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Committing to Vaccine R&D: A Global Science Policy Priority

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ABSTRACT

The amount of vaccine R&D performed, especially geared towards health issues affecting the developing world, is exceptionally undersized. Despite immunisation representing the most effective tool for achieving disease eradication, and the general consensus being optimistic about the development of a vaccine capable of fighting AIDS, Malaria and Tuberculosis, neither private nor public entities are investing sufficiently in the field. Reasons can be associated both with a lack of market incentives as well as with the low priority that these diseases set on Western political agendas. Though, seen through the Global Public Good lenses, it appears in the interest of high-income countries, their governments *in primis*, to invest public resources – financial and infra-structural – in vaccine R&D for global pandemics, as well as managing international cooperation through a global fund. The paper reviews a number of proposals put forward in the existing literature and offers a range of policy options.

Keywords: Science and health policy, Malaria, tuberculosis, HIV/AIDS, neglected diseases, global governance, free-riding, global public goods, vaccine R&D.

Comprometerse en la investigación y desarrollo de vacunas: una prioridad de la política científica global

RESUMEN

La cuantía invertida en I+D en vacunas, especialmente dirigida a cuestiones de salud que afectan al mundo en desarrollo, es excepcionalmente insuficiente. A pesar de que la inmunización representa el instrumento más efectivo para lograr la erradicación de enfermedades, y de que el consenso general es optimista sobre el desarrollo de una vacuna capaz de luchar contra el SIDA, la malaria y la tuberculosis, ni las entidades públicas ni las privadas están invirtiendo lo suficiente en este campo. Las razones de ello pueden asociarse tanto con una falta de incentivos de mercado como también con la baja prioridad que esas enfermedades tienen en las agendas políticas de Occidente. Si bien, visto desde la óptica de los Bienes Públicos Globales, parece que sería del interés de los países de rentas altas, e *in primis* de sus Gobiernos, el invertir recursos públicos – financieros y de infraestructura – en I+D en vacunas para las pandemias globales, así como gestionar la cooperación internacional por medio de un fondo global. Este trabajo revisa un conjunto de propuestas recogidas en la bibliografía existente, ofreciendo un conjunto de opciones de política al respecto.

Palabras Clave: Bienes públicos globales; Política científica y de salud; Enfermedades olvidadas; Gobernanza global; Viajeros gratuitos; I+D en vacunas.

Clasificación JEL: H40, H41, I10

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INTRODUCTION - CURRENT TRENDS IN VACCINE R&D ACTIVITIES

The Need for Vaccine R&D. - Diseases such as AIDS, Malaria and Tuberculosis (TB) are responsible for the death of over 5 million people a year world-wide (WHO, 2000), with over 70 per cent of these deaths occurring in Africa alone (EU, 2000). It is also estimated that AIDS, Malaria and TB infect 5 million (UNAIDS & WHO, 2002), 300-500 million (Harvard Malaria Initiative, 2000) and 17 million (WHO & UNICEF, 2001) individuals each year respectively. The economic and social repercussions that entire countries and continents experience as a result of these pandemics are tremendous: the UN (2001) estimates that AIDS alone will cause South Africa's GDP to fall by 17 per cent by 2010 - this without taking into account falling worker's productivity, declining savings and investment, rising business costs and decreasing life expectancy. Similar patterns are also envisaged for Malaria and TB (WHO & UNICEF, 2002).

How much is spent on Vaccine R&D? - To date, medical science has developed a number of drugs for the treatment of these diseases: there is an AIDS "cocktail" drug capable of reducing considerably the magnitude of the disease's manifestation; Malaria can somewhat be prevented, although full immunity cannot be guaranteed; and the Bacillus Calmette-Guerin (BCG) vaccine for TB has proven effective, but in young children only (Kaufmann, 2000). What has not been developed yet is a vaccine capable of eradicating these diseases. Leading health organisations (WHO & UNICEF, 2002) have argued in favour of preventive immunisation as being both economically and socially preferable to treatment, the most remarkable example being the eradication of smallpox in 1977 as a result of WHO's smallpox eradication programme (Fenner et al., 1988).

Unfortunately though, despite the proven success of immunisation, the resources devoted to vaccine research are still scarce compared to those directed to the treatment of diseases. The case of AIDS is exemplary: annual vaccine research expenditure still represents just over 10 per cent – ~US$400 million – of the annual global HIV/AIDS anti-retroviral R&D spending – US$3 billion (Esparza, 2000; EU 1999; IAVI, 2002). The figures for Malaria and TB are even more disconcerting. Just over US$55 million is the total worldwide spending on a Malaria vaccine (MVI, 2003), whilst for the development of a new TB vaccine, the WHO (WHO & UNICEF, 2002, p. 61) estimates that over the past decade spending has totalled no more than US$150 million. It is the purpose of this paper to encourage, on the one hand, the political support necessary to guarantee a robust and long-term financial commitment to preventative immunisation, and on the other to provide a rational justification for doing do. As the paper will argue, fighting infectious diseases is not a purely technical issue. On the contrary, it is a debate in which economists and policy scientists can contribute considerably.

