Microbiological Threats to Health in the Home

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OBJECTIVE: To explore a range of pathogenic microorganisms and their toxins that can cause disease in the home environment through a review of the literature.

DESIGN: Review of the literature.

ABBREVIATIONS: CDC = Centers for Disease Control and Prevention; CFU = colony forming units; MRSA = methicillin-resistant *Staphylococcus aureus*; VRE = vancomycin-resistant enterococci.

INDEX TERMS: Air quality; disease outbreaks; enteric pathogens; environmental microbiology; infectious disease prevention; laundry.

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Microbial sources of disease in the home from work, family members, and exogenous sources were explored through recent literature. Infectious agents can enter the home and be spread to family members from air, contaminated food, work clothes, rodents, and infected family members. Prevention of infections in the home includes using bleach, antibacterial soaps, and proper food handling procedures.

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GLOSSARY OF TERMS

- Enteric pathogens are microorganisms capable of causing gastroenteritis, diarrhea, and other intestinal complaints.
- Enteric viruses primarily include the diarrhea-causing Rotavirus, Norwalk virus, and other Calciviruses.
- *Escherichia coli* O157:H7 causes hemolytic diarrhea; its Shiga-like toxin can cause serious sequela of hemolytic uremic syndrome.
- Fomites are objects in the environment such as door handles, telephones, or clothing that can transmit disease after contamination.
- Loofahs are sponges made of natural vegetable fiber from plants in the cucumber family.
- MRSA is *Staphylococcus aureus* that has acquired resistance to beta lactam antimicrobial agents (penicillins and cephalosporins) leaving vancomycin as the only treatment choice in most serious infections. MRSA has all the virulence properties of methicillin susceptible *Staphylococcus aureus* and is more difficult to treat.

As clinical laboratorians, we are well acquainted with the microbiological risks at work. We follow universal precautions because we recognize that there may be infectious diseases in the specimens and the patients with whom we work. However, few of us are as careful at home or vigilant in preventing transfer of microorganisms from the workplace to the home. Even we, knowledgeable professionals, do not inspect our homes and check the temperature of our refrigerators or the cleanliness of our bathrooms and kitchens. Few monitor whether we wash our hands between food preparation steps and clean our surfaces properly. The home environment is a particularly easy place for microorganisms to spread from person to person through cross contamination.[1] Many illnesses in the home are unreported and the route of exposure cannot be traced.[2]

HOME AIR QUALITY PROBLEMS

Air quality is steadily declining in many areas and we limit air exchange to make homes tighter, more insulated, and thus, energy efficient.[3] This increases our susceptibility to respiratory infections and allergic reactions from bioaerosols produced by ill family members and environmental fungi. North Americans spend 75% to 80% of their time indoors

and many of our buildings are not safe.[4] Fungi growing in damp places in homes have been shown to cause hypersensitive pneumonitis, toxic pneumonitis, and cancer.[5] In children tested for lung impairment, smoking by parents was the main hazard, but 20% of homes had moisture stains and obvious mold growth.[4] Dampness and mold growth was associated with chronic coughs and slight impairments of lung function.[4] Infants are at particular risk of idiopathic pulmonary hemorrhage, which has been associated with growth of *Stachybotrys chartarum,* also known as *Stachybotrys atrum*, in the home.[6]

Stachybotrys chartarum has a large geographic distribution.[6] In a study of 72 mold-infected building materials in Denmark, *Stachybotrys chartarum* was one of the most frequently encountered molds along with *Penicillium* and *Aspergillus ssp*.[7] *Stachybotrys chartarum* was detected in gypsum boards, whether new or old, where it produced Satratoxin H and G.[7] Macrocyclic tricothecenes Satratoxin H and G are potent inhibitors of protein synthesis and cytotoxic to eukaryotic cells.[8] *Stachybotrys chartarum* only grows where there is moisture; therefore, keep the home dry with a humidity level of 50% or lower and repair all sources of moisture. To eliminate mold, remove the material where the fungus is growing such as drywall boards or carpet. A weak bleach solution can kill the fungus but it will return if the underlying cause of moisture is not corrected.[6]

