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Dear Dr. Mason:

I made a few comments and corrections on the Workers' Home Contamination report. Please let me know if I can be of further help.

Sincerely,

Ted Tsai

Theodore F. Tsai, M.D., M.P.H.
Assistant Director for Medical Sciences

Enclosure

Copy to: Dr. Duane Gubler

laundry. The wife and child suffered dermatitis in this case. Surface contaminations of fibrous glass can be detected using sticky sampling media and polarized microscopy [Schneider 1986; Schneider et al. 1989].

(l) Other substance

Tin is the only other chemical substance found to have been studied as a take-home contaminant [Rinehart and Yanagisawa 1993; Wainwright et al. (in press)]. Health effects of tin were not detected in theses studies.

(m) Infectious agents

Infectious agents (i.e., organisms that cause communicable diseases) are similar to toxic chemical such as lead and asbestos, in that they may be brought home on the clothes or bodies of workers. The intent of the Act is to investigate the extent to which workers' families might be exposed to life threatening pathogens because a working family member is routinely exposed to such agents in the workplace. It was not the intent of the Act that non-deadly infectious agents like the common cold be investigated [U.S. Senate 1991b].

Microorganisms are ubiquitous in nature. In humans, they are found naturally in many locations of the body including the skin, hair, and even internally in several locations such as the GI tract. These normal microbial flora help protect the host from pathogens and do not constitute any problems for healthy individuals. In fact, only a few of the bacteria, viruses, fungi, mycoplasmas, chlamydiae, rickettsiae, or protozoa found in nature are capable of causing disease in humans. For

those organisms that are effectively able to invade and cause disease, there are several ways that they may be transported from infected workers to other members of the household. These include direct contact, indirect contact, and airborne contact [adapted from Benenson 1985]:

In direct contact the immediate transfer of infectious materials may occur between individuals through a receptive portal of entry by touching (e.g., scabies), biting (e.g., hepatitis B virus [HBV]), kissing (e.g., Epstein-Barr virus), or sexual intercourse (e.g., human immunodeficiency virus [HIV]). When individuals sneeze, cough, sing, or even talk they exhale a cloud of tiny droplets of saliva. Direct projection of this droplet spray (usually in close proximity to the source - 1 meter or less) onto the conjunctiva or mucous membranes of another individual can transfer disease (e.g., common cold). Some diseases can also be transmitted transplacentally from mother to child (e.g., rubella, HIV).

Through indirect contact the transmission of infectious agents may occur by contact with intermediates such as contaminated inanimate materials (e.g., toys, clothing, eating utensils, bedding) as well as contaminated food, water, milk or biological products such as blood, tissues, or organs. Also, ~~vector-borne~~ zoonotic diseases may be directly transmitted by contact with animals that serve as reservoirs for infectious agents such as rabies. In addition, arthropod vectors such as ticks may transfer rickettsiae

(e.g., rocky mountain spotted fever), bacteria (e.g., lyme disease) or viruses (e.g., encephalitis) through bites.

Airborne disease results from aerosols containing infectious agents being generated when an individual coughs, sneezes, sings, or talks. Also, aerosols may be generated by other methods in normal work situations such as those found in slaughterhouses, rendering plants, or autopsy rooms as well as during accidents in microbiology laboratories. Droplet nuclei are aerosols that contain infectious particles that are made by the evaporation of fluid from the droplets formed during the production of aerosols. Unlike droplet spray that may remain airborne only for a few feet that are associated with direct transmission of disease, droplet nuclei may remain suspended in the air for long periods of time and are associated with respiratory diseases (e.g., tuberculosis, influenza, mumps). Some infectious diseases that are normally spread via aerosols may also be spread via fomites (e.g., in dust from contaminated clothing or bedding, combs, floors, soil, etc.) such as the microorganisms that cause Q fever and anthrax. Droplet nuclei and dust particles in the 1-5 micrometer size range may remain suspended in the air for long periods and, unlike larger particles, may easily be drawn into and retained in the alveoli of the lungs bypassing many of the defense mechanisms of the respiratory system.

Infectious diseases that most likely meet the criteria of being transported to workers' homes on workers, their clothing, or other materials brought from the workplace include those (1) that are spread

through direct skin-to-skin contact or direct contact with contaminated clothing such as **parasites** (e.g., mites or lice), (2) via **arthropod vectors** such as ticks (e.g., Lyme disease) or (3) those that may be transmitted in **aerosols** contained in dust brought to the home from the workplace (e.g., Q fever, anthrax and possibly fungal diseases). Infectious diseases that are spread by other means were not intended to be covered by the legislation. For example, tuberculosis spread by an infectious emergency service worker to family members via aerosols is not included nor is HIV infection that may be transmitted to a spouse during intercourse. The possibility appears to exist for bloodborne diseases such as HIV or HBV to be transported home on a worker's clothing soiled with body fluids from an infected person. However, the potential transmission of a bloodborne pathogen on soiled linen is considered to be negligible [CDC 1987].

