

Non-Routine Crime Scene Pathogens

By Tom Valentine, Safety Coordinator, BFS

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The following medical problems are identified as potential biohazards at law enforcement crime scene investigations. Non-routine pathogens are not intended to include “expected” human source bloodborne pathogens (e.g. AIDS and hepatitis viruses). The list was compiled by staff at the California Criminalistics Institute (CCI) and forensic scientists participating in Supervising Criminalist Fred Tulleners’ Crime Scene III course on November 29, 1993. The sole purpose of this information is to increase the awareness of all crime scene investigators to potential occupational medical problems. This information is not provided as medical advice. Whenever an investigator has concerns about health symptoms, they should seek and obtain professional medical advice.

The following summaries include information regarding the etiologic (disease causing) agents, vehicle of transmission, symptoms, treatment and prognosis. The primary sources for medical information come from Current Medical Diagnosis & Treatment, Ed. S.A. Schroeder, M.A. Krupp, et al., 1990, Appleton & Lange; Encyclopedia of Medicine, AMA, Ed. C.B. Clayman, 1989, Random House; and, Harrison’s Principles of Internal Medicine, Ed. Eugene Braunwald, Kurt J. Isselbacher, et al., 11th edition, 1987, McGraw-Hill Book Company.

Anaphylactic Shock - A life threatening allergic reaction that may occur to people with extreme sensitivity to a particular allergen (e.g., insect sting, injected pharmaceutical drug or ingestion of a particular food or drug). The reaction occurs most often following direct injection into the bloodstream provoking a massive release of histamine and other chemicals. Blood vessels dilate with a sudden loss of blood pressure (symptoms include itchy rash, breathing difficulty, swollen tongue or throat). Severe reaction or collapse requires medical attention. First aid includes raising the legs above the head to improve blood flow to heart and brain and CPR as appropriate. Individuals who have suffered severe reactions may be prescribed and carry preloaded epinephrine syringes for injection.

Creutzfeldt-Jakob Disease (CJD) - A degenerative viral brain disease causing progressive dementia and myoclonus (sudden muscular contractions). The disease is considered very rare, and there is no effective treatment with death expected within weeks to months after onset of symptoms (80% die within one year of diagnosis). CJD is limited to adults with the average age of 60 at death. The etiologic agent has been described as proteinaceous (prions) producing unconventional slow infection. In 1968, the disease was shown to be infectious by allowing chimps to eat organs from infected animals. While the source of CJD is unknown, it has been found in monkey, other primates, sheep, goats, deer, calves, minks, ferrets, cats, raccoons, skunks, mice, and rabbits. The search for risk factors have focused on eating habits. Human-human transmission has occurred by contaminated cranial electrodes, use of growth hormone

from infected cadavers and cornea transplants. The risk of occupational exposure is considered low however reported cases include one neurosurgeon, one pathologist and three pathology technicians. CJD prions are extremely hardy and resist routine hospital sterilization, disinfection, and cleaning procedures posing a serious challenge to Infection Control Professionals. Formaldehyde fixed tissue is still infectious. Safe Work Practices in excess of standard universal precautions are recommended with known or suspected cases (Appendix A).

Class Discussion - A medical examiner serving the Riverside area reportedly died from this disease (Appendix B). No other colleagues, law enforcement, or laboratory support personnel are known to be infected. Reportedly, this experienced medical examiner did not always follow standard Biosafety Level 2 (BSL 2) practices that we are familiar with for personal protective equipment and hygiene in clinical laboratory operations and which has now been integrated into Cal/OSHA standards (Appendix C).

Hantaan virus disease (at least 4 different viral agents) - Found in rodent urine, feces, and saliva in high titer – 2 of the 4 agents were known in the USA but not known to cause disease (until the Southwestern variety called Pulmonary Syndrome Hantavirus – see below). Symptoms include high fever, backache, abdominal pain with some possible hemorrhagic manifestations, polyuria (excessive urine production), recovery in 3 weeks or kidney failure. Prognosis:

Mortality	-	Soviet	3-32%
		China	7-15%
		Korea	6.6%

Pulmonary Syndrome Hantavirus 62% (42 cases, 26 deaths, Science Vol.262, 5 November 1993, p. 832.)