An emergent threat to indoor health was discovered in 1993 when the hantavirus respiratory syndrome was traced to rodent droppings in homes.[9] If not diagnosed promptly with initiation of treatment, mortality can reach 50% or more. Within the U.S., most cases have been reported in the Southwestern states. Only 15 of the 284 reported cases have been acquired east of the Mississippi River, and in 75% of cases with documented rodent exposure, exposure occurred in the home.[10] A recent case in Vermont highlighted the rodent risk in the home and the widespread nature of this disease. A 61-year-old male lived on four rural acres. Rodent droppings were found in his cellar and under his kitchen counters. He spent 23 days in the hospital (16 of those were in the intensive care unit) for his hantavirus infection. Along with acute respiratory distress syndrome, he developed disseminated intravascular coagulation and renal insufficiency.[10] The organism is transmitted by inhalation of aerosolized droppings from rodents, particularly the deer mouse, in homes.[9] Avoiding rodent-infested areas, sealing buildings from infestation, and cleaning areas with possible exposure with 10% bleach are the best preventions.[9]

HEALTH RISKS FROM LAUNDRY ORIGINATING AT HOME OR AT THE WORKPLACE

Laundry is a recently recognized source of infection. Many of us have lowered water temperatures and use shortened wash cycles to conserve energy, which may lead to transmission of infection in the home.[3] Researchers assessed the risk of transmission of *Shigella ssp.* via contaminated clothing.[2] *Shigella ssp.* cause diarrhea, and occasionally dysentery, and are transmitted via the fecal-oral route. *Shigella ssp.* can infect with a low dose because they are resistant to stomach acid, whereas *Salmonella ssp.* are susceptible to stomach acid and require a higher number of organisms to cause infection. *Shigella ssp.* are only harbored by humans and can be shed from the stool for as long as a year following infection.

Exposure to *Shigella ssp.* can occur from fomites, dishcloths, and normally soiled undergarments. Once placed in the clothes washer, organisms can be transferred from clothing, towels, or linens to other items and to the hands of the person who takes the wet items out of the washer. Although Gibson found a very small chance of infection through risk assessment techniques for one pair of soiled undergarments with 0.1 gram of feces, they did not take into consideration larger amounts of organisms from grossly stained undergarments or multiple undergarments. Once dry, clothing and linens are much less likely to transfer infection. Therefore, the greatest risk of transmitting infection from contaminated laundry probably comes from those who transfer wet laundry from the washer to the drier and do not wash their hands before preparing food.

Healthcare workers have long been concerned about transfer of pathogens from their uniforms or shoes to their homes and families. Sattar used a group of volunteers to determine if *Staphylococcus aureus* could be transferred from fabric to hands, with and without friction. They found that more organisms were transferred from moistened fabric made of polyester cotton mixture than that of 100% cotton. The authors proposed that bacteria may not be absorbed into the fibers of polyester cotton as well as they are in cotton. Friction had a statistically significant impact on transfer rates, increasing transfer by twofold to fivefold. The highest amount of transfer occurred when moistened fingers touched moistened polyester cotton fabric whether friction was used or not. Polyester cotton is a common component of garments and bedding both in hospitals and homes.[11] This study demonstrated the ease of transferring organisms from hands to fabric which may occur in the household laundry room.

Perry studied fifty-seven nurses to determine if methicillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile*, or vancomycin-resistant enterococcus (VRE) could be isolated from home-laundered uniforms. At the end of the participants' shifts, 54% of uniforms were positive for one or more of these pathogens.[12] One or more of these pathogens grew in 39% of the uniforms *after* home laundering. Three individuals failed to launder their uniforms and their uniforms all carried large numbers of MRSA at the beginning of their shift. Although Perry did not determine if any organisms were transferred to anyone, there is a strong possibility of this occurrence. Bleach or other sanitizers used in the laundry process may greatly reduce the numbers of microorganisms transferred during washing and diminish the risk of infection.[12] Gibson found a 90% to 99% decrease in probability of disease through use of sanitizing detergent. Proper laundering can prevent transfer if strict guidelines are provided and followed. Water for laundry should be 65 °C, sanitizing detergent and bleach should be used whenever possible, and types of laundry likely to be contaminated should be washed separately from other items.[2]

