A Program for Protection Of Research Employees Against Pathogenic Hazards

By James Black, John M. Lynch, M.D., and Irving Ladimer

IN THE PROCESS of investigating complex medical and biological problems, laboratory personnel become exposed to a wide variety of potentially severe hazards created by the chemical, biological, and radiological materials they handle. At the National Institutes of Health of the Public Health Service, this is true perhaps to an even greater degree than in many laboratory organizations.

Laboratory-acquired infections have been a source of danger to scientists not only because of the difficulty of safeguarding against known pathogens in small, compact work spaces but, of more importance, because of the possible presence of unknown organisms. From the early days of the Public Health Service Hygienic Laboratory down to the present extensive network of laboratory and clinical facilities at the Institutes, concern for the safety of investigators and technicians has been paramount. Laboratory hazards of this type are, of course, not unique at the National Institutes of Health (*1–4*), but its management and control of the problem appear worthy of report.

The National Institutes of Health was among the first of scientific institutions to develop a comprehensive program, which, following a severe outbreak of Q fever among the staff, was symbolized by the construction of a special memorial laboratory. The building, designed especially for the safe study of highly infectious diseases, physically embodies an integrated safety-health program emphasizing prevention, control, and accurate reporting. The program operates on a quiet day-to-day basis through the efforts of the investigators who by specific instruction and exhibition of good work habits provide continuous education for the technician.

The Institutes employ about 3,000 investigators and technical aides to increase knowledge leading to prevention and cure of neoplastic, mental, cardiovascular, neurological, dental, microbiological, and metabolic diseases. The problem of safety is a continuing one of high priority. To cope with this problem, emphasis is placed on integration of physical safeguards into all the newer buildings, on observation of safe operating techniques, and on application of medical controls for all employees engaged in hazardous tasks.

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Promoting "Hazard-Consciousness"

All preventive programs at the Institutes are based on the principle that the supervisor is responsible for the maintenance of a safe working environment. He is aided in this responsibility by the safety engineer, the radiological safety officer, and the medical officer of the employee health service.

The safety engineer fosters the development of a comprehensive program to create an atmosphere for hazard-awareness at all levels of employment. Each institute has its own safety committee which acts as a liaison between the laboratory chief and the employees, makes periodic inspections, and recommends safe-practice policies.

Protecting Against Pathogens

Although the safety committees of the National Institutes of Health concern themselves with all phases of safety, only the precautions used to minimize the possibility of infection from pathogenic organisms are described here.

Microbiological operating techniques necessitate a myriad of safe practices that form an integral part of procedure but which are rarely presented in the literature. Especially for the benefit of new workers, one of the chapters of the National Institutes of Health manual, Safe Practices, contains a guide to safe microbiological practices, some of which,

relating to aerosols, are outlined below. This guide consists essentially of a recording of safe techniques developed by the investigators and technicians over a period of many years.

1. All glassware containing infectious materials must be autoclaved before it is sent to the central glass wash unit. It cannot be left in the autoclave room unattended, and the can containing the glassware must bear an identification form (fig. a) showing the investigator's name and the length of time the material has been sterilized. Such equipment as broken syringes, broken glassware, or capillary pipettes that are likely to cause accidental lacerations or inoculation of the glass-room personnel should be autoclaved separately and discarded in "broken glass" receptacles.

2. Waring blendors containing infectious materials must be operated behind the closed sash of an exhaust hood (fig. b). Four vertically positioned ultraviolet lamps automatically turn on when the sash is lowered, and the exhaust chamber is provided with an electrically heated sterilizer.

A red jewel light indicates when the sterilizer element has attained its operating temperature of 700° F. Unless proper procedure directs otherwise, the blendor should not be opened immediately after its operation. Other recommendations to minimize the danger of aerosol hazards are:

Modify blendor to provide vaccine stopper to allow fluid to be drawn off without opening top.

Perform operation in a sterile chamber that can be decontaminated by one person in case of accident.

Provide a light plastic cover to prevent spraying of the hood chamber in the event a leak develops in the rotor bearing.

In the use of centrifuges, particularly where higher than usual speeds are involved or long periods of centrifuging are necessary, it is a good idea to make a preliminary check of the actual glass centrifuge tubes that will be used with the infectious agent.

