Microbes on Surfaces:
Factors affecting Survival and Transport

Virus Survival on Surfaces

- Adsorption State
  - Air Water Interface
  - Triple Phase Boundary
- Physical State
  - Dispersed
  - Aggregation
  - Solids associated

Virus Survival on Surfaces

- Relative humidity
  - Similar effects as seen in aerosols; effects are virus type dependent
- Moisture Content
  - In soils moisture content directly related to virus survival
    - Dessication
    - Enhanced predation

Virus Survival on Surfaces

- Temperature
  - Effects are similar to those observed in liquid media and aerosols
  - Interaction between relative humidity and temperature pronounced on surfaces for certain virus types (e.g. Polio, Herpes Simplex), less important for others (e.g. Vaccinia) (Edward, 1941)

Virus Survival on Surfaces

- Suspending Media
  - Effects similar to effects on survival in aerosols
    - Presence of fecal material
    - Presence of salts
- Type of Surface
  - Little effect documented for non-porous surfaces for most viruses; important for some virus types (Herpes simplex)
  - Surface type effect much more pronounce for porous surfaces (e.g. fabrics like cotton, synthetics and wool)
- Light
  - Effects similar to those described for aerosols and liquids

The nosocomial colonization of T. Bear.

Infect Control. 1986 Oct;7(10):495-500.

Hughes WT, Williams B, Williams B, Pearson T.

- A national effort to reduce nosocomial infections includes a program developed at the National Institutes of Health to encourage handwashing in hospitals and day care centers. The program promotes a **symbolic teddy bear (T. Bear)** with slogans to remind hospital personnel and patients to practice handwashing. One of the items used is a stuffed toy T. Bear to be dispensed to the hospitalized child. Considering the manner in which children handle stuffed toys, we suspected the **T. Bear might serve as a "fomite"** for transmission of nosocomial microbes. A prospective study of 39 sterilized T. Bears revealed that all became colonized with bacteria, fungi, or both within 1 week of hospitalization. Hospital acquired organisms cultured from the T. Bear included **Staphylococcus epidermidis, Staphylococcus aureus, alpha streptococci, Corynebacterium acnes, Micrococcus sp, Klebsiella pneumoniae, Pseudomonas aeruginosa, Escherichia coli, Bacillus sp, and species of Candida, Cryptococcus, Trichosporon, Aspergillus and others.** Concomitant cultures of the patients revealed similar isolates. Although the T. Bear handwashing campaign should not be discredited, the promotional toy may pose an unnecessary expense and hazard and should not be used in hospitals or day care centers.

Transmission dynamics of enteric bacteria in day-care centers.

Am J Epidemiol. 1983 Oct;118(4):562-72.

Ekanem EE, DuPont HL, Pickering LK, Selwyn BJ, Hawkins CM.

- The role of fomites in the transmission of diarrhea in day-care centers was evaluated. During a nine-month period (December 1980-August 1981)
  - inanimate objects and hands of children and staff in five Houston day-care centers were cultured monthly and again during outbreaks of diarrhea.
  - Air was sampled from the classrooms and bathrooms using a single-stage sieve sampler.
  - When a diarrhea outbreak occurred, stool specimens were collected from ill and well children and from staff in the affected rooms.
- Multiple pathogens accounted for 3 of 11 outbreaks.
- The rates of isolation of fecal coliforms from hands and classroom objects on routine sampling were 17% (22/131) and 13% (8/64), respectively.
- During outbreaks of diarrhea, fecal coliforms were recovered with significantly greater frequency from hands (32%; p less than 0.005) and from classroom objects (36%; p less than 0.005).
  - There was no difference in the level of fecal contamination in the toilet areas during outbreak and nonoutbreak periods.

Prevalence of rotavirus on high-risk fomites in day-care facilities. Pediatrics. 1993 Aug;92(2):202-5. Butz AM, Fosarelli P, Dick J, Cusack T, Yolken R.