MRSA TRANSMISSION FROM WORK TO HOME

Reports confirm hospital employees who carry methicillin-resistant *Staphylococcus aureus* (MRSA) in their pharynx have contaminated their homes and family.[13,14] *Staphylococcus aureus* is a virulent nosocomial pathogen that becomes difficult to treat when beta lactam antibiotics (penicillins and cephalosporins) are not efficacious. Allen reported a case of a MRSA-infected nurse who underwent three unsuccessful courses of treatment for carriage of the organism.[13] Between treatments one and two, three patients from her ward were infected with a strain of the same phage type that she carried, hence indicating the likely passage of the strain from the nurse to the patients. The three patients developed pneumonia, central line, and wound infections. Her son was also a pharyngeal carrier who was treated. Her carriage of MRSA returned. Cultures of her home revealed contamination of her linens, mattress, duvet, pillows, padded headboard, carpet, and other home furnishings. Finally, after professional cleaning of the home, replacement of old mattresses and bedding, and sanitizing of all curtains, linens, towels, and clothes, and steam cleaning of carpets, all family members were again treated. Only then was carriage by the nurse eliminated, and she returned to work without further problems.[13]

Similarly, another nurse also carried MRSA despite three courses of treatment.[14] Her parents and fianceé all carried the identical strain of MRSA indicating she passed the strain to her family and friend. Door handles, a computer shelf, and joystick grew the MRSA isolate. The home was thoroughly cleaned and all pillows and bedding were replaced. After another course of treatment, all four inhabitants were culture negative and eight months later remained free of MRSA.[14]

KITCHEN AND BATHROOM CONTAMINATION BY MICROORGANISMS CAUSING GASTROENTERITIS

Laboratorians bleach surfaces at work but often fail to properly disinfect their homes. Despite our fear of commercial restaurants, most food borne illness takes place in home kitchens.[15] In a study of *Escherichia coli* O157:H7 sporadic cases, 80% of the ill persons ate hamburgers cooked at home. Food preparers in homes where infection occurred washed their hands and work surfaces less often after handling raw meat than control persons. Safe food handling labels required since 1994 were read by 59% of the preparers but followed consistently by only 19%.[15] Home investigations of young children who had culture-confirmed *Salmonella ssp.* infections were conducted on average three days after confirmation of an isolate.[16] Strains appearing identical using molecular methods to those isolated from the originally infected child were cultured in 14 of 50 homes, again demonstrating the importance of the home for transmission of enteric infections.[16]

Preparation of raw chicken can result in widespread contamination of surfaces in the home.[17] Contaminated poultry may contain 10^8 per gram *Campylobacter* and/or *Salmonella ssp.,* both major pathogens causing gastroenteritis, which can even be isolated from the outer wrappings.[18] Sixteen of 20 kitchens tested were contaminated with one or both organisms after chicken preparation, and four kitchens had significant numbers of organisms after routine clean up. This demonstrated the ability of dishcloths and sponges to transfer bacteria to other kitchen sites in the home.[17]

Enteric viruses are shed in large numbers from the feces when a household member is ill and although they do not multiply outside the body, they can survive on inanimate objects and hands. Bellamy sampled a range of surfaces in 39 homes using culture, chemical, and molecular techniques to determine the risk of cross-contaminating enteric viruses.[19] Hemoglobin, detected with the Hemostix test strip (Bayer 2816A), was most frequently found in bathrooms indicating a risk of blood-borne viruses. Amylase, an indicator of sweat and saliva, detected using the Sigma 577 kit, was found on surfaces in bathrooms and on half of the telephones.[19] These findings suggested poor cleaning practices and an increased risk of rhino virus transmission. Viruses were not

isolated in culture because of technical feasibility problems, but viral DNA was found on tap handles in cases of illness reported two weeks previously.[19]

