

Dichlorodiphenyltrichloroethane (DDT): A Weapon Missing From the U.S. Department of Defense's Vector Control Arsenal

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Per the National Academy of Sciences: "To only a few chemicals does man owe as great a debt as to DDT." That same committee concluded that in less than two decades of use, dichlorodiphenyltrichloroethane (DDT) had prevented 500 million deaths from malaria.¹ So, what has been the history of DDT use by the U.S. military? How did a chemical with such an amazing ability to halt the spread of disease itself end up virtually eradicated in only 2 years? Is there evidence that DDT can be used safely and effectively? And, what are the current risks to U.S. military personnel?

ARTHROPOD-BORNE DISEASE, THE U.S. MILITARY, AND DDT

The list of arthropod-borne illnesses that have plagued humankind throughout its history reads like a Who's Who of infectious disease: malaria, yellow fever, typhus, dengue, plague, encephalitis, leishmaniasis, filariasis and, more recently, West Nile virus. It has been estimated that at least 80% of human infectious disease results from arthropods. Like all other segments of the population, military organizations, including those of the United States, have a long history of falling victim to these often deadly pests. But for all the variety of diseases, the most consistent threat has been malaria, transmitted by *Anopheles* mosquitoes. As COL Christian F. Ockenhouse of the U.S. Army's Medical Corps stated: "More so than any other infectious disease, malaria has all too often affected the conduct of military operations in war and in some cases has disproportionately influenced the outcome."

From July 9 to September 10, 1943 in Sicily, there were 21,482 hospital admissions for malaria compared with 17,375 battle casualties. Field testing of DDT began in Italy in August 1943 using the indoor residual spraying (IRS) method. Malaria had reached its peak in the theater in 1943, with 32,811 cases (excluding readmissions). By 1945, it had fallen to 5,765. This is not to imply that all improvement was the result of DDT alone, but there is no denying the impact. Postwar mosquito abatement programs throughout the world would include DDT. By 1959, the United States, Europe, portions of the Soviet Union, Chile, and several Caribbean islands were nearly malaria free.²

DDT has also been a useful tool in the control of other arthropod vectors, and their illnesses, which have histori-

cally plagued military operations. *Aedes aegypti*, the mosquito vector of yellow fever; *Pediculus humanus humanus* (the common body louse) vector of typhus; and *Phlebotomus argentipes*, the sandfly vector of visceral leishmaniasis, are just some of the more significant examples of communicable diseases that showed a significant decline in the face of DDT.

THE CASE AGAINST DDT

The major push against DDT began in 1962 with the publication of Rachel Carson's *Silent Spring*. This book has been largely credited as the basis of the argument against DDT and also with the founding of the modern environmental movement. Along with allegations from Ms. Carson's work, there also came a rash of questionable scientific claims that labeled DDT responsible for everything from cancer in humans, to causing birds to drop from the sky dead.³

Finally, after years of controversy, the Environmental Protection Agency, which had begun operations on December 3, 1970, under the Nixon Administration, began holding hearings. On April 25, 1972, after 80 days of testimony, Hearing Examiner Edmund Sweeney issued a 113-page decision. In it he wrote: "DDT is not a carcinogenic, mutagenic, or teratogenic hazard to man. The uses under regulations involved here do not have a deleterious effect on fresh water fish, estuarine organisms, wild birds, or other wildlife . . . and . . . there is a present need for essential uses of DDT."⁴

Unfortunately, this decision would not stand for long. On June 2, 1972, Environmental Protection Agency Administrator William Ruckelshaus issued a 40-page decision banning the chemical. In this document, Ruckelshaus omitted most of the scientific data; misnamed major chemicals involved; and proposed that farmers should use organophosphates, like carbaryl (actually not an organophosphate), instead.⁵

THE CASE FOR DDT

A review of scientific data fails to uphold the vast majority of the significant adverse claims against DDT. Although there is evidence of high levels of exposure recorded in biological samples collected near the time of peak use during the 1960s, there is conversely a dearth of evidence of significant adverse effects related to those levels. In fact, historical evidence would seem to suggest no such link exists. For example, Montrose Chemical Company employees had 1,300 man-years of exposure, and there was never any case of

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cancer during 19 years of continuous exposure at levels of approximately 17 mg/man/day.⁶

In a public demonstration of the chemical's safety, esteemed entomologist Dr. J. Gordon Edwards would eat a spoonful before each speech or lecture on the subject. He had applied DDT powder to himself and his men while serving in Italy during 1944. By 1971, Edwards estimated that he had consumed over 200 times the typical human intake. He would continue this practice until his death at age 84 from a heart attack he suffered while climbing Divide Mountain at Glacier National Park.

Other significant claims against DDT, such as massive declines in avian populations, deaths of shellfish and freshwater algae, and purported antiandrogenic effects, have all been shown to have only shaky scientific foundations at best. The World Health Organization reviewed this data, as well as its own, and recommended the continuation (many countries in Africa, particularly sub-Saharan ones, had continued to use this method) of the IRS method of application. Specifically, the World Health Organization cited increased deaths from malaria since the 1970s, along with extensive research and testing that revealed using the IRS method of DDT application poses no harm to humans or to wildlife.⁷

WHAT ARE THE CURRENT RISKS TO U.S. MILITARY PERSONNEL?

