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Thank you Chairman Brownback and members of the Subcommittee on East Asian and Pacific Affairs for the opportunity to present my views on malaria control.

Asia does not present us with the worst of malaria control problems; but this does not mean that there are no problems of malaria control in Asia. Conditions in many Asian countries are far worse today than they were decades ago when insecticides were sprayed on house walls to combat malaria. The return of malaria to the countries of North Korea and South Korea is symbolic of the reversals that have occurred[1]. However the malaria problem in South Korea is much more than symbolic, 115,000 cases of malaria occurred in North Korea in 2001[2], and malaria along the demilitarized zone now poses a risk to U.S. military personnel.

Today, the malaria control community around the world is locked into several different debates on best practices for dealing with continuing and, in some areas, worsening malaria problems[3]. One part of the debate is efficacy of different preventive measures, and this debate narrows to the issue of whether to use insecticide treated nets as the only preventive measure or whether to open the field to both the use of insecticide treated nets and indoor spraying of small quantities of insecticide on house walls. This is an important debate, because if the decision is to go with the former approach, then aid agencies will continue to use public funds to press countries to abandon their uses of indoor spraying to control malaria.

To gain a historical perspective, if we were to look from our 2004 vantage point

[1] ProMed Notice "Malaria Reemerges-Korea", http://www.tmd.ac.jp/med/mzoo/ProMed/971118.html. Also: Ree, HI. Unstable vivax malaria in Korea. Korean J Parasitology 38(3):119-138.
[2] Malaria profile DPR Korea, http://w3.whosea.org/malaria/profile-dprk.htm.
[3] Attaran and Maharaj. Ethical debate: doctoring malaria, badly: the global campaign to ban DDT.BMJ. 2000 Dec 2; 321 (7273):1403-5.

back over the history of global strategies to control malaria, we would see a period of failure followed by a period of great success followed by a period of failure.

The first period covers the years before the mid-1940s. In this era, public health officials tried many methods of malaria control. Most of these methods failed, and malaria remained largely unabated. The second period, the era of intensive household spraying programs, came after the mid 1940s. Health officials sprayed small quantities of DDT on the interior walls of a house, a process known as indoor residual spraying (IRS). To contrast the small quantity on walls with agricultural usage, the amount used on just ten acres of cotton during a growing season would be sufficient for spraying enough houses to protect 4500 people. Additionally, agricultural use puts the chemical directly into the environment and the food chain. When used in malaria control, the chemical is put only on house walls.

House spraying controlled malaria and even eradicated it in some regions. The period of spraying and its intensive control of malaria lasted for about 33 years, ending in 1979. In 1979, the World Health Organization strategy for malaria control changed to de-emphasize indoor spraying[4]. In 1985 WHO further distanced itself from indoor spraying in a World Health Assembly resolution (38.24) that directed countries to decentralize malaria control programs[5]. Those changes in global strategies brought most effective spraying programs to an end. Instead of spraying, WHO and donors like USAID place an emphasis on case treatment, community participation, and integrated vector management[6]. This modern strategy for malaria control has failed[7]. Since the startup of the "Roll Back Malaria" initiative in 1985, malaria rates have actually increased[8].

In contrast to the results of WHO's current malaria control strategy, results with

[4] Seventeenth Report, WHO Expert Committee on Malaria. *WHO Tech. Rep. Ser. No. 640* (1979).
[5] H. Gilles, D.Warrell, *Bruce-Chwatts' essential malariology*. Edward Arnold, Boston (1993).
[6] Implementation of the global malaria control strategy. *WHO Tech Rep Ser 1993, no. 839* (1993).
[7] http://www.rbm.who.int/amd2003/amr2003/ch1.htm
[8] G. Yamey. British Medical Journal: Roll Back Malaria: a failing global health campaign. 8 May 2004: http://www.accessmed-msf.org/prod/publications.asp?scntid=13520041552454&contenttype=PARA&

indoor spraying, and especially spraying with DDT, were spectacular. Almost without exception, when DDT was sprayed on interior house walls, it rapidly brought malaria rates down or completely eradicated the disease.