Pulmonary Syndrome Hantavirus symptoms – Ordinary flu-like aches and pains developing into respiratory distress within three days (capillaries begin leaking); patients enter a critical phase over a period of hours where it is harder and harder to breathe. Death may result from the loss of blood (hemorrhaging) even with mechanical ventilation. Workers in a known area of contamination who develop fever or respiratory problems within 45 days from exposure should immediately seek medical attention and inform their physician of the potential of occupational risk of hantavirus infection.

The following information comes from “Hantavirus Infection – Southwestern United States: Interim Recommendations for Risk Reduction” (MMWR July 30, 1993, Vol. 42 / No. RR-11):

Rodents are the primary reservoir host of recognized hanta viruses although other small mammals can be infected. While the deer mouse is the primary reservoir in the southwestern United States, serologic evidence of infection has also been found in pinion and brush mice, as well as western chipmunks.

Human infection may occur directly from aerosols from the animals because “persons visiting laboratories where infected rodents were housed have been infected only after a few minutes of exposure to animal holding areas. Transmission may occur when dried material contaminated with excreta are disturbed, directly introduced into broken skin, introduced onto the conjunctivae, or possibly, ingested in contaminated food or water. Persons have also become infected after being bitten by rodents.”

Person-to-person transmission has not been associated with transmission of previously identified hantavirus including the southwestern US variety. Arthropod vectors (fleas, ticks, mites, insects) are not known to transmit the disease. Dogs and cats are not known to be host reservoirs.

Respiratory protection with at least a High Efficiency Particulate Air (HEPA) filter respirator is a special precaution for workers (clean-up) in homes of persons with confirmed Hantavirus infection or buildings with heavy rodent infestations, and also for persons in affected areas who frequently handle or are exposed to rodents (e.g., mammalogist or pest control workers).

“Insufficient information is available at this time to allow general recommendations regarding risks or precautions for persons in the affected areas who work in occupations with unpredictable or incidental contact with rodents or their habitations. Examples of such occupations include telephone installers, maintenance workers, plumbers, electricians, and certain construction workers. Workers in these jobs may have to enter various buildings, crawl spaces, or other sites that may be rodent infested. Recommendations for such circumstances must be made on a case-by-case basis after the specific working environment has been assessed and state or local health departments have been consulted.”

Class Discussion – It was suggested that the recommendation to consult with local health departments apply to other diseases (e.g., TB) before entering a suspicious crime scene. One participant pointed out that they had declined to enter a crime scene involving the death of an infant that had been feverish for a few days before death – no trauma or blood was noted. Investigators were referred to poison control and public health. The family subsequently developed meningitis and required hospitalization. A coroner fell ill for 10 days, but did not require hospitalization.

Lyme disease - Caused by a bacterium/spirochete in rodents that is transferred to humans by tick bites. In the California Northern Coast, wood rats (not deer mice) and non human-biting tick maintain the disease agent. Transfer to humans in California is by the Western black-legged tick that does not efficiently maintain the disease agent. Symptoms include skin changes (red dot gradually expanding), flu-like symptoms and joint inflammation. Treatment with antibiotics is more effective during early stages of disease progression that may include the heart and nervous system.

Class discussion - It was suggested to use insect repellents to help avoid tick bites. One participant had clinical laboratory experience attempting to culture and identify the

etiologic (disease causing) agent. Reportedly, the best way to identify this disease is by recognition of the reddish circular, growing “target” pattern around the tick bite. (In early 1994, the media reported that a reliable blood test had been developed.) While chemical repellent has some success, the more effective prevention is covering exposed skin.

