Meetings

Aerobiology

Clinical and experimental aspects of airborne infection were discussed at the second International Conference on Aerobiology, held in Chicago, Illinois, 29–31 March 1966. Participants represented the United States, England, Sweden, and the Netherlands.

D. F. Proctor (Johns Hopkins University) dealt with the ability of the respiratory tract to defend against inhaled bacterial aerosols. He discussed in detail the fate of particles deposited on upper respiratory surfaces. Models of nasal airways were used to record the linear velocity and direction patterns of airflow. The use of techniques for external detection of radioactivity to measure mucociliary clearance of particles placed upon nasal mucosal surfaces was described.

Models of the nasal airway show that during quiet breathing most of the moving airstream passes over a small portion of the available surface and that linear velocities in the main stream reach 2.5 to 3.5 meters per second. Areas of turbulence are found principally in the upper anterior portion of the nose, along the floor of the nose, and at the upper portion of the posterior nasopharynx. When the flow varies between 5 and 100 liters per minute, small but possibly significant changes occur. Most of these changes develop abruptly at about 16 to 18 liters per minute, which flow is compatible with peak flow in quiet breathing in most subjects. The major changes consist of a relative increase in linear velocity in the main stream and a decrease in peripheral areas. Changes in the nasal airway, simulating those commonly found in otolaryngologic practice, grossly alter these surface-to-airstream relationships. Such changes are most significant when they involve the middle meatus.

Conventional radiographic scanning techniques and a double-collimated crystal scintillation detector have been used to locate radioisotopes placed within the nose and to track their motion in the mucociliary stream. Variations between speed and efficiency of mucociliary clearance of such particles have been found in normal subjects. A wide variation in the speed of clearance of various portions of the stream has also been found.

Tore Dalhamn (National Institute of Public Health, Sweden) described various in vivo and in vitro techniques for observing and recording ciliary activity and mucous flow in the upper respiratory tract. For in vivo observation the ciliary beat could be observed through a light microscope on an opened distal tracheal wall in a rat or rabbit. The effect on ciliary activity of gaseous contaminants such as sulfur dioxide, nitrous oxides, ammonia, and tobacco smoke was reported. To observe transport of mucus in the respiratory tract, cell fragments normally present in the mucus were used as indicators instead of the more conventionally used exogenous particles such as carbon. Major difficulties in observation of mucous flow appear to be (i) the sensitivity of mucus to even very slight dehydration, which, in turn, affects its viscosity and (ii) the nonuniformity of flow rate over the various parts of the trachea.

R. B. Couch (National Institutes of Health) reported on the effect of the route of inoculation on experimental viral disease in humans. Analysis of coughs and sneezes of volunteers infected with respiratory viruses has revealed considerable concentrations of virus in small airborne particles. Airborne particles 1 to 5 microns in diameter are deposited predominantly in the lower respiratory tract, while larger particles are retained predominantly in the upper respiratory tract.

To determine the effect of particle size on the response of the host, volunteers were inoculated with Coxsackie virus A type 21 in a 1- or 15-micron aerosol. Inoculations were also made by direct instillation in the nasopharynx. Less extensive tests were made with rhinovirus NIH 1734 and with adenovirus type 4. Illness syndromes following inoculations of small-particle aerosols with one strain of Coxsackie virus A type 21 involved the lower respiratory tract more often than that following the nasopharyngeal route. With a different strain, however, these differences were not evident. Following nasal instillation, 50 percent human infectious doses (ID_{50}) were slightly higher.

Rhinovirus produced upper respiratory illness by small-particle aerosol. Comparative infectious doses indicated greater infectivity by nasal instillation. When adenovirus was administered by aerosol, febrile disease of the upper and lower respiratory tract, similar to naturally occurring illness, occurred.

The studies have identified the relative susceptibility of the upper and lower respiratory tracts of three respiratory viruses and contrasted the responses that follow deposition of various amounts of virus at different sites. Couch concluded that airborne or contact spread of these infections is possible, and the route of actual transmission may vary in a particular situation.

E. D. Kilbourne (Cornell University) commented by stressing the importance of the nature of the Coxsackie virus inoculum in determining the localization and the severity of infection. He also mentioned that in experimental influenza virus in mice virtually all transmission of infection can be attributed to small-particle aerosols.

W. D. Sawyer (Johns Hopkins University) reported on antibiotic prophylaxis and therapy of airborne tularemia. Because their action against *Pasteurella tularensis* is only bacteriostatic, tetracycline and other broad-spectrum antibiotics have not been completely satisfactory in the treatment of acute tularemia, particularly the severe, generalized form resulting from respiratory exposure. Daily injections of tetracycline for 14 days beginning 24 hours after exposure to tularemia aerosols suppressed all clinical signs. However, *Macaca mulatta* monkeys became acutely ill within 3 days after the last treatment. Two of ten human volunteers experienced a similar reaction. Treatment with tetracycline early in the illness produced similar results. The illness rapidly disappeared in both monkeys and humans, but approximate-

ly 50 percent of the subjects had relapses after 15 and 10 days, respectively, of treatment.

Longer periods of treatment with tetracycline were evaluated in man. Prophylaxis with 0.5 gram of tetracycline twice daily for 28 days completely prevented illness. The same schedule for 14 days failed. Illness occurred both during and after a 20-day course of tetracycline treatment given every other day. Treatment with 2 grams of tetracycline daily, in divided doses, for 15 days or longer prevented relapses, but limiting the treatment to 10 days resulted in relapses in 42 percent of volunteers.