Just as the use of DDT in house spraying brought spectacular reductions in malaria, declining use of house spraying brought spectacular increases in malaria[9]. Data from countries of the Americas clearly document changes in malaria rates that coincide with changes in house spraying rates (Figure 1). Data[10] from Asian countries show similar relationships. Figures 2-5 contrast malaria rates in recent years with the years when DDT was used. The data represent annual parasite indexes (a population-based index of malaria prevalence) during the period from 1995-99 compared with identical data from 1965-69. Differences in rates for the two performance periods are stunning.

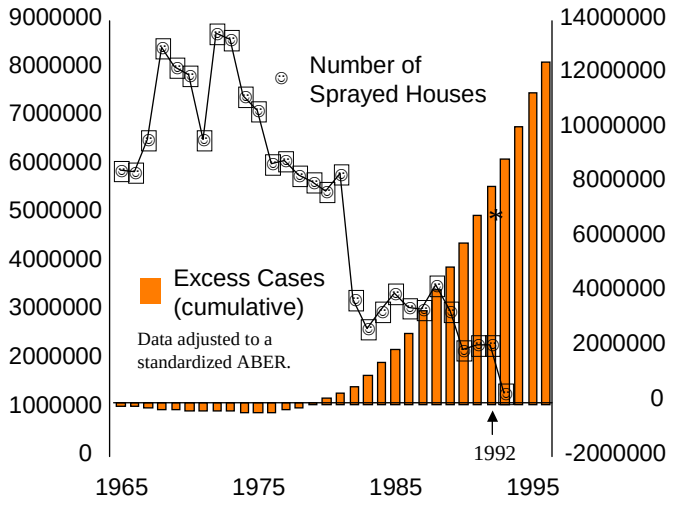


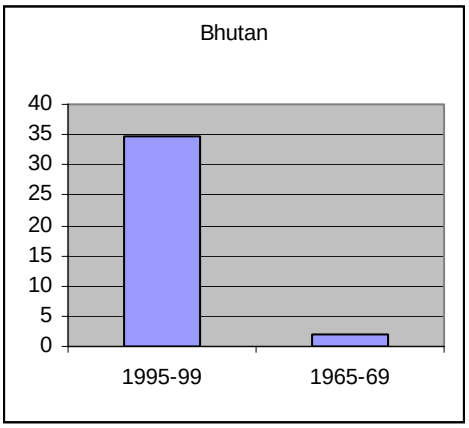
Figure 1. Impact of World Health Organization malaria control strategy in 1979 to de-emphasize indoor spraying of house walls and adoption of World Health Assembly resolution in 1985 to decentralize malaria

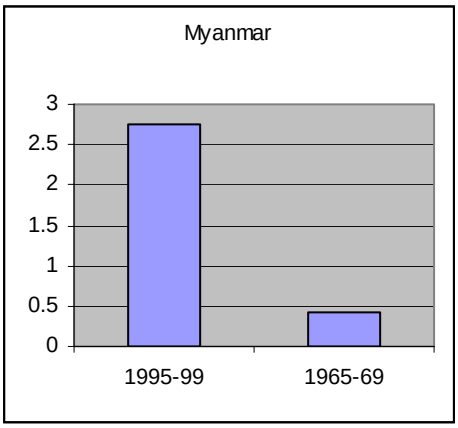
[9] D. Roberts, et. al. DDT, global strategies, and a malaria control crisis in South America. *Emerg. Inf. Dis.* **3**:297 (1997). Also: Roberts, Manguin, Mouchet. 2000. DDT house spraying and re-emerging malaria. Lancet 356:330-332.

[10] Data presented in graphs were extracted from WHO reports: WHO, malaria profile: http://w3.whosea.org/malaria/pdf/ino.pdf

control programs. Line graph represents numbers of sprayed houses. Bar graph represents cumulative numbers of excess cases over average numbers per annum for period 1965 to 1979. Left axis represents numbers of sprayed houses and right axis represents numbers of excess cases. Data presented for Brazil, Colombia, Peru, Ecuador and Venezuela. *First year number of excess cases grew by more than a million cases per year.[11]

Today, out of 30 countries in Asia, Bhutan, Myanmar, and Sri Lanka are the three most malarious[12]. In Bhutan, the malaria burden has grown 17.5-fold since the period when DDT was sprayed on house walls. For the countries of Myanmar, Sri Lanka, and India, malaria rates have grown 6.7-, 6.4-, and 807-fold, respectively.