Is a vaccine at reach? - Given the importance of preventative immunisation, it is spontaneous to interrogate ourselves as to the reasons why research in this field is so minimal. Could it be that the current state of scientific knowledge is impeding the discovery of an effective vaccine against these diseases? Or could the lack of investment in the field be simply the outcome of a rational evaluation of the expectations to hit the target? Scientific investigation is by nature surrounded by uncertainty, and even more so when searching for major scientific breakthroughs. On a whole, three scenarios can be identified in relation to the investment of targeted scientific research:

1) *One searches for something but never finds it*: despite the profuse commitment, research does not yield the desired results. The research carried out may stimulate learning and build-up investigative capacities and in some occasions it may even lead to the identification of blind alley-ways, though the problem still remains unsolved. The case of an anti-tumour vaccine falls within this category.

2) *One searches for something and finds something else*: the investments destined to scientific research do not lead to the objective prefixed, but the results obtained are still relevant to different research areas despite their failure. Kroto's discovery of the C_{60} molecule is a perfect example of serendipity.

3) *One finds what is being looked for*: the massive concentration of human and economic resources on specific projects allows obtaining the results one is aiming at. The Manhattan Project and the conquest of the moon represent striking examples of scientific results obtained as a consequence of strong political commitment.

The economics of scientific research teaches that there is not a clear linear relationship between input and output, since any investigation is dominated by incertitude[1].

However, it is the opinion of experts in the field that the major impediment to basic vaccine science appears not so much related to a knowledge gap, as to a lack of serious financial commitment (Médecins sans Frontières, 2001; the International AIDS Vaccine Initiative 2001; the World Health Organisation and UNICEF, 2002).

Is there an economic explanation for the lack of R&D investment? If a knowledge gap cannot explain the lack of investment, could a lack of incentives be blamed instead? Two aspects need to be considered: the first one relates to R&D expenditure of both

1. This concept of *incertitude* was developed by Andrew Stirling and used by the UK Economic and Social Research Council (ESRC) in 1999 (ESCR, 1999), who created a structural division of *incertitude* into four main areas related to the occurrence of an event: Risk, Ambiguity, Uncertainty, Ignorance. These areas have been constructed on the basis of the knowledge we hold of the likelihood of an event occurring and the possible outcomes. Risk: outcomes are well defined/some basis for probabilities of the event occurring. Ambiguity: outcomes are ill defined/ some basis for probabilities of the event occurring. Uncertainty: outcomes well defined/no basis for probabilities of the event occurring. Ignorance: outcomes ill defined/no basis of probabilities of the event occurring.

profit-seeking and public & non-profit agents; whilst the second one relates to the distribution of the disease burden across countries.

The system of R&D incentives – Back in 1962 Kenneth Arrow suggested that scientific knowledge is costly to produce but that its diffusion could occur at zero or very low costs. Whilst this assumption has proven wrong for the majority of scientific and technological fields, as indicated by a vast literature on technology transfer (e.g., Pavitt, 1987), it seems to hold true in the case of vaccines: indeed, vaccine costs, as for the majority of drugs and chemicals, reside within their initial development, whilst their duplication and diffusion can take place at infinitesimal cost. Although the costs of distributing vaccines can be high, past experiences indicate that resources are found once a successful vaccine is made available – confirming the negative effects of uncertainty on research investments – whilst early stages of drug development find it much harder to stir financial commitment.[2] This because profit-seeking investors would not chance their capital to fund R&D unless they had a reasonable guarantee of appropriating the returns from their discovery. The dispute over the diffusion of the HIV/AIDS cocktail drugs, between the US's so called Big Pharma and the South African government in 2001, is a perfect example of the serious implications that knowledge, and the ease with which it can be diffused, has on private investment (May, 2002). Exactly for these reasons, Arrow (1962) had warned against the dangers of leaving to market forces alone the responsibility for providing the financial incentives necessary to stimulate scientific R&D: market-demand alone would generate a knowledge-investment sub-optimal to that socially desirable. To overcome this Arrow referred to two possible solutions:

1) Resorting to institutional mechanisms, such as Intellectual Property Rights (IPRs), that guaranteed agents the right to benefit from the results of their inventions and which represent the institutional mechanisms by which private agents would be provided with the incentives necessary to invest time and resources in scientific research.

2) Alternatively, resorting to public intervention as a primary financier of scientific research – either by entrusting public infrastructures, or by outsourcing research activities to private contractors.

Within modern capitalist economies, both these forms co-exist: IPRs provide protection for private investors; the public sector performs research through a variety of publicly owned infrastructures, such as academic research laboratories, as well as

2. The development of the measles vaccine has allowed 60 % of one-year old children to be fully immunized in low income countries, and 89 % in high income countries (UNDP, 2003, table 6, column 5). In other occasions, the gap between the development of a successful vaccine and its diffusion has been much longer, and the case of smallpox is exemplary. The smallpox vaccine had been discovered in the second half of the 18th century, although the WHO smallpox eradication programme was carried out between 1967 and 1980, when the financial resources (about US$300 million) were eventually found. See Fenner et al., (1988), p. 542 and p. 258.

outsourcing research projects to private operators – as exemplified by the space and military R&D programmes contracted to the business sector.