3. When infectious material is being filtered, a trap containing an appropriate germicide should be placed between the filtering apparatus and the source of vacuum (fig. c). To further decrease the possibility of contamination to the vacuum line or pump and to minimize aerosol formation when the apparatus is disassembled, cotton plugs may be placed in the filter flask side arm, in the glass connecting tube between the two flasks, and in the glass tube connecting the trap with the source of vacuum. It should be set up in such a manner that the complete system can be easily autoclaved at the end of the experiment or periodically.

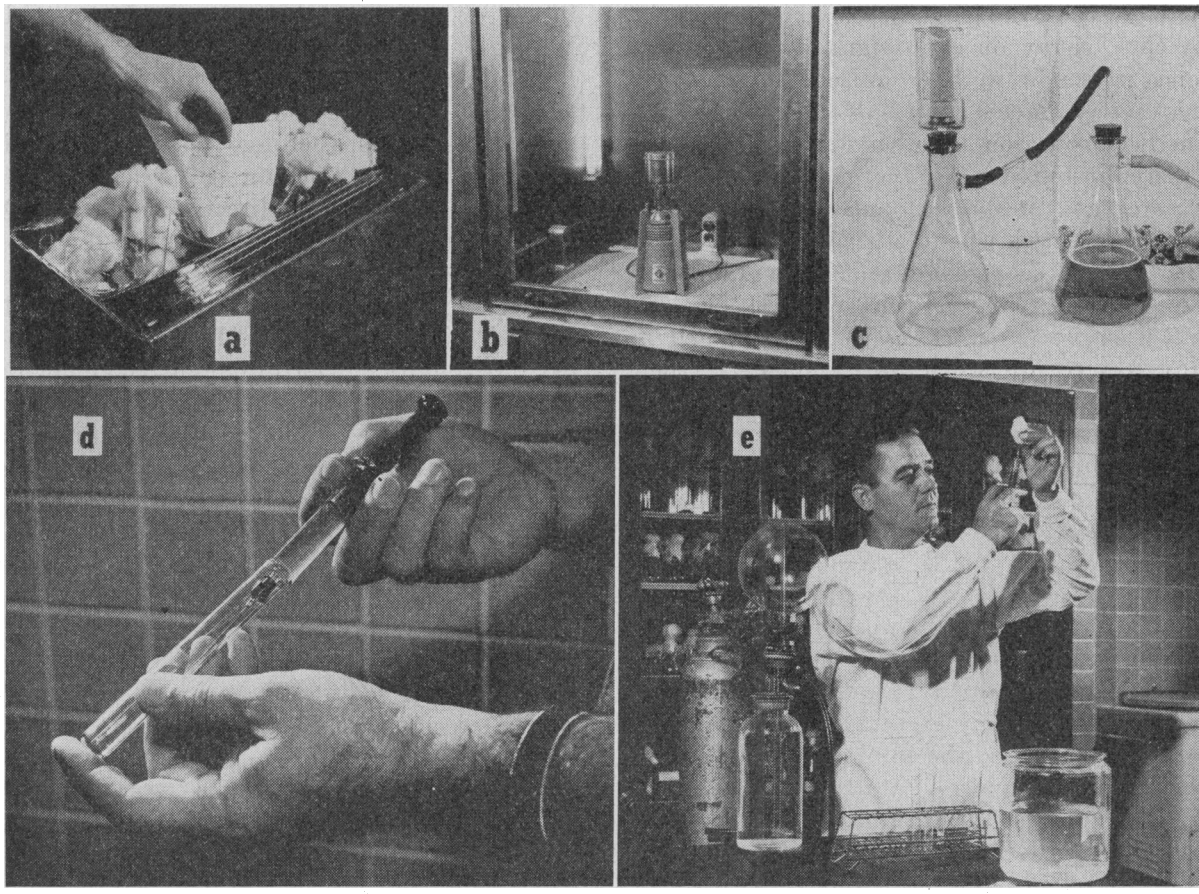
4. While infectious materials are being handled, the needle end of the syringe should be placed in an empty test tube to protect the technician against accidental puncture (fig. d). This technique will also minimize the possibility of contaminating the needle and will prevent droplets of infected material from contaminating work surfaces.

Syringes of the Luer-Lok type are recommended. Needles should be kept sharp, held securely and accurately in place, and oriented to prevent accidental spraying of assistant. Extreme care should be exercised during intranasal inoculations. Flame-sterilizing of the needle assembly should be done with caution to prevent cracking of the glass cylinder.

