

## HAND WASHING RESOURCES

1. Anonymous, Towels beat hot air driers hands down. Associated Press Newswire, 1993(July). Handwashing - Michaels.  
Reports on a study done by the University of Westminster and financed by the Association of Soft Tissue Paper Manufacturers finding that hot air dryers increased bacteria on hands more than 500%.
2. Anonymous, Alcohol for hand hygiene: New comparative studies add to the evidence base. *Can Commun Dis Resp*, 2003. 29(1): p. 4-6. Handwashing - Antimicrobial.  
Two recent studies from France have added to the evidence that hand disinfected with alcohol or alcohol based solutions is an essential component of infection control. The first addresses hand hygiene in the wards and the seconds in the operating theatre. These are quite different scenarios.
3. Anonymous, Emails about handwashing. Emails, n.d. Handwashing.  
Emails send and received on the topic of Handwashing.
4. Anonymous, Food worker rules. Paraphernalia, n.d. Handwashing.  
Collection of Stickers for Food service workers in multiple languages. Food Worker Rules - Do not work if..., Wash your hands thoroughly after you..., and Do not touch ready-to-eat foods with your hands, use...
5. Anonymous, Hand washing. Powerpoint, n.d. Handwashing.  
Slides include: Hygiene, Follow-up, Managerial responsibility, Gloves, Hand sanitizer, Hand washing station conditions, station setup, How to wash your hands, When to wash your hands, and lists common foodborne illness causes - Staphylococcus, E. coli, Salmonella, Hepatitis, Listeria, Streptococcus.
6. Anonymous, Hands and arms. Regulations, n.d. Handwashing.  
From Public Health Reasons page 720-722. Regulations 2-301.11 to 2-301.16 Hands and Arms: Clean condition, Clean procedure, Special Handwash Procedures, When to Wash, Where to Wash, Hand Sanitizers (incomplete).
7. Anonymous, Interpretive guidelines - skilled nursing facilities and intermediate care facilities. Chart, n.d. Handwashing.  
From Ray. F384 - Handwashing procedures. Included is an abstract from R. Seligmann, and S Rosenbluth's article "Comparison of Bacterial Flora on Hands of Personnel Engaged in Non-food and in Food Industries.
8. Anonymous, UK hot-air dryer microbial survey - us hot-air dryer microbial survey. Charts, n.d. Handwashing - Michaels.  
UK: % of Staphylococcus aureus (95%), other Staphylococcus species (91%), Bacillus, Enterobacteraceae (63%) - Citrobacter freundii, Serratia species, Enterobacter species, Proteus species, Hafnia alvei, Yersina species, Aeromonas salmonicida. US: % Staphylococcus species (100%), Staphylococcus aureus, Bacillus (95%), Pseudomonadaceae, Escherichia clocae, Escherichia vulneris, Enterobacter agglomerans, Flavobacterium, Acinetobacter, Fungi (48%).
9. Michaels, B., et al., Microbiological survey of hot-air hand dryers from various locations. *J Food Protection*, 2001. 64: p. 95. Handwashing - Michaels.  
Numerous studies involving various hand-drying techniques have described superior hygienic efficiency of hot-air dryers when compared to cloth or paper towels. An evaluation of methods utilized in previous studies revealed several deviations from everyday use, possibly compromising final results. In these studies, hot-air dryers being tested were new (not used), employed specially filtered air, or were run for longer periods that would normally occur. Unpublished reports revealed the potential for hot-air dryers to serve as a source of cross-contamination by acting as a reservoir and emission source for dust containing potentially pathogenic microorganisms. Microbiological sampling was performed on the air streams and mechanical components of over 30 hot-air hand dryers situated in various public locations in several US cities. Air exposure samples collected on selective media before and during machine operation indicated total bacterial contamination levels increasing significantly, confirming earlier work. Swab samples of various dryer components also revealed significant microbial contamination somewhat reflective of the air-stream data. Abstract Only.
10. AAD, Hand eczema. Online Article, 1999. Handwashing.  
AAD is the American Academy of Dermatology. Article answers questions: What causes a hand rash? Can stress cause a hand rash? How are hand rashes treated? and Is hand protection really important? (<http://www.aad.org/aadpamphrework/hand.htm>)  
Page NOT found.
11. Action, E.f., Does handwashing with soap decrease the risk of diarrhea? Online Article, 2003. Handwashing.  
Evidence for Action.
