century into a fast-growing business, which accounts for some 10% of GDP in industrialized countries today, the economic history of medicine is still paradoxically an underdeveloped field. Of course, health economists have highlighted the major impact of new medical technologies on the steady increase in health expenditure.¹⁾ Yet the historical process which made technologies favoring the change of health systems into a market is not well known. Works carried out dealing with economic and technological aspects of medicine are largely divided into two fields which do not interact very much. The first is the financial history of health systems and hospitals, especially developed in the UK, Germany and the US. However, attention to technology has been absent from these approaches.²⁾ The second is the sociology and social history of medical technologies, a typically Anglo-Saxon field. The research carried out from this perspective emphasized social networks as a major resource for innovation and for the diffusion of new technologies, but virtually ignored the influence of technologies on the structuring of a medical market.³⁾

The issue of the transformation of health systems into markets during 1880–1930 is especially crucial in non-Western countries as it went hand in hand with a second phenomenon — the introduction of Western medicine. The general trend for the social and political processes which gave way to this globalization of medicine is now known, thanks to the many works written on the history of imperial and colonial medicine.⁴⁾ Yet one still wonders exactly how technologies contributed to this change. This is particularly

true in the case of Japan, where the history of the transformation of the health system during this period is usually approached with reference to the transfer of “soft technologies”, that is, both medical knowledge as a science and institutional organization such as hospitals, medical schools and health policy. Attention to technology has been nearly absent from the Japanese historiography of medicine for this period, and the rare research efforts which have been published have dealt with medical instruments as an objective and neutral testimony of the material civilization of Meiji Japan, rather than a vector of institutional transformation.⁵⁾ This is very paradoxical if one considers that the contemporary medical instrument industry is well developed in Japan, with various kinds of actors such as an urban cluster of small and medium-sized enterprises (SMEs) in Tōkyō and the presence of large firms from the electrical appliance industry, such as Toshiba, Hitachi and Shimadzu.⁶⁾

The study of the process by which this supporting industry of medicine emerged, became structured and developed can surely contribute to a better understanding of the twofold transformation — westernization and marketization — of the Japanese health system. Consequently, this paper offers an analysis of this process with a source which has not caught the attention of medical historians so far: patents. This kind of document gives a particular and unique outlook on the technological and organizational development of the medical instrument industry in Japan, from the implementation of the Patent Monopoly Act (1885) to the beginning of the war against China (1937).

1. Patents as a historical source

Patents are intellectual property deeds which confer upon their holders the right to exploit an invention. Even if patents do not cover all innovations, as some individuals and enterprises prefer to keep their practices secret rather than protecting and making them publicly through a patent, patents are sources widely used by economic historians to measure the level of the innovation of nations and corporations,⁷⁾ as well as by business historians to shed light on the strategies adopted by firms regarding the management of technologies (MOT).⁸⁾ Indeed, using this source for both quantitative and qualitative research gives various additional insights into the dynamics of an industry, as emphasized in this paper. However, the medical instrument industry has never been the subject of interest by business and economic historians abroad, nor have historians of medicine used this source to approach the development of the industry. Consequently, there is no international benchmark on this subject to appreciate the Japanese case in a broader context.

Japan adopted its first patent legislation in 1885, in the Patent Monopoly Act.⁹⁾ This first legal instrument was quite restrictive: on the one hand, only Japanese nationals were eligible to register patents, effectively preventing foreigners from protecting their inventions and products in Japan; on the other hand, it had several limitations, such as the impossibility of patenting medicine, a maximum duration of 15 years for patent protection, and the invalidity of patents on military grounds. This legislation was extensively amended in the late 1890s to enable foreign direct investments in Japan.¹⁰⁾ Bilateral agreements for patents were signed with the United States and the United Kingdom (1897), allowing their nationals to register patents in Japan, following which Japan signed the Paris Convention for the Protection of Industrial Property in 1899.¹¹⁾ That same year, Japan recovered its right to impose custom duties and adopted a protectionist policy whose main objective was to ensure that the internationalization of patent protection system was followed not by a huge influx of imports but rather by investment and production in Japan.¹²⁾