Per Col. (Dr.) Peter Weina, chairman of the Defense Department's severe malaria program, there were 83 new cases of malaria reported among U.S. personnel in 2008. Of these, 55 were contracted in Central Asia and the Middle East, 22 in "unknown" locations, 1 in Korea, 3 in Africa, and 2 in Central or South America. This concern may become even greater as resistance to mefloquine (one of the U.S. military's first-line prophylactic medications) appears to be increasing.

Cases of leishmaniasis may be down among U.S. personnel, but Army officials are concerned that this may be because of underreporting. The Army Medical Surveillance Activity reports that at least 1,300 soldiers have been diagnosed with "clinically significant" cases of cutaneous leishmaniasis since deployment to Afghanistan or Iraq. However, a report in the Boston Globe puts the number at 2,500, and the number may be even greater when subclinical infections are included. The Army Medical Command is vague about the number of visceral cases but agrees that it is "very low." No deaths among U.S. personnel have been reported, but there have been reported cases among military working dogs.

Finally, it appears that the Army's old nemesis *Cimex lectularius*, the bed bug, appears to be staging a comeback. Despite literary reports that may trace bed bugs as far back as Aristotle, the military had enjoyed a respite thanks to DDT.

Beyond the risk posed by illness, consideration must also be given to the risks associated with the currently used methods of prophylaxis. There have been increasing concerns raised over the primary insect repellent currently used by the U.S. military, *N,N*-diethyl-3-methylbenzamide, also known as DEET. DEET targets the olfactory system in insects, humans, and other mammals, where it enters and inhibits cholinesterase activity. This is the same method of action as the class of chemical weapons known as "nerve agents." At least one study has concluded: "... findings question the safety of DEET, particularly in combination with other chemicals, and they highlight the importance of a multi-disciplinary approach to the development of safer insect repellents for use in public health."⁸

One of the primary forms of chemoprophylaxis most commonly used by U.S. forces is mefloquine. A well-designed double-blind comparison of various forms of chemoprophylaxis conducted in 2003 listed side effects that ranged from skin problems and gastrointestinal difficulties all the way to significant neuropsychiatric issues. Also of note from this study, when all the various forms of chemoprophylaxis analyzed were compared, 85% of the study participants reported some type of adverse event, regardless of which study arm they were in.⁹ Other concerns with mefloquine include the significant list of contraindications, such as noncompatible medications, significant teratogenic effects, and history of depression or psychiatric problems.

CONCLUSION

Despite its extremely short relative history of use, DDT has been able to claim a place as one of the most effective agents ever known against arthropod-borne illnesses. It has a track record of being relatively cheap, easy to use, and highly effective. Questions over its safety on a large scale may be politically untenable, but the IRS method of use in individual buildings and on personal protective equipment seems to pose little or no hazard. And though there are now increased concerns over issues such as pesticide resistance, perhaps new scientific studies on DDT efficacy and safety would be able to demonstrate an appropriate role in U.S. military vector control operations? Certainly at a minimum, well-constructed comparative analyses of the safety of DDT and current prophylactic strategies should be undertaken.

REFERENCES

1. National Academy of Sciences, Committee on Research in the Life Sciences: *The Life Sciences*, p 432. Washington, DC, National Academy of Sciences, 1970.
2. Eskenazi B, Chevriar J, Rosas LG, et al: The Pine River statement: human health consequences of DDT use. *Environ Health Perspect* 2009; 117: 1359-67.
3. Stickel LF: Birds killed by DDT. *Ann N Y Acad Sci* 1971; 60: 162-71.

4. Hearing Examiner's recommended findings, conclusions, and orders. (40 CFR 164.32). EPA, 1972. Available at http://www.epa.gov/history/topics/ddt/1972_EPA_DDT_hearing.PDF; accessed October 25, 2012.
 5. Ruckelshaus W: Opinion and Order of the Administrator. In re: Stevens Industries, Inc., et al. (Consolidated DDT Hearings before the Environmental Protection Agency), 1972. Available at <http://www.epa.gov/history/topics/ddt/DDT-Ruckelshaus.pdf>; accessed October 25, 2012.
 6. Laws ER Jr, Curley A, Biros FJ: Men with intensive occupational exposure to DDT. A clinical and chemical study. *Arch Environ Health* 1967; 15: 766-75.
 7. World Health Organization: Malaria Vector Control and Personal Protection. WHO Technical Report Series No. 936. Geneva, Switzerland, World Health Organization, 2006. Available at http://whqlibdoc.who.int/trs/WHO_TRS_936_eng.pdf; accessed October 25, 2012.
 8. Corbel V, Stankiewicz M, Pennetier C, et al: Evidence for inhibition of cholinesterases in insect and mammalian nervous systems by the insect repellent DEET. *BMC Biol* 2009; 7: 47.
 9. Schlagenhauf P, Tschopp A, Johnson R, et al: Tolerability of malaria chemoprophylaxis in non-immune travellers to sub-Saharan Africa: multi-centre, randomised, double blind, four arm study. *BMJ* 2003; 327: 1078.
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