Meningitis - Swelling of the membranes (meninges) that cover the brain and spinal cord. The disease is caused by a variety of microorganisms. Viral meningitis is usually not serious and affects up to 12,000 people each year. Meningococcal meningitis is the most common bacterial meningitis affecting up to 5,000 young people (70% under age 5) each year. The meningococcal form is life-threatening and needs prompt medical treatment. Symptoms include fever, severe headache, nausea and vomiting, dislike of light, and a stiff neck. Symptoms may develop rapidly over a few hours. A blotchy skin rash develops in about one-half of the cases. In severe cases, confusion, delirium, seizures, and coma and shock occur. Although up to 40% of the population are nasopharyngeal carriers, very few develop the disease, which is transmitted by droplets. Patients receiving prompt medical treatment usually recover. Where close household contact (or mouth-to-mouth resuscitation) occurs, prophylactic antimicrobials can be effective. Pneumococcal meningitis is the most common cause of meningitis in adults and second most common cause in children over the age of six.

Plague - (Black death of the 14th century killing 25 million) – Today, spring and summer rodent flea bites cause 10-50 cases per year with the risk of death less than 5% with prompt treatment with antibiotics. A vaccination is available for individuals at high risk. The public health concern is that wild rats will pass the fleas to urban rodents infecting people when the rat dies and the fleas leave the carcass. Symptoms of bubonic plague – within 2-5 days, fever, shivering, and severe headache; followed by “buboes” – smooth oval, reddened, intensely painful swellings usually in the groin and less common in armpits and neck or elsewhere. Bleeding around the buboes leading to dark patches may occur with occasional blood poisoning. Untreated, the disease is 50% fatal. Pneumonic plague may result as a complication of bubonic plague causing severe coughing producing blood, frothy sputum and labored breathing that is nearly always fatal unless diagnosed and treated early. The pneumonic plague can pass from person to person by infected droplets expelled during coughing.

Poison Oak - Grows as vines or bushes and leaves have three leaflets. The harmful oil resin, called urushiol, is also found in poison Ivy and Sumac. Touching results in itching, burning, and blistering at the site of contact. The response is not immediate and may occur 24 to 48 hours after contact. People with sensitivity may have extremely severe skin reactions. Prompt first aid (within 5 minutes of contact) by washing the affected area with soap and water may avoid rash; sponging with alcohol is an alternative. After rash develops, application of calamine lotion may help relieve itching and act as a drying agent. Corticosteroids may be recommended in severe cases (either topically for small areas – or by mouth if a large area is affected). Neither scratching nor the watery liquid from the blisters spread the rash.

Class Discussion - One participant indicated that a crime scene investigator in the Los Angeles area had lost several fingers to a severe skin reaction, and that highly sensitive persons may develop symptoms without direct contact with plant material. It was recommended that Laboratory Directors maintain a list of highly sensitive staff and make field assignments as appropriate to avoid the risk of exposure to highly sensitive personnel. It was pointed out that alcohol did not work in one case to denature the poison oak contamination.

Pulmonary Tuberculosis - Caused by *Mycobacterium tuberculosis* and transmitted from person to person via the aerial route (other routes have been documented but none of major importance). Tubercle bacilli form nuclei for water droplets in respiratory secretions and are expelled during coughing, sneezing, and vocalizing. The moisture evaporates leaving the desiccated bacilli airborne for long periods. Settled bacilli can absorb moisture from the environment and remain viable for weeks. Settled bacilli can be thrown back into air currents by walking through the room. While the number of bacilli excreted is usually not large and household contact for many months is required for disease transmission, some infectious persons may be highly contagious because of the extent of disease (in the respiratory system) which relates to an increased concentration of expelled bacilli and frequency of coughing. Mycobacteria are susceptible to ultraviolet light and disease transmission rarely occurs out-of-doors in daylight. Increased fresh ventilation is the most important environmental measure to prevent disease transmission.

