FLU EPIDEMICS, KNOWLEDGE SHARING, AND INTELLECTUAL PROPERTY

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Maurice Cassier, CERMES3 (CNRS-INSERM-EHESS-U.PARIS DESCARTES)

Threats in the period 2005 to 2007of an H5N1 flue pandemic, and the spread in 2009 of the H1N1 pandemic, have contributed to the construction of a new field of debate concerning intellectual property and access to treatment. Discussions on the flue epidemics are now part of the new biopolicy that emerged at the end of the 1990s in the framework of health policies aimed at combating the Aids epidemic (Moatti et al, 2003, Cassier and Correa, 2009) and of conflicts over the appropriation of biological resources (Bellivier and Noiville, 2009). This biopolicy, aimed at safeguarding patients and populations, and at affirming their "right to heath" (cf. the Brazilian constitution of 1988) and " right to life" (Foucault, 1976) is promoted by an original alliance of certain activist states in the field of health – such as Brazil–, NGOs engaged in campaigns for access to treatment, and generics laboratories such as the FarManguinhos Federal Laboratory in Brazil and the Cipla laboratory in India. In North America and Europe, the conflict over patents and breast cancer genes, from 1995 to 2008, is also emblematic of this biopolicy of access to treatment (Cassier, 2007).

Since 2005, an interesting aspect of the avian flu threat is that it has amalgamated several debates concerning the ownership and accessibility of science, life forms, and drugs. Four events have transpired: first, in the autumn of 2005, there was a clash over Roche's patented molecule, Tamiflu, and the generic copies that the Indian laboratory Cipla wanted to produce. Second, tensions surfaced over the restrictions imposed on the rapid circulation of virus sequencing data between laboratories, resulting in August 2006 in the creation of an international consortium for "data sharing". Third, a conflict broke out in 2007 between Indonesia and the WHO surveillance network over whether sovereign states should withhold virus strains that were identified and isolated in their territories. Finally, debates erupted over the proliferation of the sequences of the H5N1 virus and their impact on the development and accessibility of health technologies – a proliferation that worried the WHO to the point of it commissioning a report on this issue in November 2007 (Life Sciences Program, WIPO, 2007). There is moreover an abundance of reports on intellectual property and avian flu (US Congress, 2005, Third World Network, 2007).

The threat of a flu pandemic in autumn 2005 and the spread of the H1N1 flue epidemic in 2009 has intensified these debates over intellectual property and access to treatment. Influenza pandemics provoke great concern because they can spread suddenly and rapidly, afflicting rich and poor countries alike throughout the world, and the virus's circulation and variations must be monitored in real time to develop new vaccines. The urgency of the situation also demands the rapid availability of antiviral drugs to be administered from the first symptoms (Ferguson, 2005). Concerns about intellectual property and access to treatment have not always been of central importance. In the 1960s, Louis Galambos and Jane Eliott Sewell, investigating Merck's research on influenza, describe a relatively open, cooperative system of knowledge exchange in the characterization of new type B viral strains and vaccine development (Galambos, Sewell, 1995). As Galambos and Sewell observe,

> Although less severe than type A influenza, the new strains of type B stirred up a great deal of cooperative effort in several corners of the of the virology network. Scientists and production workers throughout the industry, universities and various government agencies in America and abroad worked to produce a vaccine of a new composition.

Nor was intellectual property or access to treatment of concern in the 1970s Swine Flu Affair, described and analysed in the Neustadt and Fineberg Report (US Department of Health, 1978). The question of industrial secrecy in vaccine preparation technologies was noted by the authors of the report when it hindered their inquiry: "Other manufactury impediments slowed some production labs, how much is hard to tell. Each company vaccine is somewhat different from the others. Their products must meet the same FDA standards, but their processes are private. Taken as a whole, we know that their production rates fell below Sencer's (hence Cooper's) early expectations. Just how much and why is obscured by the privacy" (Nesutadt and Fineberg, p 42). The impact of this secrecy on the circulation of technologies between firms, and the rapidity of the scaling up of vaccine production, is not identified by the authors as a problem. That controversy centred on question of responsibility and guarantees that firms sought from the state to cover risks concerning vaccines. A cooperative and open system of knowledge sharing in the past contrasts sharply with today's more proprietary atmosphere, saturated with patents and material transfer agreements.

This sudden proliferation of debates about intellectual property and avian flu may be a result of the new context created by the AIDS epidemic, which put drug patents and generics at the centre of public and political discourse in the early 2000s: complaint lodged in May

2000 by the United States at the WTO, against Brazil for threatening to suspend patents if the patented invention was not produced locally within three years; lawsuit in South Africa in March 2001, filed by 39 international pharmaceutical firms against the SA government for its new law on medication; Doha Declaration of November 2001 on intellectual property and public health.

Generally, these debates are seen to participate in the emergence of a new governance of the health and drug economy, involving the pharmaceutical and scientific laboratories of the North, the generic drug-producing laboratories of the south, countries claiming sovereign rights over their biological resources, and the NGOs campaigning for access to treatment[1]. For example, the AIDS patient organization Act Up has joined an NGO in Burkina Faso to demand access to Tamiflu generics. The French trade union, the CFDT, has denounced the asymmetry between industrialized countries and poor countries regarding access to antivirals[2]. The Indian generics laboratory Cipla has intervened in both industrial and public domains to defend the possibility of producing generics of flu antivirals.

These controversies over the appropriation of virus strains, genetic sequences, and antiviral drugs and vaccines have been accompanied by various proposals and plans concerning intellectual property and the circulation of knowledge and biological entities. For example, inspired by the open source model, the GISEAD consortium has defined a license for access to genetic data, so as to avoid any restrictions on the circulation of data (Nature, august 2006). The WHO report on patents on the H5N1 virus has proposed the creation of patent pools to avoid situations of lock-in of the technologies needed to develop vaccines. Patent pooling enables any potential inventor to have access to all useful technologies in the development of a new vaccine (WIPO-WHO, 2007). The WHO is seeking to develop solutions that can reconcile virus-sharing with benefit-sharing for equitable access to vaccines[3]. Exploring in detail diverse aspects of these controversies, this essay argues that the threat of an avian flu pandemic has been a laboratory for designing and testing new solutions to conflicts over intellectual property rights and the rights of access to treatment. Defining models of circulation and appropriation of knowledge and technologies pertaining to flu remains a critically important aspect of health policies during pandemics.