12. Adams, D., et al., Clinical evaluation of glove washing and re-use in dental practice. *J. Hosp. Infect.*, 1992. 20: p. 153-162. Handwashing - Gloves.  
This study has assessed the durability of four brands of latex gloves, Ansell Medical 'Medi-Grip', Regent 'Biogel D', Surgikos 'Microtouch' and the London Rubber Company 'Supreme', under conditions of repeated washing and re-use in a clinical dental setting. The microbiological effectiveness of 'Hibiscrub' as a decontaminating washing agent was examined simultaneously. Examination by an electrical test for micropunctures in 200 unused gloves of each brand revealed such defects in 6(3%) of Ansell 'Medi-Grip', 3(1.5%) of 'Biogel D', 14(7%) of Surgikos 'Microtouch' and 2(1%) of LRC 'Supreme' gloves. Following repeated clinical use, micropunctures were detected in 18% of Ansell 'Medi-Grip', 10% of 'Biogel D', 75% of Surgikos 'Microtouch' and 56% of LRC 'Supreme'. Microorganisms were isolated from the glove surfaces after 45% of the occasions on which the gloves were washed for 1 min in 'Hibiscrub' (ICI Dental). Eighty-five per cent of these isolates were environmental organisms, but oral streptococci were isolated from 8.4% of the pairs of gloves examined. The high rate of micro-puncture development following repeated washing and re-use of latex gloves indicates that they cannot effectively perform their barrier function under such conditions. The microbiological data have also revealed the potential for cross-infection between patients

- through inadequate decontamination of glove surfaces. For operative dental surgery, the results suggest that heavier, surgical type gloves are to be preferred, and that multiple use of any glove type should be discouraged.
13. AFDO, No direct hand contact with ready-to-eat foods. Draft, 1995. Handwashing.  
Keep infected food handlers from working in kitchens; cook food adequately to destroy pathogens in food; temperature control during holding can be a contributing factor for certain foodborne outbreaks associated with infected workers; handwashing is required after using the toilet or touching contaminated food/surfaces; prevent direct hand contact with ready-to-eat foods. Procedures; Classifications of hand soaps and sanitizers; Single-use gloves.
  14. Aiello, A.E., et al., Relationship between triclosan and susceptibilities of bacteria isolated from hands in the community. *Antimicrobial Agents Chemother.*, 2004. 48(8): p. 2973-2979. Handwashing - Antimicrobial.  
The possible association between triclosan and bacterial susceptibility to antibiotic was examined among staphylococci and several species of gram-negative bacteria (GNB) isolated from the hands of individuals in a community setting. Hand cultures from individuals randomized to using either antibacterial cleaning and hygiene products (including a hand soap containing 0.2% triclosan) or non-antibacterial cleaning and hygiene products for a 1-year period were taken at baseline and at the end of the year. Although there was no statistically significant association between triclosan MICs and susceptibility to antibiotic, there was an increasing trend in the association the odds ratios (ORs) for all species were compared at baseline (OR = 0.65, 95% confidence interval [95%CI] = 0.33 to 1.27) versus at the end of the year (OR = 1.08, 95%CI = 0.62 to 1.97) and for GNB alone at baseline (OR = 0.66, 95%CI = 0.29 to 1.51) versus the end of year (OR = 2.69, 95%CI = 0.78 to 9.23) regardless of the hand-washing product used. Moreover, triclosan MICs were higher in some of the species compared to earlier reports on household, clinical, and industrial isolates, and some of these isolates had triclosan MICs in the range of concentrations used in consumer products. The absence of a statistically significant association between elevated triclosan MICs and reduced antibiotic susceptibility may indicate that such a correlation does not exist or that it is relatively small among the isolates that were studied. Still, a relationship may emerge after longer-term or higher-dose exposure of bacteria to triclosan in the community setting.
  15. Alenius, H., et al., Allergen and protein content of latex gloves. *Annals of Allergy*, 1994. 73: p. 315-320. Handwashing - Gloves.  
Objective: To protect latex-allergic people and to diminish the risk of sensitization, adequate methods are needed to measure and monitor the allergen content of surgical latex gloves. Conclusions: In vitro assays showed considerable variation in the total protein and allergen contents of different latex glove brands. The amount of protein eluting from the gloves did not always correlate with their allergenicity in skin prick tests indicating that total protein measurements is not a sufficient method to monitor the allergenic properties of latex gloves.
