Blowing Up Dangerous Germs with Oily "Nano Bombs"

May 30, 1999 Ann Arbor, Michigan A few weeks ago I reported on *Dreamland* that the U. S. government is very concerned about biological warfare and bioterrorists. What would happen if anthrax spores, small pox or other dangerous infectious diseases were sprayed into the air above one or more American cities?

One new possible answer seems surprisingly simple and miraculously effective: drops of oil droplets so small they can adhere to the surface of deadly anthrax and small pox pathogens and literally explode the germs. That's why these oil drops are called "nano bombs." Nano means "one billionth." Smaller than viruses and bacteria.

This medical discovery is the work of Dr. James Baker, Professor of Medicine, Chief of the Division of Allergy and Immunology, and Director of the Center for Biologic Nanotechnology at the University of Michigan in Ann Arbor. He develops extremely small lipids and polymers that can be engineered at the protein and amino acid level.

The Defense Advanced Research Projects Agency, known as DARPA, started trying five years ago to find new ways to deal with bioterrorism. And for the last two years, DARPA has funded Dr. Baker's research into blowing up germs with a water and oil mixture in which the oil droplets are 1/100th the size of a human blood cell.

Interview:

James Baker, M. D., Director of the Center for Biologic Nanotechnology, University of Michigan, Ann Arbor, Michigan: "Essentially we've taken an old time observation that you could basically use detergent to disrupt bacteria and viruses and put a new spin on it. What we've done is actually encapsulate the detergent as a layer on the outside of oil droplets suspended in water. And because of the exact nature of this material, it very readily fuses with bacteria and viruses and delivers the detergent and the solvent on its surface to the bacteria and virus. This then causes a disruption of the membrane surrounding the bacteria and virus so it becomes unstable and literally explodes.

WHY IS IT THAT THE DROPLETS THAT BIND TO THE MEMBRANE COATING ON THE GERMS OR VIRUSES - WHY IS IT THAT IT DISRUPTS THE COATING SO MUCH THAT THESE ORGANISMS LITERALLY EXPLODE?
Well, there are two reasons for that. The first, and probably the most important is that the droplets are very small. They are actually on the same scale or smaller than the bacteria and virus.

COULD YOU PLEASE GIVE A WORD PICTURE FOR A RADIO AUDIENCE TO UNDERSTAND HOW THIS OILY WATER SUBSTANCE COULD BE USED IF THERE WAS AN ANTHRAX DROP OR DISPERSION IN THE AIR, LET'S SAY, OVER A CITY.

All right, let me give you a specific scenario that's been actually in the news. They held a mock attack in one of the subway stations in New York City. The problem was that both materials such as the train, the station and individuals were exposed. Currently, the only way to decontaminate is to use very high concentrations of formaldehyde and bleach - which number one, are very destructive to material, will probably ruin any type of paint or fabric or electrical type device in the area. And obviously are very toxic to human beings. So, there is no real way to decontaminate the area safely and to decontaminate the people safely.

This material can be used in a number of ways. It kills up to a dilution of 1:100. And at 1:100, it literally looks like skim milk and has about the same consistency and you could put it in a sprayer type device and literally spray down the whole station, the whole car, and within an hour or two, you could even spray it again. But within an hour or two about 99.9% of the spores have been killed.

ALL OF THE ANTHRAX SPORES WILL HAVE EXPLODED FROM THIS OILY WATER.
Right. In addition, you can take the people who have been exposed and also treat them topically to decontaminate them. If there are wounds that are contaminated, you can take this material and irrigate in the wounds. So, in fact, you can go in and decontaminate people as well as the environment. And in fact, by reducing the number of spores that are on people or are inhaled by people, you can go a long way in preventing the toxicity and the death associated with anthrax.

DOES THIS ALSO WORK ON THINGS LIKE CHOLERA AND LET'S SAY SOME OF THE BLOOD HEMORRHAGING EBOLA TYPE OF THING?
Yes, it does. So in fact, you could use it in a situation where you don't even know what's been released. And have the expectation that 99% of the potential organisms that might be used as a weapon would be inactivated.

HOW ARE YOU GOING TO INTERFACE NOW WITH MILITARY AND GOVERNMENT AGENCIES?
We are progressing through the Military Development Command, the Materiel Command, to perform field trials for the military this fall to evaluate this material as a decontamination agent.

