

WHAT GOOD ARE GAS MASKS?

Contrary to some reports, chemists and military experts say that gas masks can protect against nerve gases such as sarin. Although sarin gas can seep through the skin, breathing it delivers a lethal dose about 400 times faster—so the mask could give you enough time to escape from a noxious cloud. The bad news is that you need to know whether the mask really works [surplus units are untested], how to put it on (the fit must be airtight), when to put it on (by the time you recognize the symptoms, it is probably too late) and when to take it off (the masks are too uncomfortable to keep on indefinitely). None of the experts interviewed for this article bothers to own a mask.

MORE ON MAIL-ORDER SARIN

An extended version of this article appears at www.sciam.com/explorations/2001/110501sarin/

THE EARLY HISTORY OF CONTAGION

The idea of using biological organisms as agents of warfare goes back to ancient times. In 400 B.C., for instance, Scythian archers dipped arrowheads in the blood of decomposing bodies, creating poisoned missiles.

1994 and 1995 attacks—and two of its relatives, soman and GF. His secretary then placed the order with Sigma-Aldrich, one of the nation's most reputable chemical suppliers. If any order should have rung the alarm bells, this one should have.

Instead Tour got a big box the next day by overnight mail. By following one of the well-known recipes for sarin—mixing dimethyl methylphosphonate, phosphorus trichloride, sodium fluoride and alcohol in the right amounts and sequence—he could have made 280 grams of the stuff or a comparable amount of soman or GF. (That's more than 100 teaspoonfuls.) All this for \$130.20 plus shipping and handling.

Nor would delivering the agent be rocket science. To avoid handling poisons, terrorists could build a binary weapon, which performs the chemical reaction in situ. An off-the-shelf pesticide sprayer could then blow the miasma into a building ventilation system. Depending on how well the sprayer worked and how crowded the building was, 280 grams of sarin could kill between a few hundred and tens of thousands of people. The Aum attack on the Tokyo subway involved about 5,000 grams and left 12 people dead, but the cult didn't use a sprayer.

To be sure, Tour is an established name



INGREDIENTS for making sarin.

and could probably order just about any chemical from Sigma-Aldrich that he wanted. Most suppliers, however, don't do any screening of their buyers. "You just go to an online distributor, you give them a credit card number, and it comes in the mail," he says. (SCIENTIFIC AMERICAN confirmed this by placing our own order from a small supply house.)

Nerve agent experts agree that something has to be done to keep tabs on such chemicals, especially since the other difficulties of mounting a gas attack seem less daunting after September 11. Says Rudy J. Richardson of the University of Michigan: "Some of the barriers that we might have thought would be there—like, Can terrorists disperse the agent and then escape?—are not there. Today's terrorists don't care if they escape."

Some worry that restrictions would put an undue burden on industry, which has legitimate uses for the chemicals, and wouldn't stop a determined terrorist anyway. But firms already manage with controls on drug-related chemicals, and some protection would be better than no protection. "Everybody points out the ways in which a monitoring system could be bypassed, and I'm the first to agree," Tour says. "But the thing is, right now there's nothing to have to bypass."

PAM FRANCIS

BIOTERRORISM

Evaluating the Threat

DOES MASS BIOPANIC PORTEND MASS DESTRUCTION? BY ED REGIS

The September 11 terrorist attacks on the World Trade Center and the Pentagon produced a wave of fear that bioterrorism was next on the horizon and, along with it, an impression that the U.S. medical establishment was ill prepared to cope with what would be a vast catastrophe, with millions of Americans lying sick, dead or dying. The death of a Florida man from anthrax and the exposure or infection of others in multiples states further fueled these fears. The resulting wave of general hysteria,

with civilians buying up gas masks and Cipro as if there were no tomorrow, established beyond a doubt that microorganisms are remarkably successful as instruments of mass terror. Their potential as weapons of mass destruction, however, is far less clear.

The technology of biological warfare in the modern sense of disseminating viral, bacterial or rickettsial aerosols by means of biological bombs, spray nozzles or other devices goes back at least to 1923. It was then that French scientists affiliated with the

BIOTERROR: JUST THE FACTS: I

Data from the Monterey Institute of International Studies indicate that **262 biological incidents** occurred between 1900 and mid-2001.