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[1] "Des associations demandent que le Tamiflu devienne un générique", *Le Monde*, 23-24 October 2005. ("NGOs demand Tamiflu generic")

[2] "This raises the question of the patent and this antiviral's patent rights. Are we going to agree to leave people to die because a firm has the exclusive right to a drug and blocks the production of generics?", CFDT, October 2005.

[3] "Pandemic Influenza Preparedness: Sharing on influenza viruses and access to vaccine and other benefits", WHO, 20 March 2008.

1- Patents and generics: the Tamiflu patent controversy (October 2005 –October 2009)

In the autumn of 2005, after the WHO recommended stockpiling antiviral medicines in all countries[4], debate focused on Roche's legal monopoly on Tamiflu[5] and on the production of generic drugs, especially in India, Thailand, and Taiwan. While the Indian laboratory, Cipla, announced that it had synthesized the molecule in vitro and would manufacture it, Roche reasserted its legal and technological monopoly over Tamiflu. The battle over the rights to Tamiflu thus erupted on several fronts: production capacities and the available supply of drugs in case of a pandemic; the complexity of the manufacturing technology required to produce Tamiflu; the accessibility of the raw materials needed to produce the drug; and, finally, the respect for property rights and for patients' right to live.

The confrontation first surfaced with India's new intellectual property law, which recognized patents on pharmaceutical products from 2005 only. At the end of 2005, Cipla announced that copying Tamiflu was entirely legal, since no patent on the molecule had yet been issued in India. According to the company's managing director, Yusuf K. Hamied, "Since the currently available drugs to treat avian flu have not been granted patents in India, nobody can stop any generic manufacturer from producing it in the country."[6] The generic drug laboratory therefore used the absence of an Indian patent to practice reverse engineering and to launch its industrial production of the drug. Hamied continued, "So legally as of today I can produce the drug in India. Until the patent is granted..."[7] Roche reacted immediately, pointing out that a patent application had already been filed in India.[8] Cipla and Ranbaxy responded by requesting a non-exclusive licence from Roche, but to no avail. In February 2006, the Drug Controller General authorized Cipla to commercialize a generic version of Tamiflu, thus confirming the legality of generic drug production. "Roche," the authority maintained, "does not have a product patent in India and the international patent is not enough

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[4] "Responding to the avian influenza pandemic threat. Recommanded strategic actions", WHO/CSD/CSR/GIP/2005. 8, May 2005.

[5] More precisely, the Tamiflu patent is the property of a US biopharmaceutical laboratory Gilead which sold the rights on the molecule to Roche in 1996. In June 2005 Gilead tried to breach the licence contract with Roche, which it accused of not being engaged enough in the molecule's commercialization.

[6] Yusuf K. Hamied, managing director, *Business Standard*, December 9, 2005.

[7] "The Indian pharmaceutical company Cipla is first in line to make generic Tamiflu, but India's officials gesture despair at flu threat", *Global Forum for Health Research*, 21 October 2005.

[8] *Indian Express*, 26 October 2005.

according to Indian patent laws. The companies can manufacture generic versions of the drug medicine by filing a licensing application with the government"[9].

In May 2006, while the Gilead patent application was still pending, Cipla and another generics laboratory, Meditab Specialities, filed a complaint against the Tamiflu patent with the New Delhi Patent Office. The complaint insisted that there existed a "prior art" on the molecule before the patent application. The General Controller of Patents in Delhi approved this opposition and dismissed the patent application[10]. The Indian generics firms were thus engaged on three fronts: on the technological front, by conducting reverse engineering on Tamiflu; on the commercial front, by demanding authorization to commercialize in India; and on the legal front, by opposing Roche's patent application on Tamiflu in India and calling for its rejection.

Roche's legal monopoly was simultaneously strongly challenged because the company lacked the industrial capacity to meet global demand during a pandemic. In the autumn of 2005, the UN Secretary General suggested that the Tamiflu patent should reflect greater flexibility during the context of a pandemic threat. One American Democratic Senator, Charles Schumer, wrote to Roche asking the firm "to compromise on its patent rights for the sake of public health"[11]. States and international non-governmental organizations (NGOs) campaigning for greater access to medicines recommended the production of generic drugs. In situations where necessary, a compulsory licence would allow the drug's production without the patent owner's authorization.[12] At the time, the Indian government approached generic drug firms to explore the possibility of producing generics "essentially for stockpiling" under necessary circumstances with the patent owner's authorization[13].

After insisting that it be Tamiflu's sole producer[14], Roche envisaged granting licences on its patent to a network of manufacturers of its choosing[15], but it refused any proposals of compulsory licensing and generic drug production. In early 2006, the firm revealed the scope and organization of its global network of licensees, which would include several Roche's sites and more than 15 external contractors located in 9 different countries around the world : "These partners have been selected primarily on the basis of their ability to produce

[9] "No Roche patent here, India Inc can produce bird flu drug" Indian Express, 26 October 2005.
[10] Decision dated 23 March 2009, Patent Office of Delhi, 44 pages.
[11] *IP Watch*, 25 October 2005.
[12] « Des associations demandent que le Tamiflu devienne un générique » ("NGOs call for a Tamiflu generic"), *Le Monde*, 23-24 October 2005.
[13] "Indian industry pushing for compulsory licences for Tamiflu", *Intellectual Property Watch*, 25 October 2005.
[14] "The company fully intends to remain the sole manufacturer of Tamiflu, together with our partners", *The New York Times*, 14 October 2005.
[15] Roche, Basel, 16 March 2006, Media release.

substantial quantities of intermediates and finished materials in accordance with Roche's quality standards in a relatively short time frame" (Basel, 16 march 2006).

Roche thus extended the capacity to produce the drug, while retaining control over production standards and maintaining intact its ownership of the remedy. Its control over the network was based on property rights and justified by the licensees' quality standards and industrial capacity. This organization of production made it possible to increase the production of Tamiflu while limiting the emergence of generics. In December 2005, in the context of its duel with Cipla, Roche granted a licence to an Indian producer, Hetero Drugs. To reduce the price of the drug and increase its accessibility, Gilead, the owner of the patent, announced that it would not demand the same royalties on Tamiflu that it required from its sub-licensees.

NGOs, economists, and jurists nevertheless criticized Roche's sub-licensing policy on several grounds. The Third World Network, for instance, disclosed that these sub-licensing agreements contained restrictive clauses that would prevent widespread circulation of generic drugs. They would allow production solely for domestic use and for governments stockpiling, but allowed Roche to maintain its control over the most lucrative markets. Moreover, the agreements would only permit the highly limited transfer of the manufacturing technology[16].