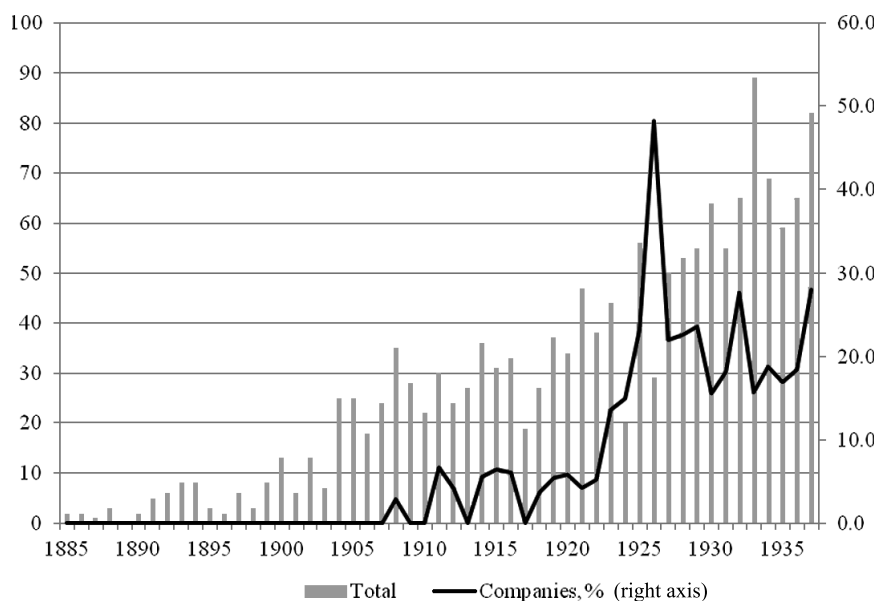


Figure 1 Number of patents for medical instruments by year and proportion of companies as a % of total, 1885–1937
 Source: Industrial Property Digital Library, www.ipdl.inpit.go.jp (last access: 27 May 2013).

Between 1885 and 1900, medical apparatuses, instruments and equipment (hereinafter abbreviated as “medical instruments”) accounted for only a tiny share of all patents, which covered a very wide scope but were concentrated in high-tech fields controlled by multinational enterprises (MNEs), such as electrical appliances, chemicals and machines. For the years 1885–1900, medical instruments amounted to only an average of 0.15% of all patents.¹³⁾ However, they were present since the early beginnings of the patent system. Accordingly, using patents as a medical history source makes it possible to highlight the major actors and the targets of innovations in the medical instruments sector. The categories used for this research as “medical instruments” are patents classified by the Japan Patent Office under the numbers 94 (sanitary instruments) and 100A (X-ray machines).¹⁴⁾ Between 1885 and 1937, a total of 1513 patents were identified as relating to medical instruments and equipment. The relevant documents contain various kinds of data, the following one having been used for the analysis: type of innovation (object or process); name and location of the inventor; name and location of the patent’s owner (if different from the inventor); date and number of the patent.

The general trend for patent registration statistics points to three distinct periods of development (see Figure 1). First, a period (1885–1901) during which the number of patents was low (4.9 per year on average), mainly due to Japan’s strong dependency on imported goods and the legal impossibility for foreigners to register their patents. Of course, the average growth rate looks relatively high (7.2%), but this is above all due to the very low number of patents registered during the first year (only two).

Second, the years 1902–1925 correspond to a first period of growth, with an average number of patents rising to 29.2 per year and an annual growth rate of 6.2%. The Japanese medical instrument industry emerged and took shape during this period. It benefited from the particular situation resulting from World War I, during which first European, then American manufacturers disappeared temporarily from Japan and

the world market, due to their shift to armaments production.

Third, growth accelerated (9.8%) in a third period (1926–1937), with an average number of patents which doubled (61.3 per year) and an industry which became largely independent of imports despite the lack of customs protectionism.¹⁵ Imports declined from 1926 onwards, and were even outstripped by exports in 1928, which indeed represented a growing share of production during these years (19.9% of production was exported in 1930; 44.3% in 1935; 52.1% in 1937).¹⁶ The industry became competitive on the world market in this period.

Consequently, the general patent registration statistics for medical instruments in Japan make it possible to distinguish three main periods, during which technological independence emerged. The next three parts of this paper feature a detailed analysis of the actors and targets of these patents.

