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Handwashing

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photograph by C.L Case Ed.D

During the 19th century, women in childbirth were dying at alarming rates in Europe and the United States. Up to 25% of women who delivered their babies in hospitals died from childbed fever (puerperal sepsis), later found to be caused by *Streptococcus pyogenes bacteria*.

As early as 1843, Dr. Oliver Wendell Holmes advocated handwashing to prevent childbed fever. Holmes was horrified by the prevalence in American hospitals of the fever, which he believed to be an infectious disease passed to pregnant women by the hands of doctors. He recommended that a physician finding two cases of the disease in his practice within a short time should remove himself from obstetrical duty for a month. Holmes's ideas were greeted with disdain by many physicians of his time.

In the late 1840's, Dr. Ignaz Semmelweis was an assistant in the maternity wards of a Vienna hospital. There he observed that the mortality rate in a delivery room staffed by medical students was up to three times higher than in a second delivery room staffed by midwives. In fact, women were terrified of the room staffed by the medical students. Semmelweis observed that the students were coming straight from their lessons in the autopsy room to the delivery room. He postulated that the students might be carrying the infection from their dissections to birthing mothers. He ordered doctors and medical students to wash their hands with a chlorinated solution before examining women in labor. The mortality rate in his maternity wards eventually dropped to less than one percent.

Despite the remarkable results, Semmelweis's colleagues greeted his findings with hostility. He eventually resigned his position. Later, he had similar dramatic results with handwashing in another maternity clinic, but to no avail. Ironically Semmelweis died in 1865 of puerperal sepsis, with his views still largely ridiculed.

Perhaps handwashing seemed odd at the time. The lack of indoor plumbing made it difficult to get water. In order to make the water comfortably warm, it would have to be heated over a fire. Besides, contact with water was associated with diseases such as malaria and typhoid fever. It is difficult perhaps in our

current day to imagine physicians being so resistant to what we now consider common practice. But the resistance continued.

In the 1870's in France, one hospital was called the House of Crime because of the alarming number of new mothers dying of childbed fever within its confines. In 1879, at a seminar at the Academy of Medicine in Paris, a noted speaker stood at the podium and cast doubt on the spread of disease through the hands. An outraged member of the audience felt compelled to protest. He shouted at the speaker: "The thing that kills women with [childbirth fever]...is you doctors that carry deadly microbes from sick women to healthy ones." That man was Louis Pasteur. Pasteur, of course, contributed to the germ theory of disease (whereas the founder to this theory was Robert Koch). He was a tireless advocate of hygiene, but his efforts too were initially met with skepticism. Skepticism, however, was not the only problem facing advocates of hygiene.

In 1910, Josephine Baker, M.D. started a program to teach hygiene to child care providers in New York. Thirty physicians sent a petition to the Mayor protesting that "it was ruining medical practice by...keeping babies well."

How Far Have We Come?

Despite its rocky beginnings, handwashing has become a part of our culture. Handwashing and other hygienic practices are taught at every level of school, advocated in the work place, and emphasized during medical training. According to the United States Centers of Disease Control and Prevention (CDC), "Handwashing is the single most important means of preventing the spread of infection."

Yet, recent studies and reports indicate that lack of or improper handwashing still contributes significantly to disease transmission. While we are all potentially at risk of contracting hand-transmitted illnesses, one-third of our population is especially vulnerable, including pregnant women, children, old people, and those with weakened immune systems.

It seems reasonable to assume that hospitals have come closest to responding to this problem. Modern surgery, after all, has long since solved many of the early problems of infection. However, fundamental problems of hygiene still exist. In 1992, The New England Journal of Medicine reported on a handwashing study in an intensive-care unit. Despite special education and monitored observation, handwashing rates were as low as 30% and never went above 48%!

Nosocomial infections are infections acquired by patients while they are in the hospital, unrelated to the condition for which the patients were hospitalized. The Centers for Disease Control and Prevention estimates that from 5% to 15% of all hospital patients acquire some type of nosocomial infection. Hospital personnel can also become infected. In 1993, 11 health-care workers became ill with hepatitis A because they didn't wash their hands after treating one of two patients with hepatitis A

The rate of nosocomial infections can be reduced by full-scale infection control programs whose expense would be recovered by the reduction of the cost involved in treating the nosocomial infections. But, as The New England Journal of Medicine report reminds us, one of the most effective, simple, and yet difficult to implement solutions would be for all hospital personnel to wash their hands between every patient!