The Third World Network recommended an alternative solution to the problem of drug access: compulsory licences that allowed for the development of a generic drug supply for countries' domestic needs and for export in circumstances where importing countries also possessed a compulsory import licence. Economist and jurist Carlos Correa advocated a similar solution, in which Roche's patent rights would be suspended in the event of a pandemic threat. "What will happen if there is a human flu pandemic?" he queried. "The rational response would be to produce and provide the drug – if proven effective – independently of the patent situation"[17]. Both the Doha Declaration of November 2005 and Article 31 of the Trade Related Intellectual Property Agreements (TRIPS) had codified this solution of lifting exclusive patent rights during of a sanitary emergency.

Opponents of the compulsory licence, however, insisted that this solution would discourage new pharmaceutical research. As Alec Van Gelder, a research fellow specializing in technology issues at the International Policy Network in London : "if governments break the patent on Tamiflu, no pharmaceutical company is going to want to develop a new antiviral for fear that their expensively developed innovative medicine will simply be stolen without

[16] The Swiss giant retorted that it had granted other companies rights on some of the ten stages of the Tamiflu production process, but that it was not prepared to give up its patent nor grant the entire manufacturing process to a third party (*La Tribune*, 12 October 2005).

[17] *Bulletin of the World Health Organization*, Volume 84, Number 5, May 2006, p 349-350.

adequate compensation for the ten or hundreds of millions of dollars invested"[18]. The Indian generic drug producer Cipla responded with a public campaign, posing the question "What interest is there in developing drugs which can save lives if the patients can't obtain them?"

Roche not only defended its monopoly by seeking to protect its property rights, but shifted the terms of public debate, observing that the major barrier to expanded Tamiflu production was not patent rights at all, but technological capacity. According to one Roche manager, "For us, the problem is not the patent but the capacity for Tamiflu production. We have ten years experience and we would like to be consulted as this is a long, complex process"[19].

Yet this barrier was not as insurmountable as Roche had claimed. Since the 1970s, generics laboratories had built up sound technological experience that permitted them to copy molecules as complex as ARVs. Recognizing the complexity of duplicating Tamiflu, Cipla highlighted its symmetrical experience in copying complex molecules such as ARVs. As Yusuf Hamied acknowledged, "It's not an easy synthesis, but our company is used to manufacturing difficult things… One of the steps in zidovudine for example uses sodium azide, and that's the step that Roche said was dangerous and hazardous. We've been doing it for the last 14 years. It's all chemistry"[20]. Cipla could reuse a synthesis technology to produce zidovudine for Tamiflu's manufacture, and in the autumn of 2005, the company announced that it had successfully developed a generic that was significantly less expensive version of Tamiflu. It added, "Once the lab work is done, things don't take too long. We are in the process of scaling up and commercializing. That should be completed next month." The following February (2006), Cipla delivered its first 100,000 dose batch of Tamiflu. At least one other laboratory followed suit, with the October 2005 announcement by a Taiwanese laboratory that it had also mastered the Tamiflu production technology[21].

Roche tried to lob another argument about barriers to generic production: the bottleneck in the procurement of the raw material for Tamiflu manufacture. The crucial material was shikimic acid, found in star aniseed, a plant which grows only in certain parts of China.[22] In October 2005 the threat of an avian influenza pandemic caused the price of this material to skyrocket from $40 to $1,000. This situation revived interest in alternative

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[18] Alec Van Gelder "H5N1 Hysteria : Patent Nonsense on Avian Flu", *International Herald Tribune*, 1 November 2005.
[19] "Countries seek to bypass Tamiflu patent", *Swissinfo*, 26 October 2006.
[20] Yusuf K Hamied, *Global Forum for Health Research*, 21 October 2005.
[21] Taiwan Info, site of the Ministry of Information, Republic of China.
[22] Alec Van Gelder "H5N1 Hysteria : Patent Nonsense on Avian Flu, *International Herald Tribune*, 1 November 2005.

production technologies. At first Roche approached Michigan University, which had patented a technology to obtain shikimic acid from recombinant bacteria (patent filed with the USPTO in 1999). The inventor of this synthetic method, Professor Frost, believed that shikimic acid was not an obstacle: "The bottelneck should not be shikimic acid availability" (Essential Drugs, 28 February 2006). Roche exploited the fermentation technology and paid royalties to Michigan University. Then, in February 2006, a group of researchers from Tokyo University patented an artificial synthesis method that seemed more productive. Roche entered into negotiations with the Japanese university to acquire the new technology.

To overcome problems pertaining to the price and procurement of shikimic acid, the generics laboratories also had the possibility of using an alternative raw material. Ranbaxy[23], for instance, used a different intermediate, quinic acid, to manufacture the Tamiflu molecule. It claimed that it had negotiated procurement contracts for adequate supplies of this ingredient and of shikimic acid.

Cipla asked Roche to divulge its process for humanitarian reasons. Hamied opined, "My suggestion is that if Roche wants to make a humanitarian gesture, let it publish its manufacturing process openly. Whoever uses Roche's process should pay it a 4% royalty on net sales. Countries have to put pressure on them. The Tamiflu issue shows that the destiny of a country or of the world cannot rest in the hands of one company or one inventor"[24].

This controversy developing around the production of Tamiflu generics was part of the emergence of a new pharmaceutical economy, one that implicated several actors who sometimes worked in concert: global South generics labs that could learn and reproduce complex molecules, governments, international institutions, NGOs defending universal access to treatments. The vanguard of the old economy, proprietary laboratories, sought to navigate the new one by seeking to protect their exclusive rights and responding to pressures for wider access to drugs. The spectre of debates over access to antiretroviral drugs in the AIDS epidemic was clear to all participants. The UN Secretary General, for instance, explicitly indicated of the Tamiflu generic drug debates, "I wouldn't want to hear the kind of debate we got into when it came to the HIV anti-retrovirals"[25]. NGOs such as Médecins Sans Frontiers (MSF) and Act Up, which had campaigned for broad access to treatment in the AIDS

[23] Thus, in the autumn of 2005, Ranbaxy, one of India's main generics firms, developed a production line for a generic Tamiflu: "Ranbaxy Laboratories Ltd. said it was ready to provide oseltamivir phosphate capsules, a treatment for Avian influenza, to the US healthcare system if asked by Washington or Roche, the innovator. The company has a current capacity to produce 300 million capsules (75 mg doses) which would be scaled up to 1.3 billion capsules a year" (*The Financial Express*, **New Delhi, December 2, 2005)**.