  16. Allwood, P.B., et al., Hand washing compliance among retail food establishment workers in Minnesota. *J. Food Prot.*, 2004. 67(12): p. 2825-2828. Handwashing.  
Inadequate hand washing by food workers is an important contributing factor to foodborne disease outbreaks in retail food establishments (RFEs). We conducted a survey of RFEs to investigate the effect of hand washing training, availability of hand washing facilities, and the ability of the person in charge (PIC) to describe hand washing according to the Minnesota Food Code (food code) on workers' ability to demonstrate food code-compliant hand washing. Only 52% of the PICs could describe the hand washing procedure outlined in the food code, and only 48% of workers could demonstrate code-compliant hand washing. The most common problems observed were failure to wash for 20 s and failure to use a fingernail brush. There was a strong positive association between the PIC being a certified food manager and being able to describe the food code hand washing procedure (odds ratio [OR], 5.5; 95% confidence interval [CI], 2.2 to 13.7), and there was an even stronger association between the PIC being able to describe hand washing and workers being able to demonstrate code-compliant hand washing (OR, 15; 95% CI, 6 to 37). Significant associations were detected among correct hand washing demonstration, physical infrastructure for hand washing, and the hand washing training methods used by the establishment. However, the principal determinant of successful hand washing demonstration was the PIC's ability to describe proper hand washing procedure. These results suggest that improving hand washing practices among food workers will require interventions that address PIC knowledge of hand washing requirement and procedure and the development and implementation of effective hand washing training methods.
  17. Altmeier, W.A., Surgical antiseptics. Book Chapter, 1983. Handwashing - Antimicrobial.  
Book titled: *Disinfection, Sterilization, and Preservation* by Block, S.S. Contents: The Skin, Mucous Membranes, Wounds, Evaluation of Specific Surgical Antiseptics - Soap - Hexachlorophene - Alcohols - Quaternary Ammonium Compounds - Iodine - Iodine Compounds - Mercurials - Chlorhexidine Gluconate - Miscellaneous Agents.
  18. Aly, R. and Maibach, H.I., Comparative study on the antimicrobial effect of 0.5% chlorhexidine gluconate and 70% isopropyl alcohol on the normal flora of hands. *Appl. Environ. Microbiol.*, 1979. 37(3): p. 610-613. Handwashing - Binder.  
Study compared the effect of chlorhexidine gluconate alcohol emollient handwash (HIBISTAT) with that of 70% isopropyl alcohol on the normal flora of hands designed to mimic conditions used for surgical preparation. The chlorhexidine significantly reduced the normal microflora on hands. There was a slightly greater reduction when this product was used in comparison to the alcohol. After the chlorhexidine treatment, there was no significant growth of bacteria over a period of 6 h when compared with the base line bacterial counts.
  19. Aly, R. and Maibach, H.I., Comparison of the antimicrobial effect of 0.5% chlorhexidine (hibistatr) and 70% isopropyl alcohol on hands contaminated with *Serratia marcescens*. *Clin. Exper. Dermatol.*, 1980. 5: p. 197-201. Handwashing - Antimicrobial.  
Two antimicrobial preparations for handwashing were compared by the gloved handwash method in 72 subjects. The test preparation was 0.5% chlorhexidine gluconate alcoholic-emollient handwash (Hibistat); the reference agent was 70% isopropyl alcohol. The hands were contaminated with *Serratia marcescens* and disinfected with each antiseptic 25 times over an 8 hour

- day. Bacterial counts were obtained for each hand after initial contamination, and after 5, 10, 15, 20, and 25 contamination/treatment procedures. There was a statistically significant reduction in recovery of *Serratia marcescens* after chlorhexidine treatment compared to alcohol ( $P<0.01$ ). When recovery of organisms was plotted against the number of handwashes, there was a significant linear reduction in transient flora for chlorhexidine treated hands ( $P<0.01$ ) but not for alcohol treated hands ( $P<0.20$ ).