R. J. Zentner (U.S. Army Biological Laboratories) described studies on toxic effects of oxygen on aerosolized and on lyophilized bacteria. He reported on the threshold concentration of oxygen toxicity and suggested that the lethal effect is caused by dehydration of the bacteria.

M. T. Hatch (Naval Biological Laboratory) described the effect of another type of stress, namely, shifts in relative humidity, on airborne bacteria. The studies show that changes in relative humidity influence the survival of airborne *S. marcescens and P. pestis.* There was no indication of which rates of changes in humidity were most lethal. Hatch stressed the physiological rather than the physicochemical nature of this effect.

Experimental airborne transmission of several viral, fungal, and bacterial diseases was discussed. W. S. Miller (U.S. Army Biological Laboratories) described studies on the infectivity of Venezuelan equine encephalomyelitis (VEE) virus for pigeons by the respiratory route. He reported that this virus can infect an avian host through the lower respiratory tract but that marked differences exist among species. Subcutaneous injection produces a disease indistinguishable from the disease produced by the respiratory route. Treatment of pigeons with a combination of Casa-terramycin and Hep Zide or with Casa-terramycin alone for 2 weeks prior to exposure to the VEE aerosols reduced resistance to respiratory challenge. In his comments, W. S. Gochenour (Walter Reed Army Institute for Research) stressed the significance of the observations of the resistance of pigeons to infection when exposed to low concentrations of VEE virus, which can accumulate to a large dose over a long period of time (3 hours).

P. S. Brachman (Communicable Disease Center) presented data on exposure of cynomolgus monkeys to naturally produced aerosols containing *Bacillus anthracis*. Anthrax infection was observed in approximately 25 percent of the exposed monkeys. The pathological findings of mediastinal edema and hemorrhagic lymphogenitis and necrosis were similar to those in monkeys exposed to experimental aerosols of *B. anthracis* and also to those in humans who developed fatal inhalation anthrax after industrial or accidental laboratory exposures. With the low dose present in chronic exposure to natural aerosols, the incubation period appeared to range from 5 to 17 days. There was no evidence suggesting the development of a subclinical anthrax infection.

Epidemiology of airborne staphylococcal infection was reviewed by R. E. O. Williams (Wright-Fleming Institute of Microbiology, England) and A. D. Langmuir (Communicable Disease Center). Williams suggested that the chief way staphylococci become airborne is by shedding of particles of skin from permanent or temporary carrier sites. The magnitude and the frequency of such dispersal was discussed, together with factors that may influence it and the manner in which airborne staphylococci travel in hospitals.

Most airborne particles containing staphylococcus range in size from 8 to 18 microns in diameter, and most of them contain one to four viable cocci. The bulk of each particle presumably consists of the epithelial squame. It is difficult to obtain conclusive evidence of the way in which airborne bacteria gain access to the new host or on the relative importance of airborne and "contact" routes of spread. The possibilities of direct airborne infection of wounds in surgical operating rooms, primary acquisition of the nasal carrier state in newborn infants in hospitals, and acquisition of staphylococci in the nose in adult patients in hospitals were discussed. The difficulty in determining the relation between dose and effect and the importance of attempts to do so were stressed. Langmuir discussed in broader terms the epidemiology and the mechanisms of transmission of airborne infection.

H. M. Yamashiroya (IIT Research Institute) described aerosol vaccination with tetanus toxoid. He was able to protect guinea pigs with tetanus toxoid by using the respiratory route of vaccination. Primary aerosol immunization as well as an aerosol booster following either respiratory or subcutaneous vaccination appear to be effective procedures. H. C. Bartlema (Medical Biological Laboratory, Netherlands) achieved similar results in mice by using dead cells of *Bordetella pertussis* as an adjuvant.

Effects of nitrogen dioxide and ozone on resistance to respiratory infection were discussed by R. Ehrlich (IIT Research Institute) and D. L. Coffin (U.S. Public Health Service). The work reported suggests a more sensitive indicator of biological effects of selected air pollutants, as demonstrated by reduction in resistance to infection. A single 2-hour exposure to 3.5 ppm of nitrogen dioxide before or after respiratory challenge with *Klebsiella pneumoniae* significantly increased mortality in mice. Continuous exposure to 0.5 ppm for 3 months produced the same effect. Mortality also increased in mice exposed to less than 0.1 ppm of ozone for 3 hours before challenge with *Streptococcus* sp. Similar reduced resistance was observed after 4 hours of exposure to photochemical automobile smog.

The conference was cosponsored by the U. S. Army Biological Laboratories and the IIT Research Institute, under the chairmanship of E. K Wolfe (U.S. Army Biological Laboratories), Mark Lepper (University of Illinois), and Richard Ehrlich (IIT Research Institute). The proceedings of the conference are scheduled for publication in *Bacteriological Reviews*.

RICHARD EHRLICH
Life Sciences Research Division,
IIT Research Institute,
Chicago, Illinois 60616

Forthcoming Events

October

28–29. Society for **Scientific Study of Religion**, annual mtg., Univ. of Chicago, Chicago, Ill. (S. Z. Klausner, The Society, 1200 17th St., NW, Washington, D.C. 20036)

30–3. **Metallurgical** Soc. of AIME, fall mtg., Chicago, Ill (American Inst. of Mining, Metallurgical, and Petroleum Engineers, 345 E. 47th St., New York, N.Y. 10017)

31–3. American Soc. for **Metals**, 48th annual congr. and natl. metal exposition, Chicago, Ill. (The Society, Metals Park, Ohio 44073)

31–4. American **Public Health** Assoc., 94th annual mtg., San Francisco, Calif. (The Association, 1790 Broadway, New York, N.Y. 10019)