It should be noted that virtually any infectious disease contracted by a worker at the workplace will be brought home and can potentially infect members of his or her household. However, since this legislation is intended to include agents that may be brought home on the worker's clothes or person, diseases that appear likely to be transmitted to the home on the worker include parasitic, vector-borne and air-borne diseases [adapted from Benenson]:

Parasitic diseases such as (1) scabies, a parasitic disease of the skin caused by a mite (*Sarcoptes scabiei*) that causes severe itching and is highly contagious. It is normally spread via skin-to-skin contact but in some cases may be spread through contact with mite-infected

undergarments or bedclothes. (2) Roundworm infection (*Ascaris lumbricoides*) from contaminated soil may be brought into houses and automobiles on the shoes of workers. The infection may than be transmitted to members of the household in dusts or via ingestion. Infection is usually highest in children aged 3-8 years. (3) Pinworm disease (*Enterobius vermicularis*) is an intestinal infection that is usually spread through direct contact from anus to mouth of infective eggs but may be spread via clothing or bedding.

Vector-borne diseases that occur in the United States include lyme disease, caused by a spirochete *Borrelia burgorferi*. Lyme disease was first recognized as a clinical disease in 1977 when a group of children in Lyme, Connecticut was infected. It is considered to be the most common vector-borne disease in the United States and is characterized by distinctive skin lesions, polyarthritis, and neurological and cardiac involvement.

Additional vector-borne diseases that may be brought home by workers in the United States include rickettsial diseases where ticks are also the vector such as rocky mountain spotted fever ~~and murine typhus fever~~. In addition, approximately 90 arthropod-borne viral diseases have been identified. These include Colorado tick fever and encephalitis that are tick-borne. The mosquito is the vector for many arboviruses that infect humans; however, mosquitos are ~~less~~ likely ~~than ticks~~ to be brought home on workers. Plague (*Yersinia pestis*) is a disease of domestic and wild rodents transmitted to humans by flea bite. Tularemia (*Francisella*

tularensis) may be spread via ticks but also may be transmitted via inhalation of contaminated dust particles.

Air-borne respiratory diseases that may be spread via the air should be considered when infectious diseases that may be "taken home" are considered. For example, rickettsiae are small (300-600nm) obligatory parasitic bacteria that are often transmitted to man through the bite of arthropod vectors such as ticks. However, the rickettsia that causes Q fever (*Coxiella burnetti*) is found in animals as well as ticks and may be transmitted to humans by inhalation of infected dust, indirectly via the drinking of infected milk, or by direct contact with animals, particularly cattle, sheep, and goats. It is an acute febrile disease with pneumonitis occurring in many cases. The organisms are highly infectious and are often spread in dusts associated with parturition. Person-to-person transmission is uncommon, although the disease may be contracted by direct contact with the laundry of exposed workers.

There are several fungal diseases that could potentially be transmitted via the clothes of workers including Aspergillosis (caused primarily by *Aspergillus fumigatus*, *A. niger*, and *A. flavus*). Several clinical conditions can be produced by these fungi including the formation of masses of hyphae within ectatic bronchi and pneumonic and disseminated infection. The organisms are often found in compost piles undergoing decay and fermentation, hay that has been stored damp, in decaying vegetation, and in cereal grains. Although not an infectious disease, *Aspergillus* species as well as many other fungi may cause allergic

reactions such as asthma in sensitive individuals.

The occupation or job elements of workers should also be considered when take-home infectious diseases are considered. For example, in occupations such as farming the worksite and home are often located virtually together and infectious agents that are at the worksite may easily be transported directly or indirectly (e.g., via vectors) into the home and infect household members. Based on the potential proximity to large reservoirs (e.g., grain storage, compost piles) of fungus on farms, there is perhaps a greater potential for fungal exposures in farm households. A study in Finland of airborne fungal spore concentrations in farm houses during the winter months indicated that some fungal genera not normally found in the urban environment (e.g., *Alternaria*, *Botrytis*) were found in the farmhouses as well as the cow barns [Pasanen et al. 1989]. The results of the study indicated that airborne fungal spores may be carried from the cow barn into the farmers' homes.

Other diseases that may be directly associated with specific occupations include animal diseases such as brucellosis and anthrax. Brucellosis is primarily an occupational disease of farm workers, slaughterhouse workers, veterinarians, and meat plant workers who are exposed to infected animals or tissues. Approximately 150-250 cases per year are reported in the United States [Benenson 1985]. Transmission is primarily by direct contact with infected animals (e.g., cattle and swine) but the bacteria can survive in dust and airborne transmission is possible [Anonymous 1978]. Anthrax (*Bacillus anthracis*) is an acute bacterial disease that usually initially affects the skin but may occasionally involve the mediastinum or intestinal tract. It

rarely occurs in developed nations. It is primarily a disease of workers who process hides and veterinarians who come in contact with infected animals. It may remain viable as a spore in soil associated with infected animals for years. Inhalation anthrax may result if the spores are inhaled while intestinal anthrax may arise if the spores are ingested [Benenson 1985].