Hospitals are not the only places in which handwashing is important. A recent study in Infectious Diseases in Children states: "In spite of all the studies about the benefits of handwashing, improper or infrequent handwashing continues to be a major factor in the spread of disease in day-care." Each year,

children in daycare centers, elderly in convalescent homes, and contact lens wearers acquire infections transported on hands. Cleanliness in the food-service industry has long been of concern with regard to transmission of foodborne illness. During the last nine years, the popularity of iguanas and other reptiles has resulted in a startling increase in the incidence of *salmonella* infections.

Salmonella: A Case Study in the Need for Improvement

Salmonella sp. is a rod-shaped bacteria with over a thousand strains capable of causing infection (salmonellosis). *Salmonella* is easily transferred among humans and animals by both direct and indirect contact. The great increase in mass production of certain food products, including poultry and eggs, has resulted in a large increase in salmonella infections. In uncooked, room-temperature food, *Salmonella* multiplies at an alarming rate. In addition to other strict hygiene practices when handling uncooked poultry and raw eggs, scrupulous handwashing is necessary, using hot and soapy water.

In the 1970s, many of us may remember having baby turtles. Researchers discovered a disturbing problem, however. A quarter million children contracted salmonellosis from their tiny pets. Legislation was quickly enacted regulating the sale of pet turtles. In recent years, the increasing popularity of reptile pets, particularly green iguanas, has brought the *Salmonella* issue back in the news.

The Centers for Disease Control and Prevention (CDC) has reported an alarming number of cases of unusual strains of *Salmonella* causing infections in both adults and children. These strains seem to be associated with reptiles. The infections have been contracted by both direct and indirect contact. Once again, pet owners are being precautioned to take adequate measures when handling their pets, including proper handwashing.

Conclusion

In 1996, the lack of handwashing is surprising. We have hot running water and the benefits of many antimicrobial soaps to prevent infections. In the food-service industry, studies indicate that inadequate handwashing and cross-contamination is responsible for as much as 40% of foodborne illnesses, including *Salmonella*. It is estimated that there are over 80 million cases of food poisoning in the United States each year, resulting in greatly increased health care costs, loss of job productivity, and as many as 10,000 deaths per year. About 20,000 people die from nosocomial infections each year, due primarily to the lack of infection control programs. $500 million would be saved if just 17% of the nosocomial infections were prevented. This money could be used for such things as cancer or AIDS research. What a simple act, handwashing, with such remarkable benefits if it were to be practiced properly.

ACCESS EXCELLENCE® Activities Exchange

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Hand washing Laboratory Activities

by: Christine L. Case, Ed.D.,
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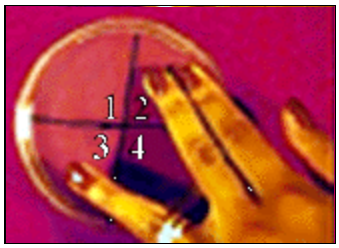
Activity #1: Fingerprint Technique



photographs by C.L Case Ed.D

Materials

These materials are for each pair of students.

- Two petri plates containing nutrient agar
- Soap

Procedure

1. Divide two nutrient agar plates into four quadrants.
    a. Label the quadrants of each plate 1 through 4.
    b. Label one plate "Water," the other "Soap."

2. One student use the "Water" plate.
    a. Touch section 1 with your fingers.
    b. Wash well without soap.
    c. Shake off excess water and while still wet touch section 2.

3. Do not dry your fingers with a towel.
    a. Wash again and while wet touch section 3.

4. Wash a final time and touch section 4.

5. Another student should use the plate labeled "Soap." Repeat the procedure step 2 (Except 2b. Wash with soap) through 4.

6. Incubate the plates inverted at 35C or room temperature until the next period. (Usually 24 hours at 35C or 48 hours at room temperature.)

7. Record your results:
   a. 4+ = maximum growth
   b. 3+ = moderate growth
   c. 2+ = some growth
   d. 1+ = a little growth
   e. neg = no growth

Activity #2: Bowl Technique

Materials

These materials are for the whole class.

- Two sterilized bowls (wash then rinse out with alcohol and sterile water)
- 100 ml sterile water per bowl
- Two petri plates containing nutrient agar

Procedure

1. Label one nutrient agar plate "Not washed," the other "Washed."

2. Go to the restroom and touch all the things you would normally touch, such as doors and faucets, but do not wash your hands.

3. Immerse your hands up to mid-palm in 100 ml sterile water. Rub your fingers against each other.

4. After everyone has rinsed their hands in the same container of sterile water, transfer 0.5 ml of the wash water from step 2 to the surface of the "Not washed" plate. Spread the inoculum over the plate with an L-shaped glass rod. (The rod can be sterilized by dipping in alcohol and washing off the alcohol with sterile water.)