5. New workers should be made conscious of the fact that infection can be spread easily by touching equipment such as doorknobs, drinking fountains, sink faucets, and telephones, or by touching their own faces. Workers handling infectious materials should not be interrupted by the telephone. Awareness of the potential hazards involved in smoking, eating, or storing lunches in areas where infectious organisms are being handled should be stressed to the newly assigned aides.

6. The ease with which infectious aerosols can be created is also stressed in the safety manual. Aerosols can be caused when long needles of small gauge are withdrawn from tubes, setting up vibrations, or when needles are withdrawn from vaccine caps unless guarded with a wet cotton pledget (fig. e).

After flame-sterilizing a needle, the operator should hesitate momentarily before plunging a hot needle into infectious material. No solution should be prepared by bubbling expiratory air through infectious liquid, nor should



Protection against pathogenic hazards.

liquid be blown from pipettes in a manner to cause an aerosol.

Medical Examinations

The medical officer of the employee health service provides periodic physical examinations, laboratory tests, X-rays, and immunizations for those employees who are working in areas where such services are required. He is responsible for notifying the individual employee of the date on which he should report for examination. At least quarterly, the laboratory chiefs are required to provide the medical officer with a list of all personnel who are exposed to infectious organisms, and, in coordination with laboratory chiefs, the medical officer determines the type and frequency of medical control to be used.

With these data on the specific locations and nature of the various organisms, the medical officer keeps the maintenance organization informed concerning specific hazards. The maintenance department is responsible for restricting its employees from the locations specified by the medical officer until the maintenance men have received the proper health safeguard.

Periodic chest X-rays are made of all employees exposed to infectious diseases, such as tuberculosis and histoplasmosis, that produce demonstrable pathology before outward symptoms can be detected. Employees working directly in the tuberculosis research unit receive chest X-rays at 3-month intervals, while employees with patient-contact duties in infectious and tropical disease areas of the Clinical Center at the Institutes receive chest X-rays at 6-month intervals. In addition, individuals with arrested tuberculosis and those who have had recent intimate contact with known active tuberculosis patients, are given appropriate followup chest X-rays. Employees working

with or exposed to monkeys are followed closely by chest X-ray for early signs of tuberculosis, since it is now well recognized that monkeys may act as a serious source of tuberculosis. As further protection, the monkeys themselves are tuberculin-tested when they arrive at the Institutes and at 6-month intervals thereafter; positive reactors would either be transferred to the tuberculosis research unit or be eliminated from further research projects entirely.

All employees working with or exposed in any way to infectious disease agents in their work, are urged to come to the employee health service whenever they have any illness, particularly febrile illness. Thorough evaluation and followup is conducted to determine possible relationship with the working environment. Employees who become ill at home, and who are unable to come to work, are urged to call their family physician who may call, if he desires, the employee health service or the employee's supervisor for information regarding the working environment. In any event, the ill employee is urged to report to the employee health service as soon as possible.

All employees in infectious disease areas are asked to provide a blood specimen every 6 months. The blood is frozen and stored for study and for comparison with blood taken in future examinations. In the event of suspected occupational disease, serums are then available for diagnostic paired studies and other determinations utilizing serum.

Every 6 months, a serology test is performed to check employees working with *Brucella*. All employees directly or indirectly exposed to Q fever are immunized. Employees are encouraged to have tetanus toxoid inoculations.

In general, any applicant for employment at the National Institutes of Health with a preexisting condition, which would make him more susceptible than the average individual to infectious diseases, would not be assigned to areas where microbiological research is being conducted.

REFERENCES

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Grain Sanitation Committee Organized

An Advisory Committee on Grain Sanitation has been appointed by the Departments of Health, Education, and Welfare and of Agriculture to recommend a program to improve the cleanliness of wheat and to reduce economic losses caused by insects and rodents.

The work of the 17-member committee has been described by its chairman, Dr. Charles Glenn King, scientific director of the Nutrition Foundation in New York City, as a cooperative attack on the problem of grain sanitation by Government agencies, the grain, milling, and baking industries, and the agricultural colleges.

At the committee's organization meeting August 11, three subcommittees were appointed. The subcommittees and their chairmen are:

Subcommittee on Education, chairman, W. H. Bowman, representative of Millers' National Federation, Chicago.

Subcommittee on Rodent Control, chairman, Dr. Harold Macy, dean of the Institute of Agriculture, University of Minnesota.

Subcommittee on Insect Control, chairman, Dr. R. C. Smith, head of the entomology department, Kansas State College.