AND THIS WOULD BE UNDER DARPA'S SUPERVISION?
No, this will be under the supervision of the U. S. Army Research and Development Command. I think we have very good data in small scale decontamination studies in our own laboratory that this material will be affective. The real issue now is how to translate it into some type of workable solution. I'm embarrassed to admit this, but we use garden sprayers and power painters to apply it. It's actually a very simplistic approach, but very effective. The military may want to use larger scale decontamination application situations for things like airplanes and other potential equipment that would be involved.

THAT WOULD SPEED UP THE PROCESS OF SPRAYING THE OILY WATER.
Exactly.

ASSUME THAT YOUR TRIALS WITH THE ARMY IN THE FALL OF 1999 GO WELL AND THE OILY WATER IS EFFECTIVE IN THE FIELD OPERATION. WOULD YOU IMAGINE THAT IF THERE WAS A TERRORIST AEROSOL DISPERSION LET'S SAY OVER NEW YORK CITY THAT THE ARMY OR DARPA OR SOMEBODY COULD COME IN WITH AIRPLANES TO DROP THE OILY WATER ALL OVER THE CITY FROM THE AIR?
That is one potential scenario, yes. I mean, you need to get good coverage. You need to make sure you get an appropriate layer of this material to interact with

the organisms. But certainly, the most remarkable thing is that this doesn't hurt the environment, doesn't hurt people and gives kill rates that are equivalent to bleach or formaldehyde. So, where you couldn't do that with any of the other agents available to treat this type of infection, anthrax, you could potentially do it with this material. You can go into a school and wash down children safely or go into an office and wash down wherever the letter was dropped or whatever and effectively take care of it and put people's minds at ease without having to put them in danger just from trying to clean up the place.

HOW LONG DO YOU THINK IT WILL BE BEFORE THIS IS BEING PRODUCED ON A LARGE SCALE FOR ANTICIPATION OF ANY TYPE OF A BIOTERRORISM ATTACK?
We have the capability to produce approximately 1600 liters/minute.

THERE AT THE UNIVERSITY OF MICHIGAN?
With one of our commercial associates. So we are already up to industrial sized production. The real limitation will be developing the lines of command and material transfer so that in that type of scenario, we can rapidly deploy the material. But it's very stable. We could storehouse it even in the concentrate which would reduce the volume needed and have it ready to go if something like that were to happen.

IT WOULD BE AFFECTIVE AGAINST ANTHRAX, CHOLERA, SMALL POX - IS THERE ANY BACTERIA OR VIRUS YOU'VE TRIED IT ON THAT IT DOESN'T WORK?
Yes. Non-envelope viruses. Things like adenovirus.

WHICH WOULD BE WHAT IN THE COMMON LANGUAGE?
Cold.

IT WILL NOT WORK AGAINST THE COLD VIRUS?
Well, adenovirus is one form of cold virus, yes. But most of the agents that cause severe diseases and are used as weaponized agents are envelope viruses or bacteria.

MEANING THE ENVELOPE IS WHAT CAN MERGE WITH THIS SOAPY OR OILY WATER?
Right.

WHY COULDN'T THIS SAME NANO APPROACH BE APPLIED TO INTERNAL MEDICINE THAT COULD KILL VIRUSES AND BACTERIA INSIDE PEOPLE?
Well, it can be used on mucosal surfaces. And in fact, one of the applications we are looking at is using it as a nasal spray where you would put it in your nose during flu season and if you inhaled flu virus, it would destroy it before it could infect you. The one problem with the material - there are a couple of problems and let me make those very specific for you. The first is that under certain conditions, it is unstable. You can't freeze it because that causes the separation of the oil and water phases. So, for some applications that require cold temperatures, it's unsuitable.

In addition, you can't give it intravenously because it turns out the only cell that is susceptible to this material is the red blood cell. Every other cell is resistant. So, you can't give it intravenously.

BECAUSE THEN ALL THE BLOOD CELLS WOULD EXPLODE.
Right. You could take plasma or infected wounds and whatever and irrigate it. And we have very nice animal studies that suggest with anthrax or with gas gangrene or the flesh-eating bacteria, we can actually have an effect in preventing wound infections by irrigating the wound with this material. So, there are internal applications where it can be used. It just can't be used systemically because of the problem with red blood cells."