Dishcloths and sponges have been repeatedly shown to be a significant source of potential pathogens in the home.[17,20,21,22] Cellulose sponges, commonly used in the U. S., contained coliforms in concentrations of 1.15 x 10^5 per mL and dish cloths had 1.3 x 10^5/mL.[21] The most common isolates were *Pseudomonas ssp*. and *Enterobacteriaceae*. Fifteen percent of sponges and dish cloths grew *Salmonella ssp.,* and 20% held *Staphylococcus aureus.* Enriquez found statistically significantly higher levels of fecal coliforms in dishcloths than cellulose sponges.[21] Chaidez collected 50 loofahs (natural vegetable fiber of plants in the cucumber family) and cellulose sponges from domestic kitchens in Mexico.[20] Coliforms averaged 1 x 10^3/mL in cellulose sponges and 1.5 x 10^4/mL in loofahs. *Staphylococcus aureus* was found in 60% of cellulose sponges and 86% of loofahs. Salmonella was found in 9.8% of items tested.[20] Rusin studied 15 homes and found the highest levels of contamination in order of frequency were the sponge/dishcloth, the drain area of the kitchen sink, sink faucet handles, cutting board, refrigerator handle, counter top, and floor in front of the sink.[22] Cutting boards can be a particular problem. They can serve as harbingers of microorganisms because they can be difficult to disinfect if they are wooden and have grooves where microorganisms can avoid disinfection.[17] Use of the same cutting boards for raw meats and for foods served uncooked such as fruit or salad without disinfection can transmit pathogens.

Bradford used a strain of *Salmonella ssp.* with enhanced tolerance to environmental conditions, to contaminate cooked beef and fresh melon.[23] Numbers of *Salmonella ssp.* on beef and melon left at room temperature rapidly increased from 10^4 to 10^6 CFU/mL in six hours. Refrigerated melon was culture negative at 24 hours while the numbers of *Salmonella ssp.* doubled in refrigerated beef. Preexposure to refrigerator or freezer temperatures did not affect the recovery of *Salmonella ssp.*[23] This is no surprise to clinical laboratorians but emphasizes the dangers of improper storage of food.

Modern working families tend to shop less often leaving food in our refrigerators longer where organisms can flourish.[3] *Listeria monocytogenes* has been recognized as a serious food outbreak pathogen that can be isolated from a large range of processed and raw foods.[24] Because listeria can grow at refrigerator temperatures, it is a particular problem when it contaminates processed foods or has been transferred to items that have a long refrigerator shelf life. Products such as cooked meats, patés, and soft cheeses have been contaminated and are frequently recalled by manufacturers.[25,26,27] In one case of recall for listeria, 40 illnesses in ten states were reported to the CDC. Hot dogs and other meat products sold under seven brand names were found to contain the infecting strain.[27] Twenty-nine cases of *Listeria monocytogenes* were identified in deli turkey and chicken meat in 2000.[26] Mexican-style fresh soft cheese made from raw milk has also caused outbreaks of *Listeria monocytogenes.*[25]

Listeria ssp. can also be found in domestic environments where they could lead to disease.[24] *Listeria ssp.* was isolated from 132 of 187 sites in six households. The most heavily contaminated sites were dish cloths, brushes for bathing, and toothbrushes. Bathrooms, kitchen sinks, and refrigerator vegetable compartments held lower numbers of *Listeria ssp.*[24] *Listeria ssp.* can only grow on wet surfaces but is not killed by drying.

Bathroom sink drain areas, flush handles, shower drains, and sink faucet handles were found to be most heavily contaminated with fecal coliforms, while bathroom counters, bathroom floors, and toilet seats were contaminated to a lesser extent.[22] The authors proposed these latter areas were cleaned more frequently or contaminated less often than the kitchen. In addition, these areas typically dry between uses lessening the numbers of coliforms.