[24] Yusuf K Hamied, "We will oppose the patent for Tamiflu", *Business World*, 20 October 2005.
[25] San Francisco *Chronicle*, 13 October 2005.

epidemic, perceived a direct linkage between the AIDS and potential avian flu epidemics when it advocated the production of Tamiflu generics. A joint petition by Act Up and a Burkina Faso network for access to essential drugs read in part, "For the African countries, which have been unable to stockpile Tamiflu, which can already see migrating birds arriving from contaminated regions of the world, and which have the highest HIV-prevalence rates, there is no more time to lose: Roche must immediately authorize and facilitate the unconditional launching of a generic production of Tamiflu"[26]. Older alliances that had solidified in the AIDS epidemic were mobilized with the threat of an avian flu pandemic. The Indian generic drug laboratory Cipla and MSF had been key partners in the campaign for generic ARVs, and they collaborated to launch the campaign for Tamiflu generics.

Proposals to apply compulsory licensing on Tamiflu came not only from these alliances, but from states themselves. In November 2005 a report prepared for the US Congress envisaged the same solution on the grounds that

> Voluntary licenses between Roche and generic drug manufacturers could help to increase production of Tamiflu to satisfy global demand. Compulsory licenses are also a possibility if Roche's sublicensing efforts fail to adequately expand production, or if poorer countries determine they cannot afford Roche's licensing fees[27].

2- An international consortium for the sharing of genetic data (August 2006 –)

Debates on the appropriation of knowledge and technologies also appeared far upstream from the drug economy, in the economy of science, among the laboratories engaged in deciphering the H5NI virus genome. Academic scientists undertook to reopen open science as soon as they encountered restrictions in the circulation of data.

Nature's (August 2006) publication of the "Global Initiative on Sharing Avian Flu Data" (GISAID) embraced a similar objective to that of the Human Genome Project consortium: to expand the public domain of science, since the threat of a flu pandemic and the concomitant need to accelerate genetic research reinforced the exigencies of freely circulating data. According to the GISAID, "The current level of collection and sharing of data is inadequate, however, given the magnitude of the threat. We propose to expand and

[26] *Le Monde*, 23-24 October 2005.
[27] "Influenza Antiviral Drugs and Patent Law Issues", *CRS Report for Congress*, Brian T Yeh, Legislative Attorney, American Law Division, p 1-12, November 18, 2005.

complement existing efforts with the creation of a global consortium"[28] The pooling of a large collection of virus strains and the rapid circulation of genetic and clinical data were essential to both research on the H5N1 virus's genetic evolution and the timely development of prophylactic treatments. The Gisaid consortium's rhetoric explicitly linked the data access to the interests of public health: "Timely development of vaccines, diagnostics and therapeutics depends on the availability of information. Such information is important for global health security"[29].

The first aim of this "world" consortium was to broaden access to sequencing data that until then had circulated within the WHO surveillance network, criticized by some researchers and biotechnology firms as too limited and compartmentalized. In March 2006, for instance, the biotechnology firm, Recombinomics, complained of excessively restricted access to this WHO database, which was "limited to 15 laboratories"[30]. At roughly the same time, an Italian virologist, Ilaria Capua, decided to put data into the GenBank public database, rather than publishing them on the WHO Influenza Sequence Database site. The virologist's initiative gathered momentum, and several countries and international agencies began sharing their avian influenza virus data more freely. On August 22, 2006, the FAO network on avian influenza (OFFLU) reiterated its objectives of exchanging scientific data and biological material, including virus strains from various countries. That same day, researchers from the U.S. Centers for Disease Control (CDC) put data on 650 flu virus genes into Genbank. And just two days later, 70 researchers, six of whom were Nobel Prize laureates, published a letter in *Nature* announcing the creation of the GISAID consortium.

The GISEAD consortium was to promote the principles of data sharing, teamwork and collaborative publication. The signatories of the founding letter justified their actions by invoking rules previously established by the International HAPMAP consortium[31], which they described as "a project to map, and make freely available, data on DNA sequence variations

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[28] *Nature*, 981, August 2006.
[29] Gisaid Epiflu Database Access Agreement, 2008.
[30] "Recombinomics identifies American Sequences in the H5N1 Virus", *PR Newswire*, March 2006.
[31] The HapMap – Haplotypes Map – is a catalogue of common genetic variants that occur in human beings. The HapMap consortium groups together the world's main centres of genome research: the US, the UK, Canada, Japan and China. Its policy for data dissemination is inspired by open source licences and is opposed to any patent that could limit free access to data produced by the consortium: "The participants in the Project believe that patents should not be issued for a SNP or haplotype for which a 'specific utility' – as defined in patent law – has not been generated. However, if a specific utility can be demonstrated for a SNP or haplotype, any group, whether associated with the Project or not, should be able to apply for a patent, as long as this action does not prevent others from obtaining access to data from the Project", International HapMap Project, Data Release Policy.

in the human genome"[32]. Data had to be put into the public domain at the latest six months after validation – an interval that would be reduced as the consortium became more experienced. Any registered user could gain access to the consortium's data, but only if that user agreed

> "to share and to credit the use of others' data, to analyze findings jointly, publish results collaboratively, and not to assert intellectual property rights against each other over technology derived from the data. Such common access will allow the technology to be used both for research and rapid development of products such as diagnostic, antiviral drugs and vaccines."[33]

These regulations have tended not only to place genetic data in the public domain, but also to put research tools into a sort of technology pool accessible to all consortium members. Research tools derived from the database could be covered by patents, but these would not apply to members of the consortium. The owners of such property rights could however exploit them outside of the circle of the consortium's authorized users. The consortium itself had no patents.