Of the 262 incidents, **157 (60 percent)** were terrorist cases, and **105 (40 percent)** were criminal cases involving extortion or murder attempts not in pursuit of a political objective.

FBI AGENTS in biohazard suits investigate anthrax cases at the American Media building in Florida.



Naval Chemical Research Laboratory detonated pathogen bombs over animals in a field at Sevran-Livry, 15 kilometers northwest of Paris, killing many of the test subjects.

Between 1943 and 1969, when President Richard M. Nixon terminated it, the U.S. pursued its own major germ warfare program, during the course of which the U.S. Army weaponized (mated with munitions and delivery systems) the causative agents of two lethal diseases, anthrax and tularemia, and three incapacitating diseases, brucellosis, Q fever and Venezuelan equine encephalitis. In addition, the army created military-grade versions of one lethal toxin, botulinum, and one incapacitating toxin, staphylococcal enterotoxin B. It also built and stockpiled more than 2.5 million biological bomb casings, ready to be filled with a biological agent when needed. During those years and afterward, several other nations, including the U.S.S.R., carried on their own germ warfare programs, amassing large amounts of hot agents, munitions and delivery systems.

The most remarkable fact about state-sponsored development of germ weapons during the 20th century, however, is that none of those nations ever used biological weapons on the battlefield, the reason being that although organisms are excellent killing machines, they make poor weapons. For one, because of the long incubation period of many pathogens, the effects of use are not immediate. Second, the resulting epidemic could be mistaken for a natural outbreak of the disease instead of one caused by the enemy. Third, the effect of biological aerosols is uncertain, dependent on chance fluctuations

of wind and weather. For all these reasons, biological weapons are not as dramatic, attention-getting, reliable or visually overpowering as conventional high explosives. The possibility of retaliation in kind to a biological attack also acts as a restraint, and there is a sense of moral repugnance attached to the idea of intentionally using living organisms to cause disease, disability or death in human beings.

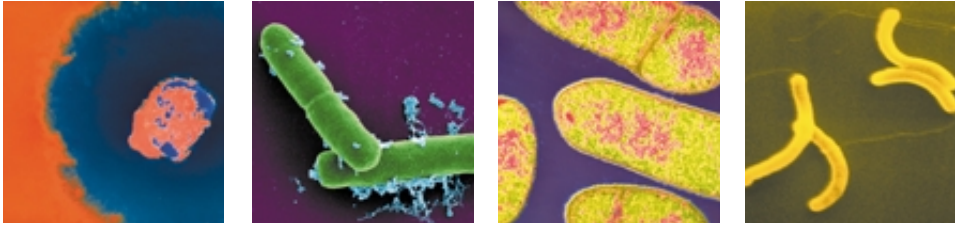
Nevertheless, none

of those deterrents might apply to terrorists, especially to groups acting outside the bounds of traditional moral standards and whose goals are to disrupt and destabilize a society by sowing fear among the populace. Precisely because they are silent, stealthy, invisible and slow-acting, germs are capable of inducing levels of anxiety approaching hysteria. Despite the panic, the history of terrorism is not replete with successful uses of biological (or chemical) agents. Until the death of a photography editor from anthrax in Atlantis, Fla., in October, no death had ever occurred in the U.S. from a biological weapon. But even this incident—and the exposure to or infection by anthrax everywhere from media outlets to post offices to the U.S. Congress—did not amount to a full-scale attack.

The single incident of a semilarge-scale biological attack occurred in 1984, when the Oregon-based Rajneesh cult contaminated restaurant salad bars by dispersing salmonella bacteria, causing 751 cases of diarrhea. (In contrast, accidental food-borne disease incidence in the U.S. is 76 million cases a year, including 315,000 hospitalizations and 5,000 deaths.)

Even if terrorists had the motive to use biological agents and lacked the moral inhibitions that would deter them, they might not have the technological means to do so. Although popular accounts are filled with scenarios of bioterrorists growing lethal bacteria in kitchens, garages and bathtubs or with home brewing kits, the technical expertise required to culture, transport and disseminate a virulent agent in sufficient quantities to cause disease is formidable.