Governments have often provided the funding necessary for research in critical areas where IPRs have not acted as a sufficient incentive for business investment. Examples are provided in the areas of defence, space, public transport, cancer and, more recently, the SARS health scare. There has never been a pure market economy that has constrained government spending in front of socially or politically sensitive issues. Though, regrettably, during the past decade, the share of publicly funded R&D has experienced a substantial reduction. In OECD countries, government financed R&D represents just 30 per cent of total R&D funding (OECD, 2003, table 14).

The North-South divide – The lack of incentives alone does not explain therefore the constrained investment towards targeted R&D for vaccine development. Geo-economic factors are also involved.

Graph 1 illustrates the distribution of the diseases across the North (high-income countries) and the South (low-income countries) and it clearly shows how the bulk of the infections are almost entirely confined to the South: Malaria is exclusive to the South, since in the North Malaria has been eradicated by improving overall environmental conditions[3]; and similarly TB has an incidence of infection 13 times higher in the South than in the North.[4] AIDS also is far more prominent in low-income countries than in high-income countries. Though in the North AIDS represents a much more serious threat than Malaria or TB. Interestingly, AIDS benefits from a greater global research and financial commitment than Malaria or TB – the annual AIDS vaccine research budget is in fact seven times greater by comparison to Malaria vaccine research, with US$400 million (IAVI, 2002) and US$55 million respectively (MVI, 2003). The fact that the North also concentrates 80 per cent of the world's GDP and 90 per cent of the world's R&D budget (see Graph 1) confers it not only the resources and the competences necessary to address these diseases, but also the power to set the medical research agenda. The South on the contrary, lacks the resources, the competencies and the political power to do so.

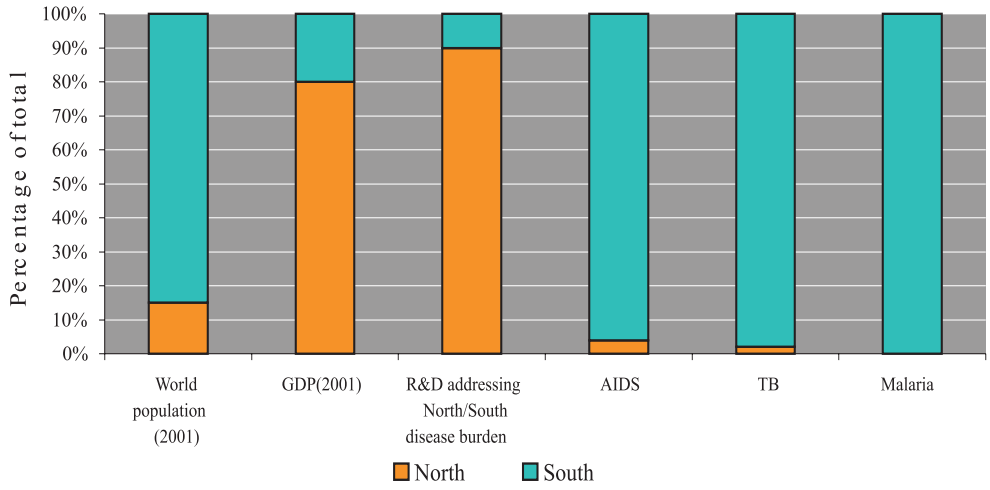
In a nutshell, and paradoxically, countries affected by the diseases lack the resources and expertise to combat them, whilst countries holding the resources and the expertise to fight diseases lack a direct health threat.

In many occasions, the South has benefited from the diffusion of knowledge originally developed for the North, as in the case of the smallpox vaccine. In other occasions, firms in the North have developed technological innovations to the benefit of the South (such as hybrid seeds), though such innovations had been developed on

3. The only high-income country with reported malaria cases is Korea (UNDP, 2003, table 7, column 8, p. 258).

4. There are 18 new cases per 100,000 inhabitants in high income countries, but as many as 233 in low income countries (World Bank, 2003, table 2.19, column 3, p. 110).

Graph 1: North/South health and resource ineualities



the expectation of a market demand in the South. There is no doubt that the "social" demand for such vaccines is higher than its "market" demand. However, there is no guarantee that the South, in spite of the high share of the disease burden, will also be able to provide a "market" demand of a magnitude attractive enough to stimulate private research. Moreover, the social pressure that would be exerted over inventors to release the vaccines in order to allow for its diffusion among poorer countries, would be such that governments would be forced to violate IPRs and resort to compulsory licenses - as the celebrated case of South Africa vs Big Pharma clearly illustrates (see Seckinelgin, 2002) - whereby private investment would be discouraged further.