- High-risk fomites were identified in two day-care centers and sampled biweekly during a 6-month study period.
- Water samples from water-play tables in each center were also collected during the study period.
- During an infectious disease outbreak, fomites were sampled from the rooms in which the outbreak occurred.
- A total of 96 fomite samples were tested for presence of rotavirus from the two centers, of which 18/96 (19%) tested positive for rotavirus.
- The timing of the positive samples differed between the two centers.
  - In the center that housed infants, a peak of rotavirus-positive fomites coincided with two enteric outbreaks.
- Rotavirus contamination was found on the telephone receiver, drinking fountain, water-play table, and toilet handles in both centers. Bacteria in large quantities were also identified in water-play table samples.

Detection of rotaviruses in the day care environment by reverse transcriptase polymerase chain reaction. J Infect Dis. 1992 Sep;166(3):507-11. Wilde J, Van R, Pickering L, Eiden J, Yolken R.

- A highly sensitive polymerase chain reaction (PCR) assay was used to detect rotavirus RNA in day care environments.
- Areas sampled included floors, diaper change areas, toy balls, and other surfaces.
- In two centers undergoing outbreaks of rotavirus, 7 (39%) of 18 toy balls had detectable rotavirus as did 8 (21%) of 39 swabs from environmental surfaces. By comparison, only 1 (5%) of 21 toy balls and 1 (2%) of 44 environmental surface swabs had detectable rotavirus in centers without rotavirus outbreaks (P = .0001).

Effect of fecal contamination on diarrheal illness rates in day-care centers. Am J Epidemiol. 1993 Aug 15;138(4):243-55.Laborde DJ, Weigle KA, Weber DJ, Kotch JB.

- Diarrheal illness without concomitant respiratory symptoms was monitored among 221 children aged < 3 years in 37 classrooms (24 day-care centers) through biweekly parental telephone interviews from October 1988 to May 1989 in Cumberland County, North Carolina.
  - The risk of diarrhea was expressed as new episodes/classroom-fortnight.
- Contamination was expressed as the log10 fecal coliform count per unit of surface area, per toy, and per child and staff hands.
- Significant predictors of diarrheal risk were any hand contamination ($p = 0.003$) and the number of contaminated moist sites (hands, faucets, and sinks) ($p = 0.006$).
- After adjusting for the child/staff ratio using weighted multiple regression, the authors found that classrooms with either any hand contamination ($p = 0.0015$) or contamination on all moist sites ($p = 0.015$) had a significant twofold increased rate of diarrhea compared with classrooms without contamination.

Incidence of enteric bacteria and Staphylococcus aureus in day care centers in Akwa Ibom State, Nigeria.

Southeast Asian J Trop Med Public Health. 2004 Mar;35(1):202-9. **Itah AY**, **Ben AE**.

- The incidence of enteric bacteria and Staphylococcus aureus in four day care centers in Akwa Ibom State was studied using culture techniques.
- The percentage frequencies of the isolates from 124 samples were Staphylococcus aureus (33.9), Escherichia coli (19.0), Klebsiella sp (14.4), Citrobacter sp (12.5) and Proteus mirabilis (7.4).
- The sources of contamination were floors, chairs, skin, bed linen, door handles, fans, children's tables, walls, windows, ceiling, headmistress's table and chairs, drinking water and wash water.

Recovery of Giardia lamblia cysts from chairs and tables in child day-care centers.

Pediatrics. 1994 Dec;94(6 Pt 2):1006-8.

Cody MM, **Sottnek HM**, **O'Leary VS**.

Occurrence of bacteria and biochemical markers on public surfaces. Int J Environ Health Res. 2005 Jun;15(3):225-34. Reynolds KA, Watt PM, Boone SA, Gerba CP.

