

Lives on the Line: DDT, Malaria, and Infant Mortality

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For half of the world, Dichlorodiphenyltrichloroethane (DDT) is a gift from God sent to remove the burden of death from the shoulders of the poor; for others, it was concocted in the fiery depths of hell to silence the birds and wreak untold havoc upon human reproduction. The often bitter international debate between these two factions has not only focused on the question of *what* the risks of DDT are, but *for whom* do these risks apply. In the late 1960's and early 1970's developed countries world wide curbed their heavy dependence on DDT. Through this act, policy makers demonstrated DDT's clear threat to environmental health and the possible, but highly uncertain, risks for human health greatly outweighed the benefits as a pesticide and insecticide [1]. The subsequent restrictions on DDT use imposed on developing countries did not properly address the risks involved in discontinuing DDT use for vector control purposes [2,3].

Developed nations, who universally do not use DDT [4], are faced with no immediate threat of DDT incited, or controlled, diseases, the debate has shifted to the relative benefit of DDT within developing nations. The risks and uncertainties associated with either DDT's continued use or elimination are highly dependent on local conditions. This has been grudgingly acknowledged by the international community, as can be seen by the exceptions to the Stockholm Convention on Persistent Organic Pollutants that allow for some use of DDT for vector control purposes [5].

DDT Then: Risks and Uncertainty

In the late 1960's and 70's when countries began to ban DDT, malaria had been eradicated in virtually all developed nations and its primary use in those countries was as an agricultural insecticide [6]. The most notable threats resulting from using DDT as an industrial scale pesticide were environmental. By 1970 it had been clearly demonstrated that DDT was directly responsible for reproductive failure in many species of birds and large fish kills throughout the United States [6].

Although environmental concerns were the primary reason for banning DDT in many countries, other concerns related to human health were also raised. Anecdotal studies regarding DDT as a carcinogen, mutagen, or nerve toxin further enforced the public's fear of this insecticide [7]. Despite that fact that most, if not all, of the studies relating human diseases to DDT exposure were statistically insignificant or irreproducible, the risks appeared so great that policy makers invoked the precautionary principle and preceded with a ban on all uses of DDT, except in emergency cases of disease outbreak [1].

Developing nations at this time, many of whom were still battling malaria, evaluated the risk of DDT differently. There was little doubt that use of DDT for vector control directly correlated to reduced incidents of malaria. The lower life expectancy and higher infant mortality in these nations reduced the relative risk of carcinogens and mutagens. Therefore in countries with a high malaria burden, the clear benefits of DDT use outweighed the highly uncertain long term affects of DDT exposure because the risk was higher and the affect more direct [8].

DDT Now: Risks and Uncertainty

DDT has been universally banned in developed nations since before the Stockholm Convention on Persistent Organic Pollutants [4]. Because the import of foodstuffs with DDT residues was prohibited in the developed countries, use of DDT for agricultural purposes world wide was virtually eliminated. The result of this is that the only possible exposure to new sources of DDT for developed nations would be environmental transport of the substance across great distances. With the large reduction in agricultural use, the probability and magnitude of this exposure route is vanishingly small.

The risks and benefits of DDT use lie solely in developing countries with high malaria burden. The primary international debate is about using DDT in indoor spraying for malaria vector control. Indoor house spraying of DDT with the standard rate of 2g/m^2 [9] could treat all of the houses of Guyana's high malaria risk population with the same amount of DDT that would be used on 0.4 km^2 for agricultural purposes [4] and only a fraction of this would be transported outside, so environmental effects can be considered negligible from this source. To assess the relative risks of using DDT in domicile spraying campaigns for malaria control verses no malaria control, the worst case scenario in terms of human life have been calculated for each case based on the prevailing literature.

- Risks of no malaria control

90% of deaths from malaria occur in sub-Saharan Africa, and the vast majority of those deaths occur in children under the age of five [8]. Infant mortality directly caused by malaria has been estimated at 9 in 1000 per year in areas where malaria is prevalent [10]. DDT has not been widely used in sub-Saharan Africa because it was not deemed feasible by the World Health Organization (WHO) [11]. DDT is currently being used in

23 countries for malaria control [6]. Multiple studies have indicated that reduction in DDT use is correlated with malaria resurgence [12, 13], indicating that the risk of not using DDT would also include the lives that would be lost in the rest of the world that currently has malaria under control. The total number of lives expected to be lost if DDT use were to be discontinued is difficult to determine. Anti-malaria campaigns have routinely included improved health care and other benefits that could be continued without DDT and have contributed substantially, but unquantifiable, to reductions in mortality [10]. Assuming perfect application and effectiveness, virtually all malaria caused deaths could be avoided by DDT. Malaria also poses monetary risks for developing nations, including but not limited to loss of revenue from tourism and loss of worker productivity.