2. The emergence of an industry (1885–1901)

Patents registered during the first period shed light on the fact the medical instrument industry's technical basis and organizational structure were still rudimentary. There were no companies and very few foreigners (3.8%) among the patent holders. Tōkyō was a major venue for research and development (R&D), accounting one-third of all patents, well ahead of the country's second largest urban area, Kyōto–Ōsaka (17.9%). However, patenting for medical instruments was not an exclusively urban phenomenon: nearly half (44.9%) of them came from cities and towns other than the country's three main cities. This meant that innovation was equitably dispersed throughout Japan and relied on individuals.

Besides, there were very few “super-inventors”, defined as the holders of more than one patent. Indeed, only seven inventors registered several patents, among which five had only two. The only person to have been a real innovator was Tanaka Kōsaborō, with four patents, followed by an additional two more in 1908 and 1912. Settled in the East Ward of Ōsaka, he was obviously an artisan — the patent no. 2919 registered

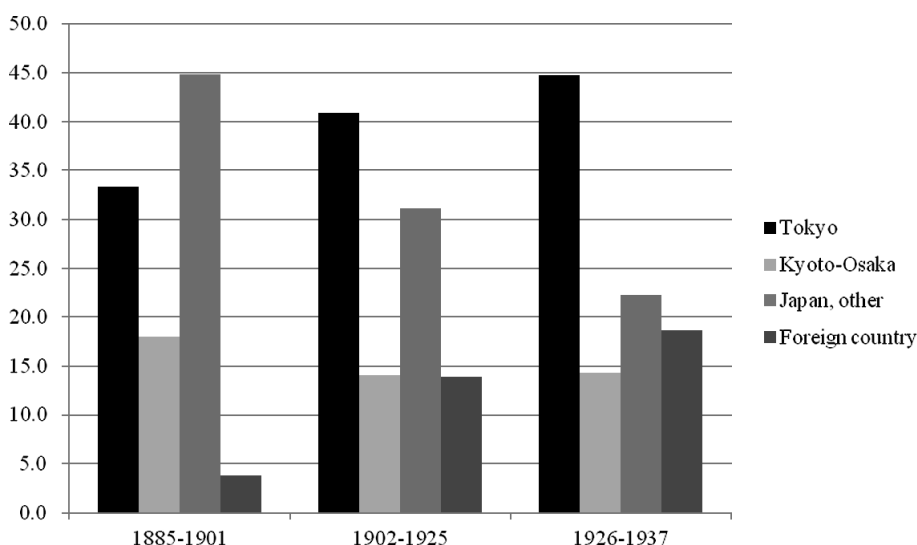


Figure 2 Patents registered for medical instruments in Japan, by location of the inventor, as a % of total, 1885–1937

Source: Industrial Property Digital Library, www.ipdl.inpit.go.jp (last access: 27 May 2013).

Table 1 Patents registered for medical instruments in Japan, by type, as a % of total, 1885–1937

	1885–1901	1902–1925	1926–1937
X-ray equipment (100A)	0.0	4.3	14.6
Diagnostic instruments (A1)	6.4	9.9	8.2
Surgical instruments (A2)	10.3	5.4	5.0
Electro-medical machines (A3)	1.3	5.1	12.1
Massage, acupuncture, and heating / cooling instruments (A4)	33.3	17.3	13.5
Sterilization equipment (A8)	9.0	10.4	4.4
Instruments for dentists (C)	5.1	10.6	10.0
Instruments for ENT specialists (D)	10.3	9.6	11.3
Other	24.4	27.4	20.9
Total	100	100	100

Source: *Tokkyo bunrui betsu somokuroku*, Tōkyō: Tokkyocho, 1958 and Industrial Property Digital Library, www.ipdl.inpit.go.jp (last access: 27 May 2013).

in 1897 mentioned him as a “commoner” (*heimin*) — involved in the sale of medical instruments, but his business must have been a small enterprise, as it did not appear in any of the official censuses or publish any catalogue kept in today’s libraries. His patents covered medical needles and a portable device for measuring the body.

Tanaka’s innovations were quite representative of the kind of object on which innovation focused during this first period. Table 1 shows clearly that, rather than high-tech equipment, instruments and tools based on mechanical and metalworking techniques, that is, traditional know-how, were the main targets of innovation at the time. The most complex instruments were sterilization facilities, a key infrastructure for the adoption of aseptic methods in hospitals in the 1890s.