FINANCING VACCINE R&D ACTIVITIES

Alternative ways of funding vaccine targeted R&D. - Not surprisingly, in recent years a common consensus regarding the need to combat these diseases has emerged, with public and private sources arguing in its favour, though the International Community has not responded accordingly. The case of the Global Fund To Fight AIDS, Malaria and Tuberculosis is exemplary. In 2000, the UN Secretary General Kofi Annan urged the International Community to fund prevention and treatment against major infectious disease by establishing an international fund (Global Fund To Fight AIDS, Malaria and Tuberculosis). Yet, to date, Annan's plea to provide constant reliable financial commitment to the fund has gone unheard (Tan, Upshur

and Ford, 2003). Most countries have met only partially their financial obligations to the fund. The USA in particular, has contributed just 10% of the US$10 billion it agreed to donated by 2008 (see Cunningham, 2003). Most of the funding for vaccine development has come from the pockets of privates and their philanthropic foundations. The Bill and Melinda Gates Foundation alone has already pledged 1 billion US dollars on prevention and control of infectious diseases through a number of national and international programmes. Other public-private partnerships have also been created with a view to providing financial support to vaccine R&D activities. Yet such initiatives, despite their good intentions, are constrained both time-wise and financially and do not represent a desirable political solution. As we shall argue later on in the paper in more detail, an international fund would appears a much more desirable mechanisms for the promotion of preventative immunisation. Although currently the Global Fund does not focus on vaccine research, but rather on the prevention and treatment of these diseases, given an adequate financial capacity, the fund could direct additional financial resources also towards vaccine research.

The costs of developing a vaccine. - Estimates concerning the costs of drug development are very heterogeneous. Figures vary from US$50 million (UNICEF and WHO, 1996) to almost US$900 million (Frank, 2003; Tufts Center for the Study of Drug Development, 2003) and this appears to depend on whether the costs of clinical, pre-clinical and post-approval tests are all accounted for (for a complete overview see UNICEF & WHO, 1996; TB Alliance, 2001; Miller, 1998; DiMasi et al., 1991; Frank, 2003; and Tufts Center for the Study of Drug Development, 2003). If we were to take the largest of these estimates and rounded it up to US$1 billion in order to account for possible hurdles, uncertainty and long lead-times within the development process of each vaccine – experts believe a Malaria and TB vaccine are still ten to fifteen years out of reach (Kaufmann, 2000, WHO & UNICEF, 2002, MVI, 2003) – the total amount for the three vaccines could amount to US$3 billion. Given the incertitude of these projects, which cannot be directly compared to other vaccines, it is reasonable to assume that the financial requirements should be higher, say about US$ 5.5 billion. An additional investment of another 2 billion dollars for other neglected diseases (say Leishmaniasis, Diarrhea, Onchocerciasis...) would represents a total financial commitment of 7.5 billion US dollars to be spread out, say, over 15 years (since on average, research project in the medical/pharmaceutical field lasts around 10 years, see Grabowski and Vernon, 1994). In the event that vaccines were found earlier than anticipated, resources could be re-directed towards either vaccine R&D for any of the other diseases under investigation, diseases other than those investigated, or the diffusion of the vaccine developed.

Although US$ 7.5 billion is a substantial amount of money compared to the current patterns of vaccine R&D expenditure - which according to the estimates here provided do not exceeded more than US$600 million - it is an affordable sum for most Western countries. Just to compare figures, US$7.5 billion equal just one tenth of the sum

spent by the US government towards the funding of the current War in Iraq (Samuelson, 2003). If, moreover, the expenditure is to be distributed uniformly over a 15 year-period, it will amount to just US$ 500 million a year. This represents less than 1 per cent of the current total OECD R&D expenditure, and about 3-4 per cent of government funded R&D (OECD, 2003, tables 1 and 14).

Although a part of the resources could be diverted from other destinations (i.e.: military expenditure), the aim of the proposal is to *increase* rather than *re-locate* current R&D expenditure patterns. This would imply a major shift in the direction of scientific and technological advance, and also the addition of a third priority to the existing leading fields of military and space R&D (among those publicly funded) and electronic and communications R&D (among those privately funded). The fight against infectious diseases will be comparable in size to the Manhattan project, but much more constructive towards human welfare.

Regrettably though, vaccine R&D does not figure amongst most governments agenda's top priorities. Just as with Nelson's dilemma over the moon and the ghetto (Nelson, 1977), we share the view that the reasons are merely a matter of priority setting. Since budget priorities are a public concern, there is no reason as to why they cannot be re-directed through an adequate pressure by civil society and the academic community. The most efficient and pragmatic way to address this health issue would be to strengthen the already existing international funds dedicated to vaccine R&D. Such funds would serve the purpose of financing international vaccine research in different countries via a variety of experimental collaborations. Both final and intermediate results, including the discovered vaccines, would be considered humanity's patrimony and a *global public good*, with the United Nations as the main coordinator since it is the only international institutions vested with the mandate and competencies necessary for its management. The remaining part of the paper argues this position.