The successful bioterrorist must first obtain a virulent strain of the desired organism (many natural strains of infectious agents are not virulent enough for biological weapons purposes). The chosen pathogen must be cultured in quantity and then be kept alive and potent during transport from place of culture to point of dispersal. It must then withstand the heat and shock of a biological bomb explosion or the mechanical shear forces of being atomized by a nebulizer. Finally, it must be delivered to the target in the proper particle size, over a wide enough geographical area and in sufficient concentration to cause mass infection. All these activities, moreover, must escape detection by anti-terrorist law-enforcement agencies. None of those feats is trivial, and it took a group of



ROGUES' GALLERY of microbes that could serve as bioweapons includes (left to right) the pathogens that cause smallpox, anthrax, botulism and cholera.

highly trained American germ warfare researchers more than a decade to produce the first reliable bioweapons delivery system.

In a mid-2000 study of bioterrorist threats against the U.S., Milton Leitenberg of the Center for International and Security Studies at the University of Maryland concluded (1) that hoaxes and threats were more likely than actual use of biological agents; (2) that small-scale sabotage attacks or attempts at personal murder were more likely than large-scale attempts at mass casualties; and (3) that a crude dispersal of a bioagent in a close area was the most likely mode of attack.

These predictions appeared prophetic when the October 2001 anthrax incidents all proved to be small-scale, crude dispersals of anthrax spores by means of delivered mail. It is estimated that those letters contained, in all, less than a gram of anthrax agent—a laboratory-scale amount, insignificant in comparison to what would be needed to mount a mass attack. During the heyday of the American germ weapons program, a U.S. Army production facility at Vigo, Ind., contained twelve 20,000-gallon fermentation tanks, each of them capable of turning out anthrax slurry literally by the

ton. Even a small laboratory amount of a “hot” agent could cause a number of casualties if disseminated in an enclosed area such as a subway tunnel; these would not be mass casualties in the sense of millions, hundreds of thousands, or tens of thousands, but the true number is conjectural and unknown.

Even a dispersal of so-called professional, military or weapons-grade anthrax (a loosely defined measure of a hot agent’s potential for causing large-scale disease) does not guarantee mass destruction. In 1979 an accident inside a biological weapons production factory in Sverdlovsk, U.S.S.R., caused, by one estimate, 10 kilograms of military-grade anthrax to waft out in a plume over a city of 1.2 million, resulting in a total of 66 fatalities. A mass release of weapons-grade anthrax, therefore, does not necessarily mean mass deaths.

Ed Regis is author of The Biology of Doom: The History of America’s Secret Germ Warfare Project (Holt, 1999).

LONDON SCHOOL OF HYGIENE/PHOTO RESEARCHERS, INC. (smallpox, cholera); GARY GAUGLER (anthrax) AND A. DOWSETT (botulism)/PHOTO RESEARCHERS, INC.

BIOTHREATS: JUST THE FACTS: II

Of all bioterror cases from 1900 to mid-2001, **66 percent** were outright hoaxes or pranks; **21 percent** were threatened attacks that did not materialize by those possessing a bioweapon or else attempted or successful efforts to obtain bioagents; and only **13 percent** were actual uses of a bioagent.

Of the **actual terrorist attacks** using bioagents, **24 percent** occurred within the U.S.; of these, no deaths occurred through mid-2001, but several fatalities were registered in October. During the period studied, there were **77 fatalities overseas** from both terrorism and criminal incidents.

AIR
SECURITY

Reseizing the Controls

REMOTELY PILOTED HIJACK RESCUES MAY BE A BAD IDEA BY STEVEN ASHLEY

We’ve all heard breathless press reports on what some airline passengers plan to do if suicidal hijackers manage once again to board a flight. But what can aerospace engineers do to foil future attempts to turn airliners into kamikaze guided missiles?

Locking the cockpit door might be all that’s needed. The flight deck bulkhead should probably also be reinforced. But the September 11 hijackings have elicited various high-technology solutions as well. One

idea that has received much attention would allow a remote operator on the ground to take charge of an airliner should terrorists with flight training get into the cockpit.

It is already possible to control and land an aircraft automatically without the pilot, although such a step is typically taken only in zero-visibility conditions. Most modern aircraft have an autopilot—a computerized system that maintains altitude, speed and direction—that could be reprogrammed to ignore commands from a hijacker and instead

TELEOPERATION: GROUND PILOT

- Military **unmanned aerial vehicles** regularly land under remote or autonomous control.
- Remote control of an airplane **might cause an accident** if it is deployed accidentally.