3. The structuring of the industry (1902–1925)

The years 1902–1925 were a period of transition during which R&D facilities were set up in this industry. The first point worth noting is the emergence of enterprises as patent holders. Even if they had only a total of 41, that is, a mere 5.9% of the total, this share grew steadily in the early 1920s (5.9% in 1920; 23.2% in 1925), a fact which reflects the scope of the change. The patent holders in question were essentially foreign enterprises — The Columbus Dental Manufacturing Co. (United States, five patents) and Quartzlampen GmbH (Germany, three patents) were the largest holders — as well as Japanese companies with foreign capital, like Tōkyō Electric Co. (12 patents), a subsidiary of General Electric (US).

An analysis of the location of patent holders also underscores this growing share of foreigners, who accounted for 13.9% of all patents during this period and included a large number of individuals. Yet the main trend in terms of geographical location was the concentration in the city of Tōkyō (40.9%) to the detriment of the second-largest metropolis (Kyōto–Ōsaka, 14.1%) and the rest of the country (31.1%). This phenomenon perfectly matches the development of the Japanese health system, which was characterized in the first quarter of the 20th century by the concentration of medical doctors in cities, especially Tōkyō, and by “the golden age” of private medicine.¹⁷⁾ Manufacturers of medical instruments settled where demand was the greatest. Geographical proximity to doctors was a key element for innovation.

However, the emergence of enterprises in this industry cannot explain this concentration, as most of the

firms registering patents were either foreign or established outside Tōkyō city (for example, the branch of Tōkyō Electric which registered patents for medical instruments was the Kawasaki plant, located in the neighboring prefecture of Kanagawa). Only four patents were registered in Tōkyō by enterprises in 1902–1925 (1.4% of Tōkyō's patents): Shibaura, an electrical appliance firms with foreign capital (1922), the trading companies Takara (1922) and Shūsō (1923), and the measuring instrument maker Tōkyō Keiki (1923). All these companies held only a single patent, so that it is hard to consider their presence as the result of the implementation of organizational capabilities to develop R&D on medical instruments.

Accordingly, one must wonder exactly who were the individuals responsible for the concentration of innovation in Tōkyō after 1902. Data mentioned in patents, albeit very limited, allow us to emphasize some characteristics. First, the 282 patents registered by individuals residing in Tōkyō hardly resulted from joint research: only 29 mentioned more than one inventor (10.2%). This meant that innovation in medical instruments was an individual process. Second, there was a wide geographical dispersion of the location of inventors in Tōkyō. The Hongō Ward, traditionally considered the centre of medical activity in the city, accounted for only 17.3% of patents. Third, a large number of “super-inventors” emerged during this period. Among the 208 individuals located in Tōkyō, 41 held more than one patent (22.1%) and six held more than five (2.9%).

The largest patent holder, with a total of 28, was Andō Yasujirō. He was not engaged in physical medicine itself, but in a side field of medicine. In fact, he specialized in designing instruments to measure skills and abilities. He was an officer in the Imperial Navy, trained during his youth in electricity and communication technologies, before shifting his interest toward psychology and rationalization of work.¹⁸⁾ The instruments for which he obtained patents were obviously used to enroll conscripts. Three other patents registered in 1930 mention the Army as the owner. After World War II, Ando shifted to rationalization and efficient movement, working to improve productivity in civilian industry. The five other super-inventors of this period feature a more traditional profile. Nakahara was a dentist involved in the development of dentist schools in Japan.¹⁹⁾ Tejima was apparently not a doctor — he is not mentioned in the censuses — and was probably a mechanic, in light of the wide variety of products and his location in Kyōbashi Ward, a traditional place for small workshops in Tōkyō.²⁰⁾ Kawanishi and Kishida are not identified, but were apparently not doctors. As for Maki, he was a manufacturer and distributor of medical instruments well established in Tōkyō, where he possessed an enterprise specialized in artificial limbs for the Army from the 1900s onwards.²¹⁾ Thus, one can conclude that the main super-inventors were not doctors, but rather people from the milieu of artisans and manufacturers, who developed their activities as a supporting industry for medicine.