In favour of the international fund for vaccine research. – Recall the uneven distribution of resources and disease burden between the North and the South (see Graph 1). Here we consider how the total bill for this R&D commitment should be distributed among countries. Unfortunately for vaccine research, countries commitment to vaccine development has not experienced the same kind of enthusiasm that has distinguished space research or military technology. Vaccine research appears to have been distinguished by a *free-rider*'s logic, by which many governments, especially European, have favoured financially the research and development of non-targeted academic activities and commercial areas that stimulate competitiveness among national firms, rather than towards research activities that may benefit humanity as a whole (European Council, 2002). The issue of competitiveness is especially relevant to the European pharmaceutical industry - which in recent years has experienced a loss of competitiveness against it's US counterpart (Orsenigo, Gambardella, Pammolli, 2000) - and replacing this competitive spirit with a cooperative attitude will require,

on the one hand, greater coordination between the initiatives currently underway and, on the other hand, the institutionalisation of a formal system of global governance. If these were achieved, countries would find it much harder to neglect their international commitments. Yet, if a cooperative spirit were to be promoted, a question more ethical than political in nature remains to be answered: by what criteria should the share of contribution between countries of the North and the South be determined? There are three dimensions that are worth considering:

1. The benefit that each country shall derive from an eventual vaccine development, connected to the estimated number of patients that would benefit from its treatment.
2. The ability of a state to contribute financially to the vaccine development – which is linked to a country's income.
3. The availability of medical and scientific infrastructures able to sustain research activities.

Given that there is a strong, positive correlation between points 2 and 3, we can assume that if a high income country is able to contribute significantly to the financing of a vaccine's development, it will also be able to support its research activities.[5] Thus, we are left to focus on two contrasting criteria: 1) either on the basis of the population benefiting from the development of a vaccine; or 2) on the basis of the capacity of a country to contribute financially (we assume that the financial contribution of each will somehow be associated to the R&D actually performed in the country). The first criterion places the greatest burden of responsibility on the South. Realistically, this hypothesis cannot be taken seriously, since countries in the South do not just lack adequate resources to finance research, they also lack the infrastructures necessary for the research to be carried out. The acquisition of knowledge is in fact a long process that requires learning capacity, absorption of competencies and the building of local know-how (e.g., Polanyi, 1962; Lundvall and Johnson, 1994; Pavitt, 1987).

The second criterion instead, places the responsibility burden on the North. As Graph 1 has shown, the North holds both the financial resources and the infrastructure necessary for performing R&D. Though, how could an argument in favour of the application of criterion 2 possibly be justified? No doubt, OECD countries would never allow Malaria or Tuberculosis to claim as many lives in their own countries with the same disinterest they have shown towards Southern peoples. It is not a coincidence that out of the eleven HIV/AIDS clades found, the one to received greater

5. Hypothetically, countries with the largest disease burden will finance R&D performed in the countries with the best medical and scientific infrastructures (such as Uganda financing R&D performed in the Harvard Medical School). But since the countries with the disease burden are also the poorest ones, this option is not realistic.

research attention has been the clade afflicting the North – despite it affecting just 4 per cent of the world's entire infected population. Whether counties in the North have a rational and ethical responsibility to finance and perform research for diseases that do not afflict them directly, depends very much on how the issue is framed and on individual ethical and ideological considerations. There are two complementary rationales that can help answer this question: the concept of global public goods, and Rawls' (1971) artifice of the "veil of ignorance".

Vaccines as Global Public Goods. – By definition, public goods exhibit the following characteristics (for an in depth analysis see Kaul et al., 2003, Kaul and Mendoza, 2003):

- either they exhibit non-excludable benefits (public good),
- or they provide non-rival benefits (public good),
- or both (pure public good),
- in the instance such benefits extend to all countries, people and generations, public goods can be considered *global* (Global Public Goods).

We discussed earlier how vaccine knowledge is *de facto* non-rival and non-excludable and that its diffusion can occur at almost zero cost. These characteristics imply that, according to the definition provided above, vaccines could classify as a public good. Indeed, in many countries, vaccines, as well as health in general, have often been considered a basic human right and as such many governments have, by political design, treated them as a public good. To qualify as a global public good, vaccines would need to benefit more than one group of countries, populations and generations (Kaul and Mendoza, 2003). Since health issues such as HIV/AIDS, Malaria and TB bring countries into a shared fate, they should also bring countries together as partners in appropriately reforming their public policy choices (Kaul et al., 2003). After all, one of the main rationales for the existence of the state is its role in providing those socially indispensable goods that, either for one reason or another, are not effectively managed by the market (Desai, 2003). Undeniably, countries at diverse levels of development have different preferences for assigning national and global public goods, yet, even the lives of the richest individuals depend on these preferences.

From an economic point of view, a healthy population generates important private and public benefits and contributes positively to a country's economic growth, whist excessive disease burden creates negative global externalities (often defined as public bads) - other than undermining past and present development achievements in the South and curtailing future economic development prospects for northern industries in Southern regions. Moreover, international travel and trade are causing an increase in prevalence within industrial countries of diseases previously endemic to the South (Kaul and Mendoza, 2003). In Switzerland, for instance, new HIV infections are exhibiting similar characteristics to those fuelling the AIDS epidemic in Africa (Tenkorang and Conceicao, 2003). Similarly, since the early 1970s, 20 diseases have

either re-emerged or spread, often in more virulent or drug-resistant forms (Kaul and Faust, 2001) and the recent appearance of the West Nile virus in the USA is a reminder that not all diseases will necessarily remain confined to the developing world.