5. Go to the restroom and touch all the things you would normally touch then wash your hands.

6. Immerse your hands up to mid-palm in 100 ml sterile water. Rub your fingers against each other.

7. After everyone has rinsed their hands in the water, transfer 0.5 ml of the wash water from step 5 to the surface of the "Washed" plate. Spread the inoculum over the plate with a sterilized glass rod.

8. Incubate the plates inverted at 35C or room temperature until the next period. (Usually 24 hours at 35C or 48 hours at room temperature.)

9. Record your results:
    a. 4+ = maximum growth
    b. 3+ = moderate growth
    c 2+ = some growth
    d. 1+ = a little growth
    e. neg = no growth

Options

Compare hot/cold water; bar/liquid soap; dispenser types, e.g., bar soap, pump bottle, slit top, powdered soap; soap ingredients, e.g., alcohol, soap, detergent, hexachlorophene, medicated soaps.

Questions

1. Why is it not necessary and, in fact, undesirable to remove all bacteria from the skin?

2. The microorganisms that are normally present on the human skin are not pathogens. Why does a surgeon scrub for 2 to 5 minutes with an antiseptic soap before operating?

3. List some diseases that can be transmitted on hands.

4. Make a sign for your school restroom that will get students to wash their hands. Make a sign for your school that will encourage students who own lizards to wash their hands after handling the lizard.

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Handwashing Resources

Books

The Life That Lives on Man by Michael Andrews. New York: Taplinger, 1977. Describes the ecology of the arthropods and bacteria that live on humans.

The Disease Detectives by Gerald Astor. New York: New American Library, 1984. Follow CDC epidemiologists as they uncover the causes of deadly diseases.

Microbe Hunters by Paul DeKruif. New York: Harcourt, Brace, and World. The stories of Leeuwenhoek, Koch, Pasteur, and others are presented in an interesting narrative.

Magnificent Microbes by Bernard Dixon. New York: Atheneum, 1976. A best-selling account of our dependence on microbes.

Man and Microbes by Arno Karlen. New York: Putnam Books, 1995. The natural history of diseases such as AIDS, Lyme disease, and plague is presented to illustrate the adaptations of humans and their parasites.

Profiles of Women Scientists by Elizabeth M. O'Hern. Washington, D.C.: Acropolis Books, 1985. Twenty short stories describe the modern contributions of women to microbiology and medicine.

Life on Man by Theodor Rosebury. New York: Viking Press. A humorous yet scientific account of the role of microbes on the human body.

The Medical Detectives by Berton Roueche. 2 vols. New York: Truman Talley Books. Roueche describes the scientific investigation of specific medical cases in a series of short stories. Other true stores of medical detection by Roueche are The Orange Man, Eleven Blue Men, and Annals of Epidemiology.

The Lives of a Cell by Lewis Thomas. New York: Viking Press, 1974. Several articles in this delightful book discuss bacteria and their relation to health and disease.

Lab Experiments Resource

Laboratory Experiments in Microbiology by T. R. Johnson and C. L. Case. Menlo Park, CA: Benjamin/Cummings Publishing Co., 1995.

Articles

"Cultured Potatoes" by Judy Contino. *Science Activities* v30 n3 p21-22 Fall 1993 Describes an activity where students with dirty hands and students with clean hands handle boiled potatoes to observe and compare the growth of mold on the potatoes.

"A Quick and Easy Simulation of Disease Transmission" by Jean L. Dickey. *American Biology Teacher* v51 n6 p364-65 Sep 1989 Described is an activity in which the transmission of disease is simulated by the students in the classroom using common solutions. Discussed are materials, preparation, procedures, and questions for classroom discussion.

"How to Spread an Epidemic in the Classroom" by E. John. *South Australian Science Teachers Journal* 4 Sep 1971 Describes classroom model of disease transmission, demonstrating the transfer of Serratia marsescens by direct contact and the detection of the "infected" person.

"Kills Germs" by the Millions by Molly Swails. *Science Activities* v17 n3 p3-6 Sep-Oct 1980 Described is a science experiment involving the isolation and study of microorganisms. Bacteria from the mouth are cultured on blood agar culture plates and are then exposed to four different mouthwashes to test their effectiveness.

"Making Rounds with Dr. Semmelweis" by Patrick N. Hunt. *Science Teacher* v51 n1 p33-37 Jan 1984 Describes a minicourse on experimental hypotheses. The courses which treats the investigative nature of biology as a major theme, teaches nonrigorous problem-solving and engenders the excitement of self-discovery. Manipulation of variables in relation to controls, the principles of deduction and induction, and their application to selected historical discoveries are discussed.