Table 2 Individuals located in Tōkyō with at least five patents, 1902–1925

Name	Location	Number of patents	Field
Andō Yasujirō	Ebara District	28	Instruments to measure skills and abilities
Nakahara Ichigorō	Kojimachi Ward	9	Instruments for dentists
Tejima Masayoshi	Kyōbashi Ward	7	Various medical instruments
Kawanishi Tejjirō	Toyotama District	5	Gauze and medicine for sterilization equipment
Kishida Ginko	Kyōbashi Ward	5	Syringes
Maki Kyūbei	Hongō Ward	5	Artificial limbs

Source: Industrial Property Digital Library, www.ipdl.inpit.go.jp (last access: 27 May 2013).

Finally, an analysis of innovation targets between 1902 and 1925 reveals a clear-cut distinction between the two major actors, namely, big business and the Tōkyō artisan milieu. Electro-medical appliances and X-ray machines emerged as a major new category in this period, with a total of 9.4% of all patents. A large share belonged to companies (20 out of a total of 67), mainly foreign firms or Japanese firms with foreign capital. Other fields relied essentially on traditional technologies, such as mechanics, and gave way to a high variety of instruments developed by a mass of individual inventors.

4. High-growth period (1926–1937)

As for the third period, it was characterized by a sharp increase in the number of patents and the growing importance of firms and institutional actors in R&D on medical instrument. They registered a total of 160 patents, that is, 21.8% of the total. Yet unlike the previous period, these were not mainly foreign or foreign-owned companies, but rather Japanese enterprises and organizations which had acquired the capacity to develop in-house R&D.²²⁾ Foreign firms accounted for only 46 patents (27.1% of all patents held by institutions). Of course, if one adds the patents registered by Tōkyō Electric (38) and Shibaura (7), both of which were Japanese subsidiaries of General Electric, foreigners' share among institutions holding patents increases to over half (53.2%). However, the overwhelming majority of the patents registered by these two companies concerned inventions by Japanese engineers (30 patents at Tōkyō Electric and four at Shibaura), whereas the practice was to register in Japan American patents developed by General Electric. The first time Tōkyō Electric patented a Japanese invention was in 1928. In all, nine Japanese engineers are mentioned as inventors in the patents of these both companies, but none of them registered a patent in his own name or for another company. These were not independent artisans or technicians — as were so abundant in Tōkyō at the time — but rather engineers with university degrees, without any link to the traditional Tōkyō milieu of medical instrument makers. For example, Tanaka Shōdō and Yoshida Hamaji, mentioned in five patents, graduated respectively from the Faculty of Sciences of the University of Tōkyō and from the Faculty of Engineering of Kyōto University.²³⁾ As Nishimura Shigehiro showed in his research, this transition was not specific to medical instruments but can be seen in all the divisions of these companies.²⁴⁾ This technological autonomy made it possible for Tōkyō Electric to free itself from American capital at the end of the 1930s.²⁵⁾

In this way, Japanese companies and organizations became key players in the development of medical instruments in the mid-1920s. However, only a very limited number of them had a real R&D strategy and registered more than five patents. The biggest patent holder was the Kyōto-based company Shimadzu (19 patents).²⁶⁾ This scientific and medical instrument maker, founded in 1875, established itself in 1924–1925 as the leading producer of X-ray equipment in Japan, thanks to a strategy of insourcing human resources for R&D and establishing a very active presence in social networks of medicine. All the 13 inventors mentioned in this firm's patents are Japanese and none of them seem to have come from the artisans' milieu, as they did not register other patents individually. Most of them were actually engineers and technicians, as collaboration with external researchers was very rare. In fact, this was the case only with a single patent obtained in 1933 for an X-ray tube (No. 101414), developed by the doctor Urano Tamonji, a promoter of radiology in Japan, in charge of the X-ray division at Ōsaka Kaisei Hospital and a lecturer at Kyōto University.²⁷⁾ However, such joint research was very uncommon for Shimadzu.