The development of a vaccine would therefore protect currently disease-free regions in the North from the expansion of Southern epidemics, as well as reducing, or eliminating even, the expenses associated with the current and/or future treatment of these diseases. The UN has estimated that the United States recoups the costs incurred from smallpox eradication programmes once every 26 days. That is every 26 days the benefits accruing from not having to deal with smallpox are equal to the US's total eradication costs (Tenkorang and Conceicao, 2003).

The funding of vaccine research for global pandemics and neglected diseases appears therefore to be both rational and necessary, even if only in terms of the preservation of the wellbeing of the North.

The Veil of Ignorance – A second justification for the North's involvement in the financing of vaccine R&D can be found in Rawls' (1971) artifice of the "original position" and the "veil of ignorance"[6]. Let assume, for the sake of the argument, that the world is split into two countries, the North and the South, and that a "selfish" individual is asked to distribute the resources of an R&D budget among the two countries. The individual must take a decision *prior* to being revealed in which of the two countries will he/she reside – thus prior to knowing his/her risk of contracting the diseases. Lets also assume that the individual has access to the data relative to each country and that he/she is aware that the North holds both abundant financial and scientific resources for R&D activities and a low risk of contracting the diseases, whilst the South exhibits opposite characteristics. Will the individual direct R&D towards cosmetic research or will he/she privilege those scientific programmes that will aim at the eradication of the diseases? Lets assume that a *rational* individual would selfishly choose the second option.

Developing Countries contribution to vaccine development. - The global public good character of vaccines and Rawl's artifice of the Veil of Ignorance as a rationale for their development, do not entail that the South should be exempted from any responsibility, nor that R&D on vaccines should be located in the most developed nations only. Despite the fact that vaccines can be transferred more easily than other technologies (say machinery or software, for instance) they still require a local learning capacity in order for their diffusion to take place. Even Coca Cola, who advertises itself as the producer of the global good for excellence, has research laboratories in all parts of the world which are vested with the responsibility to adapt the product to

6. In reality, Rawls limited himself to considering the original position in a given community and he has not extended it to the world community as such. However, we apply here the extension of Rawls' ideas by some of his followers. In particular, Charles Beitz (1979) and Thomas Pogge (2002) have convincingly extended Rawls' theory of justice also to the international arena.

local taste preferences, conditions and markets. In the case of vaccines, the need for local research would be certainly more categorical. A considerable share of the funding should also be geared towards building local knowledge in, and transferring technology to, the South through the strengthening of programmes such as those initiated by IAVI and GAVI (see www.iavi.org and www.gavi.org) which aim at training local scientists by working in close collaborations with research laboratories in the North. Empowering the South with technical competencies necessary to perform medical R&D, will contribute to bridging the current North/South health gap. However, the acquisition of knowledge is a long process that requires learning capacity, absorption of competencies and the building of local know-how (e.g., Polanyi, 1962; Lundvall and Johnson, 1994; Pavitt, 1987). The South could contribute to the abovementioned objectives by re-thinking its public financing priorities. In many Asian and African countries for instance, government spending on defence can be as high as 12 per cent of its GDP – whilst in the USA, the world's largest financier of defence is absolute terms, military expenditure does not exceed 5-6 per cent of the GDP (Verma, 2004). Clearly, even minimally, there is scope for the South to contribute financially to vaccine development.

A proposed distribution of the resources. – How should this financial commitment be distributed across countries? Table 1 illustrates a proposed distribution of the financial burden according to the "ability to pay principle" - that is to say, countries financial contribution is proportional to their GDP. The United States would provide the largest contribution, followed by the European Union. Developing countries would also provide a substantial contribution and perform significant shares of R&D. In real terms, these countries would be able to hire a proportionally larger number of researchers since salaries per scientist are substantially lower. It is also likely that developed countries will be prepared to subcontract parts of the R&D to labs in developing countries. Clinical trials require indeed on-site analysis.

Table 1: A Tentative Distribution of Requirements for Vaccine R&D

	2001 GDP	*Vaccine R&D Requirements (total 15 years)**	*Vaccine R&D Requirements (average per year)**
	Billion US $	*Billion US $*	*Billion US $*
World Total	31400,0	7,50	0,50
High Income Countries of which	25372,0	6,06	0,40
USA	9780,8	2,33	0,15
European Union 15	7181,7	1,71	0,11
Japan	4523,3	1,08	0,07
Low and Medium Income Countries	6025,0	1,44	0,09

Source: World Bank and elaborations

** Proposals for pledges to an International Vaccine Fund Proportional to GDP*

An input of financial resources is not necessarily able to generate the desired competencies. The already existing competencies in the field of immunology are, in fact, sized on the already available financial resources. A substantial part of the funding in the first years should therefore be devoted to creating human skills, in particular by promoting doctoral courses.