Domestic and exotic pets have contaminated the home and caused disease in its inhabitants. Reptiles, e.g., turtles, snakes, and lizards, caused salmonellosis in 16 states between 1996 and 1998, posing a significant threat to our health.[28] Ninety-three thousand (7%) of *Salmonella ssp.* infections are attributable to reptile or amphibian contact, usually handling the animal and not adequately washing hands afterwards. Contaminated hands can directly infect persons when they place them in their mouths or handle food. Moreover, they may contaminate fomites that can transmit the disease to persons who do not have direct contact with the animals. Most of the reported cases occur in young children who are more likely to develop bacteremia or meningitis. CDC recommends that children under five and immunocompromised individuals avoid direct and indirect contact with reptiles.[28,29]

Chicks, ducks, and African pigmy hedgehogs have also caused salmonellosis when kept as pets in homes.[30,31,32] Furthermore, birds infected with *Chlamydia psittaci* have caused psittacosis, a serious respiratory disease.[33] Birds may appear healthy but shed the bacterium intermittently when kept as pets in the

home. Cats can cause cat scratch disease and in endemic areas can carry fleas infected with *Yersinia pestis*.[34,35] Several cases of plague believed to be caused by pet cats have been reported.

Immunocompromised individuals should avoid adopting ill, stray, or juvenile pets and should not clean pet litter boxes, cages or dispose of animal waste.[36] If they must handle animal waste they should wear disposable gloves and wash their hands thoroughly afterwards. Animals with diarrhea should be checked by a veterinarian for *Cryptosporidium ssp., Giardia ssp., Salmonella ssp.,* and *Campylobacter ssp.*[36]

PREVENTION

Cogan had 60 college students and staff follow a prescribed procedure that involved preparing a chicken dish from a whole chicken and then compared clean up procedures.[17] One group of 20 (control group) was told to clean up using their usual method. The second group of 20 prepared the chicken the same way but was told to clean up using hot, soapy water to clean utensils, cutting board, and dishcloths, then use the dishcloth to clean kitchen surfaces. The third group was instructed to follow the same procedure as group two but bleach was added to the clean up solution and sprayed on kitchen surfaces. Many of the surfaces in the kitchens of the control group, i.e., group 1, grew *Salmonella* and/or *Campylobacter ssp.* Group 2 kitchens had fewer sites of contamination than those of the control group. Only group 3 that used bleach demonstrated a significant decrease in growth of *Salmonella* and/or *Campylobacter ssp.* Interestingly, although more chickens were contaminated with *Campylobacter ssp.,* more cultured sites grew *Salmonella ssp.* possibly because *Salmonella ssp.* is believed to be able to survive longer on dry surfaces.[16]

Rusin, also found bleach to be very effective for the elimination of coliforms in 14 sites in bathrooms and kitchens.[22] Rusin monitored 15 homes for three periods of ten weeks. In the control period, the first ten weeks, homes were cleaned as usual. In the second ten weeks, the first intervention was introduced, i.e., several cleaning products, most of which contained bleach, were added to household cleaning. In the third ten week period, all cleaning products contained bleach and a strict cleaning protocol was followed. Bacteria decreased in all homes between the control period and second intervention. The researchers found the greatest decrease in numbers of organisms between the first and second observations, but the third phase also demonstrated decreased numbers from those of the second. The sponge/dishcloth, kitchen sink drain, and the cutting board had the greatest decrease from the control period to the second intervention. The marked reduction in bacterial numbers in sponges and dishcloths was particularly significant because these items are more likely to spread pathogens from food to kitchen surfaces. More frequent cleaning with bleach can decrease contamination in the home.[21]

Other preventions include proper handling and refrigeration of food. Food preparation followed by holding it at room temperature is a critical control point for organisms that produce spores such as *Bacillus cereus.*[22] *B. cereus* can produce emetic or diarrheal toxins on sporulation and growth. Contamination of foods by organisms on hands such as *Staphylococcus aureus* can also grow and produce enteric toxins if not refrigerated. Leftovers must be thoroughly heated or boiled to remove contamination. Mead (1997) found hand washing before and after handling food prevented transmission of 34% of *Escherichia coli* O157:H7 infections.