- From 1999-2003, the hygiene of 1061 environmental surfaces from shopping, daycare, and office environments, personal items, and miscellaneous activities (i.e., gymnasiums, airports, movie theaters, restaurants, etc.), in four US cities, was monitored.
- Samples were analyzed for fecal and total coliform bacteria, protein, and biochemical markers. Biochemical markers, i.e., hemoglobin (blood marker), amylase (mucus, saliva, sweat, and urine marker), and urea (urine and sweat marker) were detected on 3% (26/801); 15% (120/801), and 6% (48/801) of the surfaces, respectively.
- Protein (general hygiene marker) levels > or = 200 microg/10 cm2 were present on 26% (200/801) of the surfaces tested.
- Surfaces from children's playground equipment and daycare centers were the most frequently contaminated (biochemical markers on 36%; 15/42 and 46%; 25/54, respectively).
- Surfaces from the shopping, miscellaneous activities, and office environments were positive for biochemical markers with a frequency of 21% (69/333), 21% (66/308), and 11% (12/105), respectively).
- Sixty samples were analyzed for biochemical markers and bacteria.
  - Total and fecal coliforms were detected on 20% (12/60) and 7% (4/ 60) of the surfaces, respectively.
  - Half and one-third of the sites positive for biochemical markers were also positive for total and fecal coliforms, respectively.
- Artificial contamination of public surfaces with an invisible fluorescent tracer showed that contamination from outside surfaces was transferred to 86% (30/

What factors may affect Transport of Microbial Hazards from Surfaces?

Occupational Infections

An occupational infection may be simply defined as an infection that is contracted through employment.

A broader definition can be used to sub-classify occupational infections as follows:

An occupational infection is a disease caused by a transmissible agent (bacterium, virus, fungus, parasite, etc.) that is acquired:

(a) by the nature of the work being performed eg. zoonoses in animal handlers, sexually transmitted diseases in sex workers, a wide range of infections in laboratory workers, etc. That is, the infection is *intrinsic to the work*. These are the considered by some to be the 'true occupational diseases';

(b) because of an increased vulnerability arising from work eg. silicotuberculosis; lacerations which subsequently become infected;

(c) from other workers, clients, patients and visitors eg. influenza and other common respiratory diseases in office environments; or

(d) during the course of work eg. Legionnaire's disease, and the various diseases associated with travel.

(c) and (d) are *incidental to the work*.

History of Occupational Exposure

- Biblical plaques
- Leprosy in Crusaders
- Black Death
- Typhus
- Syphilis

History cont.

- *De Morbis Artificum Diatriba* – “Diseases of Workers” 1700 B.Rammazini
- The Effects of Arts, Trades, and Professions- 1832 C.T. Thackrah
- The Occupational Diseases- 1914 W.G. Thompson
- Industrial Medicine and Surgery- 1920 H.E. Mock (Sears, Robuck & Company)
- Manual of Standard Practices for Industrial Nurses- Hanford Engineer Works
- Hunter’s Diseases of Occupations-1955 D.Hunter, most recent edition in 1994 by Raffle et al.

Occupations at Risk

- Those that work with people
  - e.g. healthcare workers, daycare workers, public safety/emergency response
- Those that work with animals/food production
  - e.g. veterinarians, farmworkers, abbatoirs
- Those that work outdoors
- Those that work around water
- Those that travel
- Those who work indoors

Occupational Risk Factors for Influenza

- Exposure to Children
- Prolonged Face to Face contact
- High Volume Population Exposure
- Enclosed Areas
- Schools and Universities
- The Military
- Animal Exposure
- Health Care Setting
- Aerospace Environment

Occupational Risks

- http://www.haz-map.com/infect.htm
- Military
- Wastewater Workers
- Metal Workers
- Butchers/Abbatoirs

What Occupations are at risk for Histoplasmosis??

Histoplasmosis

An intracellular mycotic infection of the reticuloendothelial system caused by the inhalation of the fungus. Approximately 95% of cases of histoplasmosis are inapparent, subclinical or benign. Five percent of the cases have chronic progressive lung disease, chronic cutaneous or systemic disease or an acute fulminating fatal systemic disease. All stages of this disease may mimic tuberculosis.

Distribution: World-wide, especially U.S.A. Sporadic cases do occur in Australia.

Aetiological Agent: *Histoplasma capsulatum*, especially from soil enriched with excreta from chicken, starlings and bats.