DISCUSSION – IMPLEMENTATION AND IMPLICATIONS

International Coordination – From what has just been argued it follows that research activities necessitate of international coordination. By this we entail:

1) *A central funding organisation* - This organisation should decentralise funding decisions at the national or regional level. However, it should keep control of the various decisions taken. Although we acknowledge the recent years' growing disillusionment in governments and formal institutions, such as the UN and the WHO[7], these nevertheless play a critical role with respect to global health. The WHO is the only global institution that benefits from the mandate to oversee international health cooperation and responsible for the protection and promotion of global commons. Its role derives from its ability to convene a broad array of actors, develop consensus, and mobilise resources. With respect to legitimacy, the WHO is currently attended by 191 member states, all of which have equal voting rights irrespective of size of their population or of their financial contribution (Buse and Walt, 2000). No other institution can claim near universal membership of nation states, nor can it benefit from a technical network-support as extensive as that of the WHO. The WHO could also act as a catalyst and coordinator for, say, activities across the Global Fund to fight AIDS, Malaria and Tuberculosis, Global Alliance for Vaccine Initiative (GAVI), International Aids Vaccine Initiative, UNAIDS and Medicins sans Frontieres' Drugs for Neglected Diseases initiative (DNDi).

2) *A periodic evaluation of the results* – Its aim is to increase funding to those groups obtaining more encouraging results. This evaluation would be performed by scientific peer review - this is common practice already within many research funding bodies, such as the US National Institute of Health and the UK Medical Research Council, where funding for research is based on a scientific peer-review process. Members of the scientific community should also be encouraged to continuously exchange information with other research groups. Preliminary and intermediate results could be widely disseminated through typical academic channels (scientific journals, conferences, academic courses, Internet and electronic fora).

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7. Think of Jonathan Mann's resignation from the WHO in 1990 as a symbol of protest against what he defined "a lack of commitment" and unimaginative leadership fighting global diseases (Goodle, 1994).

3) *An evaluation from subjects that do not belong to the scientific community* - This is meant to avoid targeted research being transformed into disciplinary research. A periodic external control by stakeholders will help to keep the research activity within the scope of its target. Stakeholders would include government officials, NGOs, health associations and firms working in the pharmaceutical sector - this would also allow taxpayers to exert a greater control over the funding of public research.

Also, the coordination of finalised research should *not* prevent duplication, since it is widely accepted that a certain degree of duplication proves beneficial to scientific enquiry. The problem in fact is not duplication as much as the lack of exchange of information.

The risks of public contracts to the private sector. - There is no requirement that public financial commitment must also be performed by public institutions. Policy makers, at both the national and international levels, can decide as to whether R&D should be contracted to private organisations or carried out in public infrastructures. This certainly would not be unprecedented. In the case of space and defence, it is common – especially in the United States – to contract out R&D to private research centres. There are of course a number of risks in outsourcing to private contractors. Outsourcing efficiency is entirely dependent on the capability of the public contracting party to manage the contract and to demand specific results from his contractor. Research contracts are very different from any other procurement for their high degree of incertitude. Private contractors tend to disclose the minimum information, especially if they can trade any additional or unexpected result achieved via separate contracts. This would appear a major obstacle since the dissemination of preliminary and intermediate results is an important component of the R&D activity. The public contracting party should master a high degree of competence in contract-dealing and a strong leadership in directing research. Successful examples of public-to-private contracts have been provided by military research activities, especially within the USA, though the transposition of competencies within the Pentagon and Ministries of Defence to the Health sector will take time and much effort.

The inefficiency of the public sector. - It is often argued that the efficiency of public research in targeted R&D is scarce due to a lack of incentives (Suarez-Villa, 2000, p. 196). There is no evidence that documents the inferiority in efficiency of public research as opposed to private. If there were a problem of lack of incentives, then the public sector must, and could, find suitable mechanisms to stimulate its productivity. An increase in the range of publicly funded R&D institutions will also increase competition among public laboratories. Each will be competing to secure funding on the ground of the results achieved. Also within the public sector there is the risk that useful intermediate research results may be kept secret in order to insure funding, though this is a problem that can be easily solved by acting upon incentive mechanisms. It would be sufficient that evaluation criteria privilege the diffusion of

research results, for instance by taking into account the number of scientific publications produced by each research team.

Privately funded research. - There is ultimately the case of privately financed and profit-seeking R&D[8]. Although we are advocating a greater public commitment towards vaccine research, we do not aim at impeding the private, and profit-seeking, funding of scientific research in the field. Nevertheless, the rules of the game for businesses should be explicit: should private investors be granted IPRs over the results of their research in the field of vaccine? Or, alternatively, which type of remuneration (or compensation) should be provided to them in exchange of the expropriation of their knowledge?

There has been a widespread concern about the exclusive nature of IPRs that has ranged from governments of developing countries (Shiva, 2001), to civil society (MSF, 2001) and academia (see, for example, May, 2000, Thurow, 1997, Mazzoleni & Nelson, 1998, Coriat & Orsi, 2002, Heller & Eisenberg, 1998). These different institutions and scholars have stressed the risk that proprietary knowledge will dangerously exclude vast amounts of the world's population from the benefits of newly developed vaccines. We agree with the view that IPRs increase social exclusion from life saving drugs, and that weakening IPRs might enable a greater access to drugs globally. In the short term, it is relevant to challenge these companies in order to reduce their monopoly power on essential drugs, but the pressure by large corporations to enforce their IPRs even in the field of life saving drugs simply reflects the fact that profit-seeking agents *have* generated new knowledge. In a slightly different vein, we argue that the problem to be addressed is not so much the proprietary nature of the already existing knowledge, as much as devising new mechanisms for the public ownership of knowledge newly generated.