Initial infection is from 1 to 3 organisms that reach the deep lungs (alveoli) where they are ingested by scavenger cells in the blood (macrophages) and transported to regional lymph nodes where they are destroyed or pass to the blood stream resulting in widespread dissemination. Surviving bacilli inside the macrophages continue to multiply for 2 to 8 weeks until the cellular immune response (T-lymphocytes) is effective in stopping the spread of disease by grouping the infection into nodules (granulomas). Mycobacteria may survive inside the granulomas but be held in check from further spread, and the granulomas may calcify and be detectable on chest X-rays. This stage of infection usually does not produce symptoms and is termed primary tuberculosis. The overwhelming majority (90%) of primary tuberculosis cases (in the US) end at this stage. (95% of the individuals who successfully resolve the primary infection undergo complete healing with no subsequent recurrence.) Progressive primary tuberculosis occurs in the remaining 10% of the infected cases resulting in the following symptoms: a dry cough at first progresses to a productive cough containing sputum, pus and sometimes blood. Other symptoms include fatigue, weight loss, anorexia, low-grade fever, and night sweats. Untreated, the pulmonary lesions grow and normal pulmonary architecture is lost, resulting in death in about 60% of the cases with median course to death of 2.5 years. Sometimes the disease reactivates. Reactivation tuberculosis presents similar symptoms as pulmonary tuberculosis and occurs when the immune system is no longer effective in containing the “walled-off” bacilli.

In 1989, the Encyclopedia of Medicine reported that “Almost all properly treated patients with tuberculosis are cured....The only cause of treatment failure is noncompliance.” In

December 1992, a government hearing was convened regarding the returning epidemic of tuberculosis in New York City. Dr. Karen Brudney testified about increased resistance to the two mainstay drugs against TB (i.e., isoniazid and rifampin). Approximately 1 in 3 were resistant to isoniazid in New York relative to 1 in 10 nationally. Approximately 1 in 5 were resistant to both first-line drugs which reduced the cure rate from 100% to less than 50%. Additionally, the treatment time goes from 6 months to 18 to 24 months with many months of injections. The second-line drugs that then must be used are more toxic and less effective. In December 1993, the media reported that Roosevelt Island sanitarium was again opened up in New York to ensure treatment regimens are followed.

Prevention of TB after some types of exposures may be medically indicated with drugs. A number of live TB vaccines are available and known collectively as BCG. However, the efficacy (ability to produce the desired effect) is in question. Controlled studies in North America and Britain indicate that vaccination offered greater than 80% protection while little or no protection developed in other populations. The vaccine is not routinely used in laboratory personnel. BSL 2 precautions are recommended for preparing acid fast smears while BSL 3 precautions are recommended for propagation and manipulation of cultures or handling non-human primates (because they have a respiratory reflex like humans and can transmit the disease through the aerial mode.) BSL 3 add respirators to the list of potential personal protective equipment, and the 1988 version of "Biosafety in Microbiological and Biomedical Laboratories" has a special precaution for the use of "Molded surgical masks or respirators are worn in rooms containing infected animals." An article in Occupational Health & Safety, by Neville Tompkins, Vol. 62, May 1993, reports that while some experts disagree, NIOSH recommended in October 1992, that high-powered air purifying respirators be worn by health care workers. Reportedly, other major public health and medical organizations including the CDC, American Lung Association, and Infectious Disease Society of America recommend (in part) that "Health care workers and others entering TB isolation rooms should wear particulate respirators which resemble surgical masks but are far more effective in blocking TB bacteria." In October 1993, the CDC recommended filter characteristics capable of removing particles of 1-micron size at 95% efficiency. The only filters that meet that standard today are HEPA filters that remove particles of 0.3-micron size at 99.97% efficiency. In May 1994, NIOSH proposed changes in the respirator certification process to test filters for particles of 0.3 microns but at three different efficiencies (99.97%, 99%, and 95%).