The second-largest patent holder was the medical instrument maker Gotō Fū-undō, in Tōkyō (six patents). Originally, this company founded in 1886 was a manufacturer and distributor of drugs, which diversified into the sale of instruments in the 1900s.²⁸⁾ His ability to market medical equipments allowed him to become the representative agent for several German makers in the 1920s, including Siemens, with which a commercial agreement was signed (1926) and a joint venture was set up under the name of Gotō Fū-undō Manufacturing for producing some equipment in Japan (1932).²⁹⁾ Yet Siemens limited the transfer of technology to its Japanese partner to a maximum, preferring to export high value-added finished goods. Thus, the patents registered by Gotō during this period did not concern high-tech equipment, but rather traditional instruments for surgery, ENT specialists, blood pressure and drug preparation, that is, for innovation developed outside the partnership with Siemens. Among the four inventors mentioned, one is known as an independent medical personality who worked for Gotō. Endō Shigekiyo, a specialist in public health and anti-tuberculosis policies, developed some installations to maintain patients' ribcages (patents Nos. 88404 in 1930 and 96560 in 1932).³⁰⁾ Thus, none of Gotō's patents had any link to the cooperation with Siemens.

Finally, the Army was also one of the largest institutional patent holders (six patents). All of its inventions consisted of equipment to protect the human body (breathing system, eyes, etc.) against toxic gas attacks. So, there were no instruments for healing, but rather devices aiming at keeping the body safe from damage. Developing efficient gas masks was a key issue for military medical engineers: a total of 20 patents were registered in this field in Japan before 1937. Apart from four patents held by the Army, others were held by the Navy (2), Japanese (3) and foreign (4) individuals, as well as by Japanese (1), German (4) and other nations' (2) enterprises. Besides, several of the Army's inventors were members not of its medical division (*eiseibutai*), but rather of the division specialized in the development of new weapons. This was for example the case of Adachi Juku, who graduated in chemistry from the University of Tōkyō (1925) and enrolled in the Scientific Research Center (*rikugun kagaku kenkyujo*), then in the Technology Research Center (*rikugun gijutsu kenkyujo*) of the Army, where he supervised the production of new armaments.³¹⁾ After the war, the know-how acquired in this technology was transferred for civilian use, particularly to develop anesthesia apparatuses, inhalation equipments and incubators.

Consequently, the employment of university graduates and cooperation with public R&D centers enabled Japanese enterprises and organizations to engage in innovation related to core technologies, not only peripheral innovation. A good example is provided by X-ray tubes, the core technology in radiology, a field controlled by General Electric and a few small European companies. In Japan, patent statistics show that a total of 64 patents relating to this product had been registered by 1937, among which 17 by foreign companies (26.6%) and 18 by Tōkyō Electric but mentioning an American inventor (28.1%). Thus, patents for X-ray tubes mentioning a Japanese inventor amounted to only 29, that is, less than half of the total (45.3%). But their analysis emphasized a gradual technological empowerment. Until 1928, all the patents developed by Japanese engineers were registered by individuals. They focused mostly on the improvement of existing tubes, such as patent No. 44,286 on "the improvement of a Roentgen tube" (1922) registered by Ōkura Rinpei. The same year, Ōkura was granted two other patents (Nos. 43,032 and 45,255) for X-ray tubes using aluminum instead of tungsten as employed by General Electric. As for Miyata Shigetarō, he individually registered a patent in 1929 for "the improvement of a vacuum tube vent" (No. 77,251). Then the situation changed dramatically in the 1930s. Tōkyō Electric began to register patents developed

by its Japanese engineers in 1929. They amounted to a total of nine, against 11 for inventions made by American engineers. Other Japanese companies without foreign capital such as Shimadzu (1930) and Shibuya Roentgen (1937), began to register patents for X-ray tubes in the 1930s. Innovation was then carried out within big enterprises. It did not rely so much on foreign companies and focused more on core technologies.

The second feature of this period is the success of Tōkyō city, where the concentration of patents went on to reach 44.8% of the total, while the second-largest urban area of Kyōto–Ōsaka had a paltry 14.3% and the rest of the country followed in decline (22.3%). Thus, Tōkyō held more than half of all patents registered by Japanese nationals, the remainder being patents registered by foreigners (18.6%). What is more, the characteristics relating to Tōkyō observed during the previous period were still present. There was no concentration in specific areas of the city: for example, Hongō Ward had only 44 among 329 patents (13.4%). Also, these patents were mostly held by individuals: only 55 of Tōkyō's patents were registered by companies and institutions (16.7%), essentially by Shibaura (7), Gotō Fū-undō (6) and Yokokawa Electric (2). This was due to the fact that the biggest medical instruments firms were located outside the capital (Kawasaki for Tōkyō Electric and Kyōto for Shimadzu).