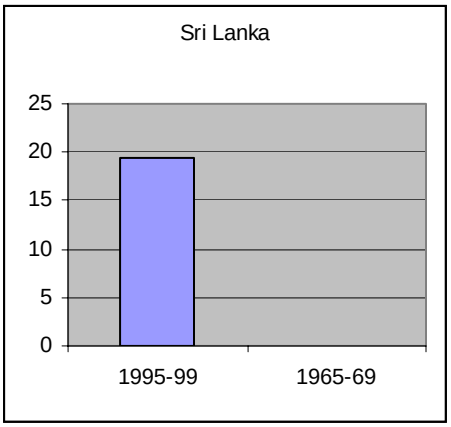


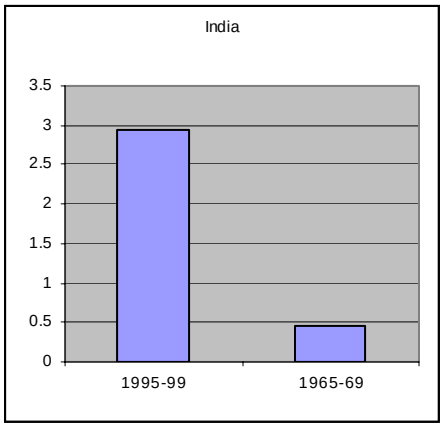
Figures 2 and 3. Annual parasite indexes (APIs) for Bhutan and Myanmar for comparison periods of 1995-99 versus 1965-59[13]. The latter (1965-69) covers a period when DDT was used to spray house walls for malaria control. The period 1995-99 represents a period when DDT was not used to spray houses. Left axes represent API values, or the number of cases per thousand population.

[11]Data extracted from:PAHO reports "Status of Malaria In the Americas." Calculations of numbers of cases derived by standardizing slide positive rates per 1000 population according to a standardized annual blood examination rate. Standardized rate was calculated as average for each country during period of 1965 to 1979. Adjustments were made for differences in size of population across 5 countries.

[12] Malaria rate by country:http://www.overpopulation.com/faq/health/infectious_diseases/malaria/asia.html.

[13] Data presented in graphs were extracted from WHO reports: WHO, malaria profile: http://w3.whosea.org/malaria/pdf/ino.pdf





Figures 4 and 5. Annual parasite indexes (APIs) for Sri Lanka and India for comparison periods of 1995-99 versus 1965-59[14]. The latter (1965-69) covers a period when DDT was used to spray house walls for malaria control. The period 1995-99 represents a period when DDT was not used to spray houses (still used to a greatly reduced extent in India). Left axes represent API values, or the number of cases per thousand population.

WHO, however, touts one Asian country as a success story of its modern malaria control strategy, Vietnam. A WHO report[15] entitled "A STORY TO BE SHARED: THE SUCCESSFUL FIGHT AGAINST MALARIA IN VIETNAM" recounts the story of this success. The report describes Vietnam's transition from a program based on indoor spraying using DDT to a program of spraying with Icon (a pyrethroid) and treated nets, as well as changes in strategies of case detection and case treatment. If this is the success story that is the basis for USAID's and WHO's current strategies for malaria control, they need to re-evaluate the lessons this story teaches.

The story begins in 1991, when over a million cases of malaria occurred in Vietnam, and ends in 1999, when the number of cases of malaria dropped to under 400,000. The report's overview states that the government completely changed the malaria control strategy in 1991 away from use of DDT, implying that this was a voluntary change. In fact, I visited Vietnam's control program in the early 1990s. Government officials told me that they wanted to use DDT, because it still worked well in Vietnam, but Vietnam had long ago used most of its DDT stocks. The government had been trying to get DDT for several years. However international agencies and foreign

[14] Data presented in graphs were extracted from WHO reports: WHO, malaria profile: http://w3.whosea.org/malaria/pdf/ino.pdf
[15] WHO WPRO. 2000. A Story to be Shared: The Successful Fight Against Malaria in Vietnam. 15pp.

donors refused to help the government make those purchases. Vietnam didn't choose to switch to another insecticide. It had no choice but to switch. I have heard this same story of international agencies and donors like USAID blocking use of DDT in country after country, in both Asia and the Americas.