Rabies - An acute viral disease caused by the transmission of infected secretions, usually saliva, from an infected dog licking over damaged skin, mucous membrane, or from a bite. Transmission is also known from infected aerosols and post-exposure prophylaxis is always indicated subsequent to a bite where the bat cannot be sacrificed for brain tissue testing (other common reservoirs include skunks, foxes, and raccoons). The virus replicates in muscle tissue near the point of entry and then travels from the wound along nerve pathways to the brain where further replication occurs in the gray matter. The virus then spreads to other tissues and organs via autonomic nerves. Depending on the amount of virus introduced, the host's immune defenses, and the distance the virus must travel to the brain, incubation varies significantly from 10 days to over 1 year (average 4 to 8 weeks). Clinical symptoms include fever, headache, malaise, myalgias (muscular pain),

anorexia, nausea, vomiting, sore throat, inability to drink water – progressing to marked increase of motor activity, excitation, confusion, hallucinations, combativeness, bizarre aberrations of thought, shorter periods of lucid thought – progressing further to coma and finally death by respiratory failure. Once symptoms start, the disease is almost always fatal with only three well documented cases of recovery. Post exposure prophylaxis is effective. Follow-up evaluation from over 575 cases of bites from confirmed rabid animals has shown that no person who has received both passive (antirabies antiserum) and active immunization (antirabies vaccine) has developed the disease. In the USA, fewer than 5 rabies cases are reported each year.

Rocky Mountain Spotted Fever - Caused by a parasitic microorganism (a type of rickettsia) to arthropods (insect and insect-like animals, e.g., lice, fleas, ticks and mites). Like viruses, rickettsiae can only procreate by invading the cells of another life form. Transfer to humans is by the bite of an infected tick or their feces where the rickettsiae can pass through a break in the skin to access blood. About 1,000 cases are reported per year and mostly on the Atlantic seaboard. Symptoms include anorexia, nausea, and sore throat progressing to fever, aching, and headache in 3 to 10 days. Two to six days after symptoms begin, small pink spots appear on the wrists and ankles, then spread over the body, darken, enlarge and bleed. Treatment with antibiotics usually cures the disease. Untreated cases marked with high fever may result in death from pneumonia or heart failure. Prevention: use insect repellent in tick-infested areas, examine the body daily, and gently pull away ticks with forceps when found.

San Joaquin Valley Fever - Caused by inhalation of a mold that grows in soil – about 60% of infections are subclinical (unrecognized except for a positive coccidioidin skin test). Symptoms may be more severe in other cases requiring medical attention. Less than 1% of the cases result in spreading of the disease from the chest or meningeal form which have significant long-term mortality rates. Prognosis in cases where the disease is limited to the chest is good by providing necessary symptomatic therapy. Limited disease symptoms after 10-30 days incubation include influenza-like illness with malaise (vague feeling of illness or depression), fever, backache, headache, and cough.

Scabies - Mites barely visible as white dots burrow into the skin where they lay eggs and can be seen on the skin as tiny, gray, scaly swelling, usually between fingers, on wrists and genitals and armpits. Infestation causes intense itching, especially at night, and scratching results in scabs and sores. Although infestation is most likely through physical contact (e.g., sexual intercourse), scabies is highly contagious and can pass from one person to another who is standing close beside the person infested. Usually the whole family is treated by applying an insecticide lotion to all skin below the head.

Snake Bite - May be predominately neurotoxic (coral snake) causing respiratory paralysis; or predominately cytolytic (e.g. rattlesnake) causing local pain, redness, swelling, and forcing the flow of blood out of surrounding tissue. Tingling in the mouth, metallic taste, nausea and vomiting may occur. Emergency treatment includes: immobilizing the patient and part bitten in a horizontal position. Avoid manipulation of the area bitten and immediately transport the patient to a medical facility for treatment.