The following are a number of examples from the literature that are indicative of the circumstances where infectious agents have been transmitted to the homes of workers:

(1) An HIV infected 28-year-old male with a disseminated *Mycobacterium avium* infection was admitted to an Italian hospital in 1991. He was also diagnosed as being infected with the mite *Sarcoptes scabiei*. The hospital staff were aware of this infection and used protective clothing, gloves, and booties. However, within one month, 29 staff members were infected with the mite. Six relatives of the staff were infected at home [Scalzini et al. 1992].

(2) In 1991, an immunocompromised patient (non-HIV related) was admitted to a hospital in Kansas. Forty-nine hospital staff members were subsequently infected with scabies including those with frequent direct care responsibilities such as nurses and respiratory therapists. Ancillary staff including those from social services and housekeeping were also infected. Fourteen family members of the staff were infected with scabies from the

index patient [Clark et al. 1992].

(3) In 1984 an outbreak of Q fever in Idaho was associated with a sheep research station. Two of the 18 cases of Q fever were family members of workers employed at the station. One was a 14-month old child while the second was the wife of a worker. It is assumed that these family members were infected with fomites brought home on the clothes of the workers. It is also worth noting that a farmer who had no direct contact with the research station also contracted Q fever. It is thought that he was infected from a Q-fever infected guard dog he had received from the research station [Rauch et al. 1987].

(4) A case was reported in England where 10 people became ill with Q fever who were performers in an Easter play at their village church. One of the members of the play was a shepherd who came to rehearsals in his work clothes. *C. burnetti* was isolated from the dust collected from the shepherd's clothes [Marmon and Stoker 1956].

(5) Giardiasis is a protozoan (*Giardia lamblia*) infection that primarily attacks the small intestine and is associated with symptoms that include diarrhea, cramps, and bloating. It is most often contracted from fecally contaminated water or food but may be transmitted person-to-person. In 1979, the Minnesota Department of Health conducted an evaluation of an outbreak of

giardiasis at a rural public school system. Nineteen of the 60 employees of the school system met the case definition for giardiasis. Three members of the employees' households also had persistent diarrhea consistent with giardiasis infection [Osterholm et al. 1981].

(2) Incidences of Take-Home Contamination - Industrial Hygiene Aspects

(a) Sources of Take-Home Contamination

In reviewing the numerous studies listed in Table 15, one finds that sources of chemicals exposure for family members include the classic mode of taking chemicals home on work clothes and several instances of atypical sources. Chemicals reported in the table include lead, mercury, pesticides, cadmium, asbestos, etc. Lead is the most frequent agent identified due perhaps to its widespread use and routine screening. Industries associated with lead being taken home include lead battery production, manufacture of pewter objects, pottery manufacturing, lead mines and lead smelters.

Several case studies include atypical situations that do not involve strictly carrying toxin chemicals home on the clothes. In a study reported by Bagnell and Eklenberger [1977], a baby was exposed to tetrachloroethylene (TCE) via the mother's breast milk. The mother did not work with TCE, but was exposed via daily visits to her husbands place of work (dry cleaning establishment) to have lunch (0.5 to 1 hour). A second atypical case, reported by Benning [1958], involved emotional upset at home due to employees being exposed to high levels of

8. After laundering contaminated clothing, the washer should have an "empty load" wash with detergent and full volume and time settings to reduce the chance of contamination of later wash cycles.

9. One should wear rubber gloves to handle pesticide-soiled clothing, and dispose of these when deterioration is noted, and at the end of the pesticide season. A separate garbage-bag lined cardboard box should be used as a hamper, and discarded at the end of the application season. All appropriate safety and health measures should be taken when handling the clothing.

Airshowers and Shoecleaners

Simonson and Mecham [1983] showed that airshowers removed from 5 to 72% of lead dust from clothing in workplace studies, and 23% to 69% in laboratory studies. Some small amount of breakthrough the clothing (posing a possible skin exposure) was noted. Shoe cleaners were observed (non-quantitatively) to be effective, although potential problems with adequate maintenance were noted.

Other Agents

Little is reported regarding laundering to remove biologic agents, such as anthrax, which can be transmitted to laundry personnel via work clothes [Hardy 1965], or fungal spores which can be brought into farmers' homes on work clothes [Pasanen et al. 1989].

Washing & drying (in a dryer) should kill ticks brought home on clothing.

(3) Review of Federal and State Laws