The consortium effectively came into existence in early 2008, and an access licence to its database has been available since May of that year. This licence first defines the databases containing the virus sequences, their annotations, health security information pertaining to the use of these data, and the regulatory authorizations of vaccines and therapies derived from the consortium's data. It then specifies the scope of users' rights and the nature of their obligations. All the data collected by GISAID are accessible to the community of authorized users and contributors. Licensees are "granted a non-exclusive, worldwide, royalty-free, non-transferable and revocable license to access and use the GISAID Epiflu Database"; they can use, amend, and distribute these data, including for commercial use[34]. In return, they agree to grant GISAID "a non-exclusive, world wide, royalty-free, transferable, and irrevocable license to collect, store, reproduce, access, modify, display and distribute and otherwise use the data submitted by You " (as provider). The data supplier has to agree to the sequences that it contributes to the consortium being placed in the public domain: "You acknowledge that such sequences shall be freely accessible through said publicly funded database". "Authorized Users" are the both data suppliers and users who are signatories of the access licence. On the subject of intellectual property, GISAID users agree not to exercise rights that may restrict the

[32] "A global initiative on sharing avian flu data", *Nature*, 31 August 2006.
[33] GISAID, 19 February 2007.
[34] GISAID EPIFLU Database Access Agreement.

use of the data by other authorized GISAID users. Any data that they have contributed can be used by other authorized users to develop vaccines, diagnoses or drugs. Although an authorized user is free to impose restrictions on non-members for the use of data that it put into GISAID, it may not prevent them from joining GISAID, thus becoming authorized users: "You understand the GISAID and Authorized Users intend to use the Data Provided by You, for research purposes and/or for the development, testing and dissemination of interventions such as vaccines, diagnostics and therapeutics".

To what extent is this sharing of data compatible with patents on viruses and on their gene sequences? The access licence published by the consortium in May 2008 does not proscribe them; it nevertheless specifies that signatories of the licence should not exercise rights that limit the access and use rights of other users, who have the right to use data provided by any supplier, including for the development of vaccines, diagnostics and drugs. It is therefore not authorized to exercise an exclusive property right on data contributed to the consortium, against another user who has signed the access license. Moreover, the consortium's code of conduct stipulates that "all participants in GISAID accordingly agree to respect proprietary rights but voluntarily set them aside for others who have agreed to share them in the same way. We view this equitable sharing as an important safeguard for global public health"[35]. The consortium's position seems to be extremely unfavourable to virus patenting. According to GISAID,

> "influenza viruses have not been subject to intellectual property rights historically. This tradition has been important because the required changes in influenza viruses contained in human influenza virus vaccines to match those viruses circulating currently in the field must occur at a speed far in excess of the legal process associated with the attainment of commercial protection" (Frequently Asked Questions, GISAID, 2008).

Apart from the difficulty of patenting eminently variable objects, a convention does exist in the biomedical community on the non-patentability of viruses, because it remains in the interests of the broader public health: "In order to allow rapid development of products such as vaccines and other interventions on an equitable basis by all countries and other interested parties, the convention has been for human health professionals to share virus specimens and data openly without creating barriers of exclusivity such as the filing of patents" (FAQ, Gisaid, 2008). But even prior to the consortium's creation, from 2004, patents

[35] "Frequently Asked Questions", GISAID, 2008.

on sequences of the H5N1 virus proliferated. The WHO consequently commissioned a report which recommended, *inter alia*, the creation of patent pools to avoid situations of lock-in[36].

Finally, one GISAID consortium objective was to encourage cooperation between industrialized countries and developing countries, disproportionately affected by avian flu. Among its intentions were "to draw international attention to the necessity to increase funding and technical assistance for affected countries, and to set up surveillance programmes".[37] Indonesian, Chinese, Vietnamese and Thai scientists were signatories of the GISAID agreement, and the Indonesian government originally supported efforts to pool data and biological material.[38] But in late 2006 a crisis erupted when the Indonesian government withheld virus strains isolated on its territory, from the WHO Global Influenza Surveillance network. Indonesia nevertheless agreed to participate in the new international GISAID consortium[39] whose data management principles, inspired by open-source licences, were designed to prevent any opportunistic appropriation of common data. With the Gisaid database it was possible to identify the contributors and users of virus strains: public laboratories, pharmaceutical firms, and universities. Gisaid also included a licence requiring the users of viral strains to request the supplier's authorization before filing a patent on a vaccine. The consortium furthermore urged scientists to collaborate with national laboratories that provided information on the virus. An Indian scientist, Nirmal Kumar Ganguly, former Director General of the Indian Council of Medical Research, recommended the WHO's involvement: "I think WHO should consider supporting this platform" (AP, 16 May 2008).

The Gisaid EPIFLU database, hosted by the Swiss Institute of Bioinformatics, a private firm, was launched in May 2008, simultaneously with the disclosure of the access licence to the consortium's data. It became a reference research tool for the scientific community and the WHO[40]. In April 2009 the sequencing data of the H1N1 virus were put into the Gisaid and WHO databases: "I would like to point out that full genome sequences of Mexican viruses have been available in the public domain at the GISAID database http://www.gisaid.org since April 24, 2009. Sequences were posted in the public domain as soon as they were completed and curated. The availability of sequences at GISAID was also posted at the WHO website" (Ruben Donis, CDC, 4 May 2009). The Gisaid consortium announced: "The GISAID platform offers a comprehensive collection of the

[36] "Patent issues related to influenza viruses and its genes", working paper, WHO, November 2007, 41 pages.
[37] *Nature*, 31 August 2006.
[38] *Nature*, 24 August 2006: "Bird Flu Data Liberated".
[39] "Indonesia agrees to hand bird flu information to new online database" (Associated Press, 16 May 2008).
[40] Max Planck Institute for Informatics, The Recent Outbreak of the Novel H1N1 Influenza: MPII Provides the Portal for Accessing the Relevant Viral Sequence Data, 28 April 2009.

sequence of the A/H1N1 pandemic flu strain (swine lineage) together with latest news, discussion and scientific contributions on the subject" (GISAID website). Ironically, in July 2009, as swine flue was spreading, conflict broke out between Gisaid and the Swiss bioinformatics firm SIB, which Gisaid accused of misappropriation[41]. While the data base remained accessible for users on the private firm's website, it was no longer available on the consortium's site. In August 2009 Gisaid sued SIB in the US and Geneva to obtain the reopening of its Internet link. The consortium eventually shifted its database to the Max Planck Institute for Informatics[42].