Antibacterial soap may also be helpful in lessening skin infections.[27] Skin infections are more common in children because they have many more cuts and abrasions and in the elderly who have thin skin and may be incontinent.[27] *Staphylococcus aureus* is the primary skin pathogen and is carried by many persons in their anterior nares (30% to 35%), the perineum (20%), and axilla and toe webs (5% to 10%).[28] When using quantitative microbial risk assessment principles, Rose found a 19-fold reduction of infections were found after placing *S. aureus* on the skin of volunteers who used soap containing antibacterial agents versus those who used soap without antibacterial agents.[27]

CONCLUSION

From this review of the literature, it is clear that homes are not always safe havens. However, much can be accomplished to make our homes safer and healthier. From effective air filtering, elimination of dampness, rodent removal, sanitation of laundry, disinfection of kitchens and bathrooms, good food handling practices, and use of antibacterial soaps, many infections can be prevented. Because our homes are not monitored or inspected, vigilance at home is at least as important as that at work and in some cases, more significant to our health. As clinical laboratorians and healthcare providers, we should not only keep a safe home but become advocates in our communities to promote awareness of preventative practices.

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REFERENCES

1. Larson E. Perspectives on home hygiene: building a rational approach. Am J Infect Control 1999;27(6):S1-3.
2. Gibson L, Rose J, Haas C. Use of quantitative microbial risk assessment for evaluation of the benefits of laundry sanitation. Am J Infect Control 1999;27(6):S34-9.
3. Sattar S, Tetro J, Sprinthorpe V. Impact of changing societal trends on the spread of infections in American and Canadian homes. Am J Infect Control 1999;27(6):S4-21.
4. Culjpers C, Swaen G, Wesseling G, and others. Adverse effects of the indoor environment on respiratory health in primary school children. Environ Res 1995;68(1):11-23.
5. Sorenson W. Fungal spores: hazardous to health? Environ Health Perspect 1999;107(Supplement 3):469-72.
6. Dearborn D, Yike I, Sorenson W, and others. Overview of investigations into pulmonary hemorrhage among infants in Cleveland, Ohio. Environ Health Perspect 1999;107(Supplement 3):495-9.
7. Gravesen S, Nielsen P, Iversen R, and others. Microfungal contamination of damp buildings—examples of risk constructions and risk materials. Environ Health Perspect 1999;107(Supplement 3):505-8.
8. Flappan, SM, Portnoy, J, Jones, P, and others. Infant pulmonary hemorrhage in a suburban home with water damage and mold (*Stachybotrys astra*). Environ Health Perspect 1999; 107: 927-30.
9. Van Bevern P. Hantavirus pulmonary syndrome: How great a threat? Clin Rev 2000;10(7):108-18.
10. CDC. Hantavirus pulmonary syndrome—Vermont, 2000. Morbid Mortal Wkly Rep 2001;50(28):603-5.
11. Sattar S, Springthorpe S, Mani S, and others. Transfer of bacteria from fabrics to hands and other fabrics: development and application of a quantitative method using *Staphylococcus aureus* as a model. J of Appl Microbiol 2001;90(6):962-70.
12. Perry C, Marshall R, Jones E. Bacterial contamination of uniforms. J of Hosp Infect 2001;48(3):238-41.
13. Allen K, Anson J, Parsons L, and others. Staff carriage of methicillin-resistant *Staphylococcus aureus* (EMRSA 15) and the home environment: a case report. J Hosp Infect 1997;37(1):74-5.
14. Masterton R, Coia J, Notman A, and others. Refractory methicillin-resistant *Staphylococcus aureus* carriage associated with contamination of the home environment. J Hosp Infect 1995;29(4):318-9.
15. Mead P, Finelli L, Lambert-Fair M, and others. Risk factors for sporadic infection with *Escherichia coli* O157:H7. Arch Intern Med 1997;157(2):204-8.