Despite its unwilling switch, Vietnam did have significant reductions in malaria between 1991-1999, brought about by the use of indoor spraying, effective case treatment, and the use of treated nets. When indoor spraying is used, malaria cases drop immediately, which is fortunate as the use of nets grew slowly in Vietnam. The costs of the program however skyrocketed. In 1991, malaria control cost $US 540,000. From then to 1999, the malaria program cost $US 28 million (about $US 3.5 million per year), and it didn't yield as large a decline in malaria cases as control programs had in the past. In earlier years when the country carried out DDT spraying, malaria declined by a factor of 20-fold (2000%) in the north and 4-fold in the south. In 1999, Vietnam reported 350,000 cases, representing a 2.9-fold decline from number of cases in 1991. In areas where malaria is brought under control, treated nets are the primary preventive measure. House spraying remains the primary means of control in remote areas, areas of persistent malaria, and in outbreak areas. Although Vietnam has enjoyed some success, the 350,000 cases in 1999 represents a lot of malaria, making Vietnam the fourth most malarious country in Asia[16].

WHO and others seem to overlook the fact that effectiveness of the Vietnam system seems dependent on the authoritarian rule of a socialist system and its extensive network of rural communes. The report states that once a year re-treatment of nets is not adequate and nets must be retreated every 6 months, which requires an extensive network of trained malaria control workers. Additionally, Vietnam workers declared in "final words of wisdom" that control requires a strong national program, one with a dedicated team, a high level of support and a fair amount of vertically controlled components. Ironically, WHO has worked diligently to eliminate the vertical components of malaria

[16] Malaria rate by country:http://www.overpopulation.com/faq/health/infectious_diseases/malaria/asia.html

control programs, going so far as to direct countries to eliminate those infrastructures[17], which Vietnam thinks were so critical to its success.

It is in fact quite peculiar that WHO and aid agencies such as USAID tout Vietnam's control effort as such a success story. The program bucks WHO policy in that house spraying remained a key part of control and the community participation, which WHO considers such a triumph, was not the result of the spontaneous embrace of the people, but rather directed by a strong centralized, authoritarian government.

Vietnam however is not the only country in Asia to control malaria. Thailand, a nearby country with similar vectors, environments, and malaria problems, has not embraced treated nets and community participation to the extent as has Vietnam. Indoor spraying remains, as it has for decades, the mainstay of Thailand's preventive measures. In 1999, out of the 30 Asian countries, Thailand was the 11th most malarious country in Asia; Vietnam was the 4th. Yet even though Thailand has similar conditions and far lower malaria rates[18] than Vietnam and has consistently maintained those lower rates for decades (See Figure 6, malaria rates for the comparison periods of 1995-99 and 1965-69), WHO and other aid agencies consider Vietnam the success story in Asia, not Thailand.

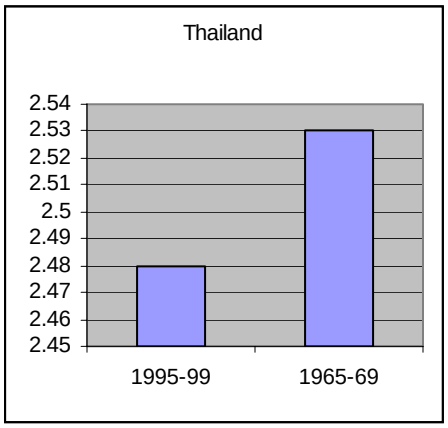


Figure 6. Annual parasite indexes (APIs) for Thailand for comparison periods of 1995-99 versus 1965-59. The latter (1965-69) represents a period when global eradication defined the methods of indoor spraying. The period 1995-99 is a period when indoor spraying was sustained, using DDT and other insecticides. Left axis represents API values, or the number of cases per thousand population.

[17] World Health Assembly adopted resolution 38.24 in 1985 calling on countries to decentralize their malaria control programs by moving malaria control into primary health care systems.
[18] WHO, malaria profile: http://w3.whosea.org/malaria/pdf/ino.pdf

Since the shift in malaria control policies that began in 1979 occurred, malaria has increased greatly in countries outside Africa (see Figures 1-5). In Africa, which had been excluded from the malaria eradication campaign of the 1950s and 60s, there is almost no evidence that malaria rates are changing for the better as a result of implementing the WHO program of case treatment, community participation, integrated vector management, and treated nets, but not indoor spraying[19]. On the other hand, countries in Africa that have gone against WHO doctrine and used indoor spraying, such as Madagascar[20] and Zambia[21], have seen large declines in malaria rates.