3- Virus sharing and benefit sharing: the clash with Indonesia (2006 – 2007)

Research on the H5N1 virus opened a third front in the intellectual property field: states' sovereignty on viral strains isolated on their territories, and equitable agreements of the "virus against treatment" type, for the benefit of countries that provided strains. At the beginning of 2006, Indonesia decided to suspend the payment of virus strains isolated on its territory. The Indonesian government, subsequently joined by Thailand, justified its action on two grounds: first, strains freely provided to the WHO surveillance network by South-East Asian countries had been patented by research centres affiliated to the WHO network without the consent of the countries of origin; and second, the vaccines and antiviral medications remained inaccessible for countries of the South, even though they had been developed from virus strains isolated in poor countries, for instance from Vietnam. A Thai government representative, Suwit Wibulpolprasert, maintained that virus sharing needed to be premised on full and equal access to vaccines and treatments. "We are not opposing the sharing of information and viruses," this official asserted, "but on the condition that every country have the equal opportunity to get access to vaccine and antivirals if a pandemic occurs".[43]

This decision to suspend contributions of virus strains to the WHO surveillance network was strongly criticized by the US Secretary of State for Health who denounced any measure to retain viruses, and by the scientists attached to the international system of sharing virus strains: "Controversy about H5N1 virus sharing has worried global health officials and researchers. Some have voiced the concern that countries might claim their H5N1 samples are protected under intellectual property laws, which could hamper the monitoring of genetic

[41] "GISAID Launches Second Influenza Database" by GISAID Foundation. Dated 14 September 2009.
[42] Flu database row escalates - September 14, 2009, Declan Butler, *Nature*.
[43] CIDRAP, 6 February 2007.

mutations, the development of therapeutics products, and scientific work on a host of their pathogens". For about 50 years, M.McKenna of CIDRAP's NEWS observed, "the system has operated on goodwill with its costs borne by the WHO membership and no compensation offered for viral contributions".[44] Claiming ownership of virus strains would effectively slow down the process of vaccine development and would raise the price of vaccines, lamented biologist Doris Bucher of the New York Medical College[45]. Indonesia was accused of reuining the system of free sharing of data: "In December Indonesia broke a long tradition of free international sharing of flu virus specimens by withholding its H5N1 samples as a protest against the high cost of commercial vaccines derived from such samples"[46]. The US Secretary of State also criticized the withholding of influenza viruses from the global surveillance network, arguing that this action “greatly threatens global public health and is inconsistent with the spirit of legal obligations we have all agreed to undertake through our adherence to the international Heath Regulations".[47] And some worried that “countries might claim their H5N1 samples are protected under intellectual property laws, which could hamper the monitoring of genetic mutations, the development of therapeutic products, and scientific work on a host of other pathogens," thus damaging both public health and science.[48]

In view of Indonesia's claims of inequity, some WHO experts recognized the need to change the terms of the exchange, and "to balance the sharing of viruses through global surveillance and...to make the access to vaccines and those sorts of technology broadly available."[49] In early 2007, the WHO General Assembly began discussions of these concerns. But by May of that year, tensions heightened when over 20 countries threatened to withhold virus strains isolated on their territories on the grounds that the 1992 Rio convention on biological diversity had given states the rights to genetic resources in their territories. These countries called for the renegotiation of the virus sharing system, in which their contribution of viruses to the WHO network would be compensated by a significant increase in research investments in developing countries, and a guarantee of "fair and equitable vaccine distribution". Indonesia advocated for the right of countries of origin to decide if their virus strains could be given to pharmaceutical companies, and many of its counterparts in the global south petitioned to develop their own manufacturing capacity of vaccines. In February 2007, WHO spokesperson David Heymann reported on the negotiations engaged in with the

[44] CIDRAP, 6 february 2007.
[45] Center for Infectious Disease Research and Policy, 19 June 2007.
[46] CIDRAP NEWS - Center for Infectious Disease Research & Policy, 1 August 2007.
[47] (CIDRAP, 23 May 2007).
[48] CIDRAP, 1 August 2007.
[49] Dr KK. Fukuda, WHO, June 2007, Center for Infectious Disease Research and Policy.

Indonesian Health Ministry: "At the same time, we're working with industries in Indonesia to develop local vaccine product capacity through technology transfer" (Reuters, 16 February 2007).

Faced with the threat of effective mutiny, the WHO took two measures that acknowledged but did not entirely concede to these countries' grievances. First, it announced a more transparent monitoring of viruses through the WHO Global Influenza Surveillance Network. The WHO resolution in May 2007 specified that vaccine manufacturers would have free and total access to viruses during a public health crisis, whereas Indonesia "had proposed that the WHO supply H5N1 virus samples to vaccine manufacturers only with the consent of the source country" (CIDRAP News, May 23). US Secretary of State Mike Leawitt was very pleased "that member states must continue to share flu viruses with the agency's flu surveillance network" (CIDRAP news, Mays 23, 2007)

Second, it established an international stock of vaccines for the H5N1 virus or any other pandemic virus and adopted rules for the equitable distribution of these vaccines during a pandemic; but did not permit, as some countries of the global south had proposed, the development of individual country vaccine stockpiles[50] and their own manufacturing capacity.

Indonesia had indeed been jockeying to acquire the vaccine production technology, something that the WHO had months earlier explicitly recommended.[51] Indonesia ultimately developed a partnership with the vaccine producer Baxter International, offering its virus samples in exchange for vaccine development technologies (CIDRAP, 23 May 2007). This non-exclusive partnership agreement was non-exclusive, and thus did not prohibit Indonesia from sharing its virus samples with other parties. Egypt subsequently petitioned the WHO to guarantee the transfer of vaccine technologies to developing countries.

This episode with Indonesia and other countries of the global South propelled to the fore questions about technology sharing and equal access to treatment, by revealing profound asymmetries in a system of sharing biological materials, particularly when capacities for vaccine research and production are unevenly distributed and when legal monopolies on the medical products and technologies are derived from these biological materials. The system is rife with contradiction: Virus strains are freely donated and circulated and they exist as public goods, while at the same time, certain agents (pharmaceutical companies, for instance)

[50] "Developing countries …would like to have their own stockpiles, or would like to have some benefits from the viruses that they have given, seeing that there is not great access to vaccines in the world", Heymann said, CIDRAP, 23 May 2007).

[51] "Avian and pandemic Influenza. Best practice for sharing influenza viruses and sequence data » WHO, 22 March 2007.

retain exclusive rights on the medical technologies based on these freely circulating virus strains (Chan and de Wildt, 2007). Various institutions and networks have sought to address these disparities. In August 2007, for instance, the WHO published a declaration on "the sharing of flu viruses and access to vaccines, and other advantages," and it spearheaded discussions to devise the means for sharing benefits, in which participants articulated principles of pooling strains and sequencing data and generated initiatives for sharing technologies and medical products. The GISAID consortium also attempted to tackle these questions, by prescribing shared access to inventions derived from the data that it collected and produced (members of the consortium may not assert IP rights against one another). But these measures alone were insufficient to guarantee technology transfer and the equal accessibility of the most recent products. Moreover, exclusive property rights continued to proliferate on the vaccine preparation technologies, and the WHO was finally compelled to respond in late 2007[52].