Thus, as observed in 1902-1925, individuals were by far the largest patent holders in Tōkyō (83.3%). The proportion of super-inventors was, however, stable. Among the 225 individuals mentioned in Tōkyō — who registered a total of 274 patents — 53 appeared more than once (23.6%) and 12 at least five times (5.8%). These top twelve inventors present a very diversified picture — much more so than during the previous period. Two had a total of nine patents. Ando, already the largest inventor during the previous period, essentially kept on developing military innovations (four out of his nine patents belonged to the Army: Nos. 88119, 89144, 90013 and 90017, all in 1930). As for Noishiki, he was an entrepreneur and a researcher, specializing in electro-medical equipment, who worked for several companies as a freelancer. His education background is unknown, but he registered two patents in 1927 for companies, a Japanese one (Asahi Denka Kōgyō, No. 74767) and an American one (Westinghouse Lamp Co., No. 72703). He also possessed his own research centre in the mid-1930s.³²⁾ The other persons present in this top 12 ranking can be classified in three categories.

First, there were three medical doctors. Tsutsumi Yōzō, graduated from Keiō University (1926) and a specialist in ENT, was especially engaged in the development of instruments for his field. He published several papers in the main journal of medical instrumentation in Japan, *Ika kikai gaku zasshi*.³³⁾ Inoue Kojirō was a dentist and became famous as a promoter for the manufacture in Japan of attachments for artificial teeth. He founded his own enterprise for this business under the name Inoue Attachment Ltd. As for Mori Hanbei, he graduated from the University of Tōkyō (1917) then served as director of a private hospital in Hongō Ward during the 1930s and 1940s.³⁴⁾

Second, two technicians or engineers were identified. Koizumi Kikuta's speciality was developing and manufacturing tubes for X-ray equipment. One of his first inventions was obviously bought by the German multinational Siemens, mentioned as the owner of his patent No. 72704 registered in 1927. After World War II, he founded his own enterprise, Koizumi X-Ray Kōsha (1946).³⁵⁾ The career of the second person, Yamakoshi Choshichi, is not known in detail, but he specialized in diagnostic equipment and published a paper in the journal *Ika kikai gaku zasshi* in 1933.

Third, four persons were not identified (Matsumoto, Shimizu, Taguchi and Utsumi). Their names do not

Table 3 Individuals located in Tōkyō with at least five patents, 1926–1937

Name	Location	Number of patents	Field
Andō Yasujirō	Ebara District	9	Instruments to measure skills and abilities
Noishiki Yoshinaga	Kojimachi Ward	9	Electro-medical machines
Tsutsumi Yōzō	Kamataku Ward	8	ENT instruments
Koizumi Kikuta	Shibuya Ward	8	X-ray equipment
Shimizu Kumakichi	Kanda Ward	8	Various medical instruments
Mori Hanbei	Hongō Ward	7	Various medical instruments
Inoue Kojirō	Koishikawa Ward	7	Artificial teeth
Taguchi Junzō	Yotsuya Ward	6	Artificial teeth
Utsumi Yodai	Kanda Ward	6	ENT instruments
Matsumoto Shigeru	Hongō Ward	5	Various medical instruments
Takahashi Yasutarō	Hongō Ward	5	Various medical instruments
Yamakoshi Choshichi	Shitaya Ward	5	Various medical instruments

Source: Industrial Property Digital Library, www.ipdl.inpit.go.jp (last access: 27 May 2013).

appear in most of the professional yearbooks of doctors and in enterprise censuses, which probably means they were artisans active in the very dense milieu of medical instrument makers in Tōkyō, providing tools and equipments for medical doctors and hospitals.

Beyond this apparently wide diversity of profiles, one key element must be underlined: the lack of a clear-cut boundary between professions and the integration of the medical world with the fields of industrial production and R&D. The necessity of working together to develop new instruments and technologies for medical practice was institutionalized in 1923 with the creation of the Japanese Society of Medical Instrumentation (*Nihon ika kikai gaku*), which brought together professionals from medicine and manufacturing.³⁶⁾ This association played a key role in the development of an independent medical instrument industry starting in the late 1920s, thanks to the promotion of new production methods (standardization, mass production) and the improvement of product quality. Besides, engineers and professional researchers tended to replace artisans. In all, a new kind of innovator emerged in this business, closer to market needs and to enterprises and involved in joint research.