16. Schutze G, Sikes J, Stefanova R, and others. The home environment and salmonellosis in children. Pediatr 1999;103(1):E1.
17. Cogan T, Bloomfield S, Humphrey T. The effectiveness of hygiene procedures for prevention of cross-contamination from chicken carcasses in the domestic kitchen. Lett Appl Microbiol 1999;29(5):354-8.
18. Cason J, Bailey J, Stern N, and others. Relationship between aerobic bacteria, *Salmonella* and *Campylobacter* on broiler carcasses. Poult Sci 1997;76(7):1037-41.
19. Bellamy K, Laban K, Barrett K, and others. Detection of viruses and body fluids which may contain viruses in the domestic environment. Epidemiol Infect 1998;121(3):673-80.
20. Chaidez C, Gerba CP. Bacteriological analysis of cellulose sponges and loofahs in domestic kitchens from a developing country. Dairy Food Environ Sanit 2000;20(11):834-7.
21. Enriquez C, Enriquez-Gordillo R, Kennedy D, and others. Bacteriological survey of used cellulose sponges and cotton dishcloths from domestic kitchens. Dairy Food Environ Sanit 1997;17(1):20-4.
22. Rusin P, Orosz-Coughlin P, Gerba C. Reduction of fecal coliform, coliform, and heterotrophic plate count bacteria in the household kitchen and bathroom by disinfection with hypochlorite cleaners. J of Appl Microbiol 1998;85(5):819-28.
23. Bradford M, Humphrey T, Lappin-Scott H. The cross-contamination and survival of *Salmonella enteritidis* PT4 on sterile and non-sterile foodstuffs. Lett Appl Microbiol 1997;24(4):261-4.
24. Beumer R, te Giffel M, Spoorenberg E, and others. *Listeria species* in domestic environments. Epidemiol Infect 1996;117(3):437-42.
25. Centers for Disease Control and Prevention. Outbreak of listeriosis associated with homemade Mexican-style cheese—North Carolina, October 2000—January 2001. Morbid Mortal Wkly Rep 2001;50(26):560-2.
26. Centers for Disease Control and Prevention. Multistate outbreak of listeriosis—United States, 2000. Morbid Mortal Wkly Rep 2001;49(50):1129.
27. Centers for Disease Control and Prevention. Multistate outbreak of listeriosis—United States, 1998. Morbid Mortal Wkly Rep 2001;47(50):108.
28. Centers for Disease Control and Prevention. Reptile-associated salmonellosis–selected states, 1996-1998. Morbid Mortal Wkly Rep 1999;48(44):1009-13.
29. Centers for Disease Control and Prevention. Reptile-associated salmonellosis — selected states, 1994-1995. Morbid Mortal Wkly Rep 1996;44(17):347.
30. Centers for Disease Control and Prevention. Salmonella serotype montevideo infections associated with chicks — Idaho, Washington, and Oregon, Spring 1995 and 1996. Morbid Mortal Wkly Rep 1997;46(11):237-9.
31. Centers for Disease Control and Prevention. *Salmonella hadar* associated with pet ducklings–Connecticut, Maryland, and Pennsylvania, 1991. Morbid Mortal Wkly Rep 1992;41(11):185-7.
32. Centers for Disease Control and Prevention. African pygmy hedgehog-associated salmonellosis – Washington, 1994. Morbid Mortal Wkly Rep 1995;44(24):462.
33. Centers for Disease Control and Prevention. Compendium of psittacosis (chlamydiosis) control, 1997. Morbid Mortal Wkly Rep 1997;46(RR13):1-8.
34. Centers for Disease Control and Prevention. Cat-scratch disease in children–Texas, September 2000–August 2001. Morbid Mortal Wkly Rep 2002;51(10):212-4.
35. Centers for Disease Control and Prevention. Fatal human plague–Arizona and Colorado, 1996. Morbid Mortal Wkly Rep 1997;46(27):617-20.
36. Centers for Disease Control and Prevention. Guidelines for preventing opportunistic infections among hematopoietic stem cell transplant recipients. Morbid Mortal Wkly Rep 2000;49(RR10):47-8.
37. Rose J, Haas C. A risk assessment framework for the evaluation of skin infections and the potential impact of antibacterial soap washing. Am J Infect Control1999;27(6):S26-33.
38. Noble W. Skin bacteriology and the role of *Staphylococcus aureus* in infection. Br J Derm 1998;139(Suppl 53):9-12.