4- Proliferation of patents, patent pooling and compulsory licences

Over the course of 2007, several reports evaluated the scope of intellectual property on the H5N1 virus and vaccine preparation technologies and assessed the impact of these patents and Material Transfer Agreements on the development and availability of vaccines. The Third World Network (an NGO)[53] and the WHO[54] drew up these reports in which they both developed proposals to organize the collective management of property rights or to use the flexible provisions of the TRIPS agreements on intellectual property to advocate compulsory licences in case of a health emergency.

These reports noted a steep increase in the number of patents filed in 2006 and 2007, a trend consistent with the steady increases in influenza vaccine patents from the 1990s[55]. But in the case of avian flu, this pattern was even more dramatic: in the first nine months alone of 2007, some 35% of all patents related to the H5N1 virus.[footnote source??] These patents covered the genetic sequences of the virus the key technologies of vaccine production (reverse genetics, adjuvant and cell culture technology).

[52] In 2006 the WHO devised an "action plan to increase the vaccine supply" in the context of a flue pandemic. This plan recommended technology transfers to developing countries but made no mention of the proliferation of patents on viruses and technologies.
[53] "Some Intellectual Property Issues Related to H5N1 Influenza Viruses, Research and Vaccines", Edward Hammond, July 2007, pp. 1-21.
[54] "Patent Issues related to influenza viruses and its genes", Report commissioned by the WHO from the World Intellectual Property Organization (WIPO), November 2007, pp. 1- 41.
[55] "PCT Applications for influenza vaccines (1983 – June 2007)", report of the Third World Network, page 4.

While in general, a patent on a gene sequence confers property rights on all the uses of that sequence, the patents on influenza virus gene sequences present particular problems, because of the wide variability of viral strains. Patent authors nevertheless seek to circumvent this problem by claiming rights to a particular sequence and any other sequence that is 95% similar to it. They can also lay claim to numerous variations of the same gene. The gene patents that they acquire often have a very broad scope, covering the genes and their variants, the proteins encoded by these genes, their antibodies, and the uses of the genes and proteins in vaccines. Several of the existing patents cover avian influenza gene sequences from strains isolated in Indonesia, Vietnam, China and Thailand. For example, the US firm Protelix owns a patent that covers HA and NA genes derived from Indonesian and Thai strains, as well as a method to obtain variants used in vaccines[56]. Such patents covering many variants will likely block or hinder the development of a vaccine that impinges with the patent.

MedImmune's patents cover a new technology for altering viruses to obtain vaccine viruses. Whereas older techniques to reassemble virus were not patented, reverse genetics technology to produce influenza viruses from gene sequences is patented, as one November 2007 WHO report observed.[57] Vaccine manufacturers could find themselves dependent on this patent covering a key technology. In the case of reverse genetics, according to one Nature article, "companies that make...[a] vaccine would have to pay royalties to the patent holders. Companies are reluctant to do this, but scientists working in the field say that industry is trying to hammer out this issue."[58] MedImmune announced in the event of a pandemic emergency, it would authorize the free use of the technology, but only during the R&D phase; it would "begin charging only when the vaccines go into commercial production"[59]. But if the a company asserts its rights to royalties once the vaccines are commercialized, how would it be possible to assert equal access to vaccines and to protect the broader public health? The Third World Network notes that the US government *can* legally compel a firm to grant open or free licences in event of a pandemic if it financed the firm's research; under the "march-in rights" class of the Bayh Dole Act, a US government funding agency can disregard a patent under certain circumstance[60].

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[56] PCT Application WO2007051036, 3 May 2007.
[57] Report for the WHO meeting on pandemic Influenza Preparedness : Sharing of Influenza Viruses and Access to Vaccines and Other Benefits, November 2007.
[58] *Nature*, 26 May 2005.
[59] CIDRAP, 19 june 2007.
[60] "Some Intellectual Property Issues Related to H5N1 Influenza Viruses, Research and Vaccines", page 17. The march-in-rights provision was included in the Bayh Dole Act to protect the public against unreasonable use of patented inventions stemming from state-funded research. It provided for suspension of a patent licence if the licensee "has failed to make the product available to the public on reasonable terms" or if "action is necessary to

To address the dispersal of property rights and lock-in situations, which impeded use of key technologies or material, the WHO has recommended several types of measures. Its November 2007 report suggested ensuring wide access to new medical technologies through the structuring of "patent pools" or the "strategic use" of patents held by public institutions or public/private partnerships[61]. Several complexities make such changes politically challenging to effect: the difficulties of creating patent pools in the biotechnology sector; the heterogeneity of actors, firms, universities, and government agencies; and the wide dispersal of property rights. But a public agency or government could credibly initiate these changes. Although one expert commissioned by the WHO did not envisage such a role for the WHO, this international health organization could well play a central political role in the collective management of property rights to ensure the development and widespread accessibility of vaccines.

Several countries have proposed a system of compulsory licenses in the event of a pandemic crisis. Thailand, noting that it and Brazil used in 2006 and 2007 compulsory licensing to manufacture generic drugs for HIV/AIDS and for cardiovascular diseases, emphasized that these licences would be especially justifiable during a pandemic emergency.[62] India has gone even further, requesting that during health emergencies countries be authorized to produce vaccines, irrespective of the patent owners. In such a system of automatic compulsory licences, countries could legally produce vaccines without any restrictions at all[63].

CONCLUSION

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alleviate health or safety needs which are not reasonably satisfied by the current manufacturer". 18 U.S.C. Section 203(1)(b).2, "The Bayh-Dole Act and March-In Rights", David Halperin, May 2001.

[61] "Patent Issues related to influenza viruses and their genes", WHO, 2007, page 38. Public institutions or public/private partnerships could for example issue non-exclusive or free licences on their patents, or put them in the public domain ("public patents").