- *Risks of DDT use*

Long term exposure to DDT has been tentatively correlated with numerous reproductive disorders in humans, including reduced semen quality, probability of pregnancy, spontaneous abortion, preterm delivery, reduced birth weight, increased chance of gender-related birth defects, and shortened duration of lactation [10]. Women exposed to DDT only through indoor house spraying in Kwa-Zulu had as much as 59.30ppm concentration of DDT and its derivatives in their milk fat. Calculating the daily intake of infants consuming breast milk with the average concentrations of DDT found in this study results in 0.376 mg/kg/day, almost 19 times the WHO Allowed Daily Intake (ADI) [9]. These values substantially exceeded those found to be associated with reduced lactation in Mexican and US women; concentrations of exposure related to preterm birth and spontaneous abortion are more difficult to compare because they are measured as micrograms/L of serum [10]. Assuming the worst case scenario that DDT

does in fact cause these disorders, and combining these results with studies on the effects of preterm birth and reduced duration of lactation on infant mortality, continuous indoor DDT spraying could result in up to 20 deaths per 1000 live births in the affected population [14].

Despite the large body of scientific literature surrounding DDT, no two studies have been able to directly confirm or refute each other. This is due primarily to conflicting study parameters, whether it be sample size, which isomer of DDT is being tested, or the level of concentration that is being examined [10]. Consequently, the uncertainty regarding DDT's negative affects on human health is large and unquantifiable because it consists not only of the scientific uncertainty of each study, but also the unknown uncertainty regarding the works' validity.

Uncertainties and the Policy Response

Both scenarios have large, primarily unquantifiable uncertainties. DDT application in sub-Saharan Africa has been anything but perfect. Irregular spraying and plastering over or washing sprayed walls are some of the many things that reduce the effectiveness of DDT campaigns [15]. Yet in other regions, DDT has virtually eliminated transmission of malaria, therefore approaching the perfect scenario[16]. The uncertainties related to the effectiveness of DDT spraying, therefore, arise primarily from societal differences that are so diverse that they are virtually impossible to quantify. The risk of not using DDT can also be diminished by implementation of alternative Malaria control methods, such as land management, aggressive health care initiatives, and other insecticides [8].

The uncertainties related to the negative effects of DDT exposure in humans are primarily scientific. Time limitations, lack of controls, and methods of data collection

have greatly increased the uncertainties of effects on humans. Studies that could accurately track the relation of DDT exposure to long term effects in humans would require decades, something that is impractical for a variety of reasons. The alternative, which is to use data bases and census information from decades ago introduce unquantifiable uncertainty due to lack of necessary variables and variances in collection techniques between different databases, making them difficult to compare. Short term studies can give some insight, but for the most part have only been capable of showing exposure to DDT and correlations, not effects [17]. Some of the uncertainty could be reduced by independent researchers conducting studies using the same parameters as previous studies so that the results could be directly compared.

Uncertainties have been used by proponents of both DDT house spraying and the banning of DDT for all purposes. Scientists and policy makers in favor of continued DDT use cite the large uncertainty regarding the negative effects of DDT on people and the relatively nonexistent uncertainty regarding DDT's lethality to mosquitoes. Scientists and policy makers in favor of ending DDT use emphasize the enormous risk of possible DDT induced disorders, the certainty of DDT's effects on the environment, the ineffective use in parts of Africa, and growing mosquito resistance world wide as reasons to provoke the precautionary principle.

The risks and benefits of DDT use vary by region depending on the feasibility of sustained house spraying. In areas where DDT spraying has been successful, such as significant portions of South and Central America, and Asia, the risk of eliminating DDT from the malaria control program is large and there is little uncertainty that the number of malaria cases is inversely related to DDT use. In areas where DDT house spraying has been deemed ineffective, discontinuing its use would present a lower risk. Risk/benefit

analyses of DDT use must be conducted independently for different regions and situations, something that has been reluctantly acknowledged by the international community of developed nations up to this point.

Sources

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