Finally, an analysis of the kinds of objects on which R&D focused during this period brings out two points (see Table 1). At first, the two categories which experienced the highest growth were X-ray equipment (14.6%) and electro-medical machines (12.1%). These were new technologies and they transformed the true nature of the medical practice, changing it into a real business, and faced very high demand for this reason.³⁷⁾ Moreover, these technologies were largely controlled by enterprises — usually foreign MNEs. Enterprises indeed possessed nearly half of the patents in this field (46.9%), the main actors being Tōkyō Electric (36), Shimadzu (19), Siemens (8), Shibaura (6), Philips (6) and Westinghouse (5). Among them, only Shibaura was in Tōkyō city, which explains the low proportion of Tōkyō's patents in this field (37.2%). However, some small firms in Tōkyō were engaged in this business beside big medical business, producing parts or specializing in the assembly and the sale of X-ray equipment, various activities which led some of them to register some patents. This was for example the case of Shibuya Roentgen, founded in 1928 and close to the Hitachi group,³⁸⁾ which registered a patent in 1937, and of Dainihon Roentgen, in Ōsaka, which obtained one in 1935. Some medical doctors also engaged in R&D for such equipment, like Naogami Yasohachi, the director of a private hospital in Tōkyō and the holder of a patent registered in 1920 (No. 35745).³⁹⁾

Yet, these new technologies, even though they were growing fast, amounted to only about one-quarter of all patents in 1926-1937 (26.7%). Traditional medical instruments and equipment, which primarily relied on mechanical techniques, continued to account for the overwhelming majority of patenting. In this field, companies and foreigners were not very significant. This was the very special world of artisans, small entrepreneurs and medical doctors, mainly in Tōkyō city.

Conclusion

The analysis of Japanese patents on medical instruments and equipment between 1885 and 1937 sheds light on the coexistence of two main distinct ways of carrying out R&D. The first one is the traditional approach: artisans and mechanics involved in the making of instruments since the Edo period continued to develop some innovations for medical doctors despite the institutional change which came with the adoption of Western medicine. The technological base for this professional milieu — fine mechanics and metallurgy — allowed it to continue throughout World War II. However, a major geographical shift occurred in the early 20th century, with the gradual concentration of activities in Tōkyō city and the emergence of a real urban industrial district.

The second one was R&D carried out by big firms, especially foreign multinational enterprises. They established themselves as key actors in this industry from the 1920s onwards, but were not particularly clustered in Tōkyō. In reality, their organizational structure was due to a major technological innovation: the application of electricity to medicine. Indeed, big business was especially present in the field of X-ray equipment and electro-medical machines. Most of these firms relied on foreign technologies and had agreements with American (Tōkyō Electric) and German (Gotō Fū-undō) multinational enterprises. The technological empowerment of the Japanese medical instrument industry occurred after the period covered in this article: wartime and cooperation between companies, universities and the military authorities supported the improvement of the technical level of this industry and was a key driver of postwar growth. Yet the process of the acquisition of knowledge and technology by Japanese medical instrument makers is still unclear and will be the focus of further research.

Thus, a supporting industry for medicine emerged in Japan during 1885–1937. Using patents as a historical source makes it possible to highlight some key trends of this phenomenon. Yet they only give a partial view of far-reaching change in the health system and its transformation into a market, tackling the supply of new technologies to medical practitioners. Studying the changes in demand and the reaction of medical doctors to innovation also appears to be a key issue for further research. The joint research conducted from 1923 onwards by the Japanese Society of Medical Instrumentation had a direct impact on the standardization of instruments and equipments in the prewar years. The Society organized a special committee for the unification of standards in 1927, greatly facilitating the diffusion of the use of new medical technologies among medical doctors and the rapid adoption of new technologies.⁴⁰⁾ Big business also adopted marketing strategies to support the sale and use of its products, the best example being undoubtedly the school for X-ray technicians which Shimadzu opened in Kyoto in 1927.⁴¹⁾ The use of complementary sources, produced notably by the users of new technologies (medical doctors and hospitals), should help us arrive at a proper view of the structure of the Japanese medical market during the first third of the 20th century and help us improve our knowledge of medicine using a business history perspective.

Notes

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