One fascinating aspect of attempts to implement WHO's current strategy for malaria control is that countries of Africa are the focal point of these efforts. This is doubtless due to Africa having the worst malaria problems in the world[22]. These countries were excluded from global eradication efforts and so have had limited experience successfully controlling their malaria problems. In this regard African nations are unlike many countries in the Americas and Asia that enjoyed high levels of success during the eradication era. Curiously countries that have had more experience with successful malaria control are less likely to adopt the use of treated nets. The Pan American Health Organization, for example, won't recommend them for malaria control in the Americas. Although donors provide generous funds for net use, nets are only now gaining a foothold in control programs outside Africa. As this occurs, the countries of Africa, frustrated by their continuing high malaria rates, are expressing interest in using indoor spraying.

As I stated at the beginning of this testimony, a large part of the debate about best practices for preventing malaria is whether to use insecticide treated nets as the only

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[19] G. Yamey. British Medical Journal: Roll Back Malaria: a failing global health campaign. 8 May 2004: http://www.accessmed-msf.org/prod/publications.asp?scntid=13520041552454&contenttype=PARA&

[20] Description of DDT use in Madagascar described on the Malaria Foundation International website: http://www.malaria.org/DDTEconomist14_XII_00.html.

[21] Sharp et al. (2002) "Malaria control by residual insecticide spraying in Chingola and Chililabombwe, Copperbelt Province, Zambia" Tropical Medicine and International Health, 7, no. 9:732-36.

[22] Ranking of countries by malaria mortality: http://www.overpopulation.com/faq/health/infectious_diseases/malaria/asia.html

preventive measure or whether to open the field to both the use of insecticide treated nets and the indoor spraying of small quantities of insecticide on house walls. Frankly, I am surprised that we are having this debate at all. There is no scientific basis for stopping or preventing indoor spraying of insecticides. On the contrary, replacing spraying with nets defies a fundamental lesson of preventive medicine.

Clearly delineated within the annals of occupational preventive medicine is the fundamental truth that the least desirable preventive measure for reducing environmental risk is reliance on personal protective measures[23]. We have certainly learned this lesson over and over again in the military. This principle is expressed in the form of patients failing to take a full course of drugs, failure of troops to wear uniforms properly to prevent insects from biting, or failure to properly apply topical repellents, or failure to use their bed nets.

It is a fundamental fact that proper use of nets requires user compliance. The user must be educated into proper use and must then be highly disciplined in proper use, night after night after night. Additionally, the user must be conscientious and follow a routine of repairing nets and retreating nets with insecticides. Another fundamental aspect of personal protective measure is that the measure may not lower overall environmental risk. For example, placing infants or pregnant women under treated nets may do little to lower risk for others in the household. For these reasons, even if we were certain of full user compliance, we would still need to be certain the practice would truly deliver a meaningful level of disease prevention. This is an important question, and I will present one single study to illustrate why we should worry about that specific issue opposed to blanket acceptance of treated nets as the only approach to malaria prevention.

A bed net study was conducted in the small and highly malarious Phan Tien

[23] Rom, WN. Editor. Environmental and Occupational Medicine, Third Edition. Lippincott-Raven Publishers, Philadelphia, PA:1753-1755. Also: Olishifaki, JB, Editor-in-Chief. Fundamental of Industrial Hygiene, Second Edition. National Safety Council. Section on Fundamental Concepts, pages 35-39.

village in southern Vietnam from 1995 to 1999[24]. Case treatment and treated net use was closely supervised and tightly monitored. Malaria was reduced, but, as stated by the investigators, "The number of passive cases [cases coming to the clinic for diagnosis and treatment] had dropped steadily from year to year (despite an increase in population), but rose again in 1999." The investigators also stated "After 1997, when malaria incidence had started to decline, the population became less interested in participating." This is a very telling statement that confirms the weakness of methods that require sustained user compliance. My summary of this study is that at the beginning in 1995 there were 104 cases of falciparum malaria, in the last year of the study, in 1999, there were 102 cases. So, after five years of costly effort, there had been a 2% drop in falciparum malaria, a difference of 104 cases versus 102.

To iterate, the fundamental lessons of occupational preventive medicine is that use of personal protective measures is the least desirable of methods for reducing environmental risk. The flip side of this principle is that the most desirable method for reducing environmental risk is to engineer risk out of the human environment[25]. The use of indoor spraying is absolutely consistent with that fundamental principle of preventive medicine. Let me explain why.