Do not give the victim alcohol, stimulants, or apply ice. The trauma to underlying tissue resulting from incision and suction performed by untrained personnel is probably not justified considering less than 10% of the venom can be recovered.

Spider Bite - Most spider toxin causes only local pain, redness, and swelling and is self limiting. The more venomous black widow causes generalized muscular pains, muscle spasms starting at the site and spreading, and rigidity. Symptoms may continue for several days. Death from cardiac arrest or respiratory failure occurs occasionally in children and the elderly, but is uncommon in adults. Treatment for black widow bites is to relieve symptoms with narcotics or muscle relaxants. Antivenom is usually not required but is used for the very young or elderly who do not respond to the above treatment. There is no proven treatment for the bite of the brown recluse spider. Its bite may lead to the death of local tissue, requiring excision; other treatments are being developed.

Tetanus - Caused by spores of a bacteria found in soil and manure (and human intestines); 100 cases per year, producing pain and tingling at the site of inoculation followed by spastic reaction of nearby muscles. Symptoms usually include stiffness of the jaw (“lockjaw”) and neck, dysphagia (difficulty swallowing), and irritability. Spasms and rigidity of muscles develop in the abdomen, neck and back. Asphyxia (unconsciousness or death caused by lack of oxygen) may result from spasms in the larynx or chest. Spasms usually subside in 10 to 14 days. The disease is completely preventable by active immunization beginning with childhood vaccination and obtaining booster doses every 10 years or at the time of puncture injury (including human bites) if it occurs 5 years after a dose.

Non-Routine Crime Scene Pathogens

Appendix A

Biological Safety Level 2 (BSL 2) standard and special safe working practices were intended for controlled facility/healthcare environments and address a variety of subject such as facility design, access, hazard warning signs, containment devices (such as ventilation hoods), vector control, specialized equipment, housekeeping and waste handling. Crime scene environments do not present laboratory controlled conditions, making the use of personal protective equipment and basic hygiene potentially more important to avoid exposure incidents.

1. No mouth pipetting (also ref. Cal/OSHA standard CCRT8 5193 (d)(2)(L))
Mechanical pipetting is used.
2. No eating, drinking, smoking, or applying cosmetics in the work area (ref. 5193 (d)(2)(I)).
3. Procedures are performed carefully to minimize aerosols (Cal/OSHA requires procedures be performed in a manner to minimize splashing, spraying, spattering, and generation of droplets – ref. 5193 (d)(3)(K)).

4. Use standard barrier protections whenever physical contact with contaminated items is anticipated (ref. 5193 (d)(3)(I) for gloves; (K) for body clothing; and (L) for caps and shoe covers). Standard barrier protections include:
 - a. Plastic or rubber (water proof) gloves;
 - b. Lab coats or jump suits.

5. Use appropriate personal protective equipment (or containment equipment) whenever: a) procedures have a high potential for creating aerosols, or b) high concentration or large volumes of infectious agents are used:
 - a. Particulate surgical mask and goggles or a face shield (this is specifically recommended for evidence technicians scraping blood for laboratory analysis – ref. MMWR June 23, 1998, Vol. 38 No. S-6, page 24).
 - b. Cal/OSHA requires the equipment listed in a. (above) whenever splashes, spray, spatter, or droplets of blood or other potentially infectious materials may be generated and eye, nose, or mouth contamination can be reasonably anticipated – ref. 5193 (d)(3)(J).

6. Barrier protection is removed before leaving the laboratory (Cal/OSHA requires hand washing after the removal of gloves or other personal equipment – ref. CCRT8 5193 (d)(2)(E)).

7. Sinks are required for hand washing and hands are washed before leaving the laboratory (Cal/OSHA requires employers to provide antiseptic hand cleanser in conjunction with clean cloth/paper towels or antiseptic towelettes when hand washing facilities are not feasible; employees are then required to wash their hands with soap and running water as soon as feasible – ref. CCRT8 5193 (d)(2)(D)).