The proposal we are here advocating would therefore put profit-seeking R&D – at least for vaccine R&D – in a residual position, since the public financing of vaccine research would lower, on the one hand, the bargaining power of business investors, and on the other their ability to charge monopoly pricing. Yet, even in a residual position, the outcome of business funded R&D could prove crucial to medical research, and that is why it ought to be limited, but not discouraged entirely. Kremer (2003) suggests using "purchasing commitments" as an incentive to attract private investment, whilst public money would be used solely to purchase large quantities of successful vaccines. "Purchasing Commitments" would act as a form of "pull" research mechanisms - that is issuing for instance a "prize" on the development of successful vaccine in order to stimulate private research - and although they would have the advantage of delivering the costs and the risks of R&D entirely on the shoulders of the private sector - whilst demanding taxpayers to contribute solely in the event that

8. Donations form private sources for non-profit cases do not belong to this category and are more likely to be in the same category of publicly funded R&D.

success was reached - this approach presents nevertheless an important hurdle. Basing incentives exclusively on the winner's remuneration entails an entirely competitive spirit between the various research groups. Although, on the one hand, this would stimulate competition between firms in medical areas previously neglected, the exclusivity of the prize would force the various competing agents to maintain secret all intermediate results of their research. As we have argued extensively in this paper, competitiveness and secrecy are detrimental to the social optimality of knowledge production.

CONCLUDING REMARKS

Vaccines hold the capacity to eradicate diseases affecting millions of people and we would argue that there is a certain degree of confidence that the target could be hit by investing adequate resources. Although certainty is always lacking in scientific investigation, there is enough rationale to invest much more than it is currently invested. We have argued that the reason as to why there is so little vaccine R&D is traceable to the lack of adequate incentives. Business sources have limited interest to invest. Governments of developed countries lack commitment to invest because they are negligibly affected by these diseases. Not surprisingly, the largest amount of R&D is focussed on AIDS, which, compared to TB and Malaria, is the only disease to exert a substantial health threat to the North.

Given this scenario, only a major steer in the science policy priorities of Western governments can alter this structure. An international vaccine fund represents the most effective and efficient means to manage an international research activity but commitment must be insured and coordination must be effective, and here is where a supra-national agency such as the WHO would come into play. We have provided a tentative distribution of the resources across countries on the ground of their economic welfare, implying a significant but feasible increase in the R&D budget of industrially advanced countries. We have also provided some suggestions on the way in which this fund could be managed, and on the advantages of R&D carried in in-house public labs and through international collaboration.

Is such a proposal feasible? In spite of official commitments agreed within inter-governmental summits, national authorities have been very reluctant to open up new lines of economic resources - this is clearly illustrated by the steep decrease in Official Development Aid since the fall of the Berlin Wall (World Bank, 2003, p. 13). We believe, nevertheless, that there is nothing inevitable in these trends, on the contrary, they are merely the outcome of conscient policy decisions. Governments in the North have often shown to be attentive to public opinion, and the latter has been sensitive to a number of global campaigns, as the South African case has shown. We therefore address, in particular, three different communities: the global movements, the academic

community and the restricted but influential community of science policy analysts.

Global movements have already played a crucial role in steering government priorities in key areas such as environment, disarmament, and human rights (see, for example, Glasius, Kaldor and Anheier, 2001 and 2002). Concerning the health agenda, global movements have heavily criticised the privatisation of knowledge (see Shiva, 2001). We would urge these movements to reconsider their priorities and focus on the need to increase publicly funded R&D of drugs for neglected diseases, as opposed to issues of access to medicines. IPRs are just a consequence of knowledge development, whilst the resources to fund knowledge production are the real issue at stake.

The other community we address are scientists, a category of individuals whose work is, or should be, performed on moral and ethical grounds. In many cases scientists hold the ability to direct strategically the priorities of their research. Governments do not have the information to direct scientific investigation unless there are scientists providing them with the technical expertise. Scientists could therefore devote increasing attention to the welfare implications and consequences of their work and induce governments to devote more resources to global health priorities. Governments need to adapt their funding and administrative priorities to support the emergence and healthy growth of research networks (Geuna et al. 2003)

Last but not least, we address the small community of science policy analysts and advisors. We note that in the last two decades there has been a growing focus on science and technology as shapers of economic performance, rather than enhancers of social welbeing. The circle of scholars of science and technology policy has been a close advisor to policy makers. If today, so much attention has been placed upon technologies for industrial innovation, and so little towards medical research for developing countries, it is due, in part, to the choices and priority setting of this community.

Whether governments will listen to a request for a change in priority setting will depend on the ability of global movements, scientific communities, and science & technology policy advisors to pursue the same objectives. If this were to be reached, policy makers will have no other option than to act.

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