[62] "At the WHO technical briefing session, senior Thai health official Dr. Suwit Wibulpolprasert said that the avian flu virus and vaccine issue had become very sensitive.… He said that even in a normal situation like the present, countries like Brazil and Thailand that make use of the flexibilities in the WTO's TRIPS agreement were facing pressures that they had never experienced before.In a pandemic situation, the countries' use of such flexibilities in relation to intellectual property should not be questioned at all, he said » By Martin Khor, Geneva, 16 May 2007, Third World Network.

[63] « India stated that in an emergency, countries should be able to make vaccines, regardless of who holds the patent. If compulsory licencing is automatically allowed, countries would be enabled to make the vaccines », By Martin Khor, Geneva, 16 May 2007, Third World Network.

This threatened avian influenza pandemic has been a laboratory for developing new ideas about intellectual property as it is applied to science, life forms, and drugs. It has precipitated debates over intellectual property rights on viral strains, vaccines, antivirals, and genetic data, but at the initiative of public authorities, it has simultaneously favoured new claims and proposals for the collective management of IP rights. Such management schemes have sought to work within flexible provisions in IP rights to produce generic drugs, to hasten the development of accessible medical technologies, or to make new rules between those countries that donate viral strains and those that produce vaccines for sharing more equitably the benefits of these new medical technologies.

Debates over intellectual property in the context of a menacing avian flu pandemic helped to facilitate the establishment of a new biopharmaceuticals economy populated not only by traditional actors (the WHO and pharmaceutical laboratories), but also new ones, including NGOs, countries of the global South, scientific consortiums, biotechnology firms. To be sure, this new biopharmaceutical regime not only characterizes the world of influenza research and medical technology development; it developed during the AIDS epidemic, and more generally flourished in the changing legal contexts of IP rights on drugs and life forms since the 1980s. But the threat of an avian influenza pandemic revived and updated it.

The spread of the H1NI flue pandemic in 2009 has raised questions of intellectual property and technology transfer that appeared in the period fro 2005 to 2007. Debate reverted to issues of unequal access to antivirals and vaccines in developing countries and the poorest countries. Discussions on antivirals focused on the role that generic drugs should play in combating the pandemic. The Indian generics producer Cipla[64] and NGOs put pressure on the WHO to recommend the use of generics[65]. The Third World Network criticized the WHO's reserve as regards generics, which it imputed to the wish not to offend the owner laboratories from which it was hoping for donations to its stock of antivirals. MSF criticized the restrictive terms of the voluntary licences granted by Roche in India and China, which stipulated that generics produced in this framework could be sold only to the local government to deal with a "risk of a pandemic". The NGO recommended compulsory licences. Roche replied that Tamiflu could be reproduced freely in several countries of South-East Asia where it was not patented: "… Tamiflu is not patent protected in Thailand, Philippines and Indonesia, so the governments of these countries are free to manufacture

[64] "We could make a lot more, but there is need for firm commitment from countries and international agencies like WHO. The ball is in their court", Yusuf Hamied, 11 May 2009, The Associated Press.
[65] "Influenza H1N1: Generic production must be part of the solution for access to influenza medicines", MSF, 5 August 2009.

oseltamivir". In view of the extreme concentration of vaccine production in the countries of the North, MSF called for an active transfer of production technologies to developing countries. In July 2009, at a conference of the WIPO (World Intellectual Property Organisation), WHO Director Margaret Chan treaded very carefully on the minefield of intellectual property and public health. Whereas the flue pandemic was spreading, she refrained from mentioning the issue of using generics for antivirals[66]. She also excluded the argument of the impact of intellectual property on vaccine availability: "this shortage of vaccine supply, faced with a universal need, is the result of a limited world production capacity. Basically, it is not the result of problems of intellectual property"[67]. On the question of increasing the world's vaccine production capacity, the WHO pointed out that it had helped six producers in developing countries to acquire the technology[68]. MSF again emphasized the link between the question of vaccine technology transfer and that of intellectual property, and urged the WHO to intervene in this respect: "The WHO should give more support to the laboratories in developing countries that are ready to produce the vaccine, including by reviewing and proposing new ways of overcoming obstacles pertaining to IP and technological know-how"[69]. These discussions illustrate the new configuration of players in the struggle against flue epidemics: both traditional players such as the WHO and producers of vaccines and antiviral drugs in the North, and new ones, that is, generics laboratories in the South, international NGOs, and IP organizations (WIPO).

References

Cassier M (2007) Cassier M, “Délimiter le marché de la santé et faire le droit du vivant”, Revue d’Economie industrielle n° 120, December, p

Cassier M, Correa M (2009), « Les politiques de santé au Brésil. Technologie, industrie, Etat et Santé publique », Sciences Sociales et Santé, September 2009, Vol. 27, n° 3, John Libbey.

Chan and de Wildt (2007) "Developing Countries, Donor Leverage, and access to Bird Flu Vaccines", DESA Working Paper n° 41, p 1-9.

Ferguson N. (2005) "Strategies for containing an emerging influenza pandemic in Southeast Asia". *Nature*. **436**, no 7051, 3 August.

[66] A WHO report dated 21 May 2009 on the use of antiviral drugs against the H1N1 flue also makes no mention of the question of generics. It is limited to the constitution of an emergency stock provided by donors.
[67] "Renforcer la coopération multilatérale en matière de propriété intellectuelle et de santé publique", Dr M. Chan, 14 July 2009.
[68] OMS, 2 May 2009, Vaccins contre le nouveau virus grippal.
[69] Interview with Dr Fournier of MSF, 4 August 2009, source : MSF.

Foucault M (1976) *La volonté de savoir, Droit de mort et pouvoir sur la vie, Gallimard.*

L. Galambos, JE Sewel, *Networks of innovation. Vaccine Development at Merck, Sharp and Dohme, and Mulford, 1895-1995*, Cambridge University Press, 1995.

Moatti J.-P., Coriat B., Souteyrand Y., Barnett T., Dumoulin J., Flori Y.-A, eds, (2003) , *Economics of AIDS and access to HIV/AIDS care in developing countries. Issues and challenge*, Paris. ANRS Collection 'Sciences sociales et sida'.

RE Neustadt and HV. Fineberg , The Swine Flu Affair,

Third World Network, 2007, "Some IP Issues related to H5N1 Influenza Viruses, Research and Vaccines", July 2007, 21 pages.

US Congress, 2005, "Influenza Antiviral Drugs and Patent Law Issues" , Congressional Issues Service in the US, 2005, 12 pages ;

WIPO "Patent issues related to influenza viruses and its genes", working paper, WHO, November 2007, 41 pages.