Most cases of malaria are acquired inside houses. Mosquitoes that aggressively enter and bite indoors transmit the infections. Indoor residual spraying can act to prevent mosquitoes from entering houses in the first place. If they still enter, then chemical contact indoors may stimulate mosquitoes to exit without biting, or if they remain indoors, the chemical can, with longer contact, kill the mosquitoes. In other words, the chemical applied to house walls exerts multiple and sequential actions to prevent indoor transmission of malaria and other diseases[26].

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[24] Hung, LQ, et al., Control of malaria: a successful experience from Vietnam. Bulletin of the World Health Organization 2002;80:660-666

[25] Rom, WN. Editor. Environmental and Occupational Medicine, Third Edition. Lippincott-Raven Publishers, Philadelphia, PA:1753-1755. Also: Olishifaki, JB, Editor-in-Chief. Fundamental of Industrial Hygiene, Second Edition. National Safety Council. Section on Fundamental Concepts, pages 35-39.

[26] Roberts, DR, et al., 2000. A probability model of vector behavior: Effects of DDT repellency, irritancy and toxicity in malaria control. J. Vector Ecol. 25(1):48-61.

These relationships explain why indoor spraying has been so wonderfully effective in combating malaria and other diseases. I want to emphasize that lack of effectiveness is not the reason that WHO and bilateral and multilateral donors have pressed countries to stop indoor spraying. To the contrary, indoor spraying has been and continues to be the most highly effective measure yet discovered for malaria prevention. WHO, USAID and others argue that indoor spraying should not be used because it requires a strong and well-developed public health infrastructure. This is a contrived argument that ignores the lessons from the history of malaria control. House spraying was used to dramatically reduce malaria in many countries of the world long before WHO defined the organizational structures for malaria eradication by use of indoor spraying. The countries accomplished those great achievements largely on their own accord. I can think of two remarkable examples, one is Guyana and another is Taiwan. Guyana began experimenting with indoor spraying in 1946. The country quickly instituted a national program of indoor spraying and reduced malaria by 99% within 3 years[27]. Taiwan began a national program in 1952 and had reduced numbers of cases from 1.2 million per year to just 676 in 1956[28]. These accomplishments predated the beginning of malaria eradication. In comparison, during the last 20 years treated nets have been pilot tested in many countries. There is not one result that is even remotely comparable with the performance of indoor spraying in Guyana or Taiwan.

The infrastructure argument against indoor spraying also ignores the fact that WHO, bilateral, and multilateral agencies have implemented policies and strategies under a 1985 WHA resolution that have effectively eliminated infrastructures they claim are needed for indoor spraying. So it is extremely disingenuous to say a method cannot be used because infrastructure does not exist, when those who oppose using the method are directly responsible for eliminating the needed infrastructures in the first place.

[27] Giglioli, G. 1951. Eradication of Anopheles darlingi from the inhabited areas of British Guiana by DDT residual spraying. J. National Mal. Soc. 10:142-161.
[28] Depart of Health, Republic of China, Malaria eradication in Taiwan (Department of Health, Republic of China), p 183.

What I have described in the preceding text and figures is a struggle between public health science and an environmental ideology. It is an ideology that strives for an environmental utopia, an environment free of man-made chemicals. The ideology is strong, pervasive and extremely destructive. It prioritizes a scientifically unfounded risk of environmental harm over the basic health needs of the world's poorest and most vulnerable people. As the driving force behind the modern policies for malaria control, it ignores the time honored practice of malaria control to use all available measures to curb the disease, and replaces it instead with partial control measures adopted because they are apparently more palatable to those living in developed countries. Our national and international bureaucracies put this ideology over the needs of poor people in developing countries. I, along with many others in the malaria control community, do not agree with this ideology. This ideology has created a colossal public health and humanitarian disaster. In particular, we object to the use of public funds to pressure developing countries to comply with policies and strategies that increase the risk of disease and death. It is an irrefutable fact that for over two decades WHO, bilateral and multilateral donors, and other international agencies have been pressing countries to abandon indoor spray programs. The world has already paid an enormous price in lost life, lost economic vitality, and lost human welfare as a result of those practices. It is time to stop this flagrant use of public funds to force compliance with a scientifically fraudulent and immoral ideology.