20. Ansari, S.A., et al., In vivo protocol for testing efficacy of handwashing agents against viruses and bacteria: Experiments with rotavirus and *Escherichia coli*. *Appl. Environ. Microbiol.*, 1989. 55(12): p. 3113-3118. Handwashing - Antimicrobial. Ten antiseptic formulations, an unmediated liquid soap, and tap water alone were compared for their capacities to eliminate human rotavirus from the finger pads of adult volunteers; three of the antiseptics, the soap, and the tap water alone were also tested against *Escherichia coli*. A fecal suspension of virus or bacterium was placed on each finger pad and air dried. The contaminated site was exposed to the test product for 10 s, rinsed in tap water, and dried on a paper towel. The residual virus or bacterium was then eluted. Selected agents were also tested by an analogous whole-hand method by which the entire palm surfaces of both hands were contaminated. Alcohols (70%) alone or with Savlon reduced the virus titer by greater than 99%, whereas the reductions by Proviiodine, Dettol, and Hibisol ranged from 95 to 97%. Aqueous solutions of chlorhexidine gluconate were significantly less effective for virus removal or inactivation than 70% alcohol solutions. Furthermore, Savlon in water (1:200) was found to be much less effective in eliminating the virus (80.6%) than the bacterium (98.9%). The tap water alone and the soap reduced the virus titers by 83.6 and 72.5% and the bacterial titers by 90 and 68.7%, respectively. The results of the whole-hand method agreed well with those of the finger pad protocol. We conclude that the finger pad method is a suitable model for testing the in vivo efficacy of hand-washing agents and emphasize the need for using appropriate test viruses and bacteria. 2.
  21. Ansari, S.A., et al., Comparison of cloth, paper, and warm air drying in eliminating viruses and bacteria from washed hands. *Am J Infect Control*, 1991. 19: p. 243-249. Handwashing - Michaels. We compared the efficiency of paper, cloth, and electric warm air drying in eliminating rotaviruses and *Escherichia coli* remaining on finger pads washed with 70% isopropanol, a medicated liquid soap, an unmediated liquid soap, or tap water alone. The contaminated area on the finger pads of a volunteer was exposed to the hand-washing agent for 10 seconds and then rinsed in 40°C tap water. The washed areas were dried for 10 seconds by one of the three methods. Irrespective of the hand-washing agent used, electric air drying produced the highest and cloth drying the lowest reduction in the numbers of both test organisms. These findings indicate the importance of selecting the right means for drying washed hands, particularly when less effective hand-washing agents are used. . 2.
  22. Arnseth, L., Putting gloves to the test - material testing: A manufacturer's strong point. Online Article, 2001. Handwashing - Gloves. <http://www.vpico.com/articlemanager/printerfriendly.aspx?article=60681>. Posted on 04/01/2001. Discusses glove testing by the manufacturers regarding failure of material.
  23. Ashenburg, K., Our enemy hands. *New York Times*, 2007(November 27, 2007). Handwashing. Even with antibiotics, washing off microbes remains an excellent idea. This ancient mark of courtesy is now celebrated in public health campaigns, and the Centers for Disease Control and Prevention has anointed it as "the single most important means of preventing the spread of infection." So, learn from science as well as the wisdom of our ancestors, and wash your hands.
  24. ASM, Handwashing survey fact sheet. Fact Sheet, 1996. Handwashing. Survey Findings; Survey Methods - Observational survey, Telephone survey; Consequences of Poorly Washed Hands - Food-related illness, Infection in childcare centers, Infection from pets. More people say they wash their hands after using public restrooms, but fewer do. 60% of New Yorkers, 78% Chicago, 71% New Orleans, 69% San Francisco, 64% Atlanta. Women wash their hands more often than men. More likely to wash hands after changing diapers or before handling or eating food. Data collected in August of 1996. 81 million people in the US become ill from food-related diseases each year. 60% of children under the age of 6 attend daycare and are at greater risk for gastrointestinal disease. Many salmonella infections are associated with reptiles.
  25. ASM, Handwashing tips. Tip Sheet, 1996. Handwashing. When should you wash your hands? How should you wash your hands? Remember to wash your hands. How - warm running water, soap, wash all surfaces - with a nail brush, rub together for 10-15 seconds, dry towards fingertips. Pamphlet included.
  26. ASTM, Standard test method for evaluation of health care personnel handwash formulation. Book, 1987. Handwashing. How to test handwashing. Scope, Referenced Documents, Summary of Test Method, Significance and Use, Apparatus, Materials and Reagents, Test Organism, Panelists, Procedure, Enumeration of Bacteria in Sampling Solution, Determination of Reduction, Comparison of Test Materials with a Control Material, Precision and Bias.
  27. Ayliffe, G.A.J., et al., Comparison of two methods for assessing the removal of total organisms and pathogens from the skin. *J. Hyg., Camb.*, 1975. 75: p. 259-274. Handwashing - Binder. A standard hand-wash sampling technique was compared with a simple finger-streak sampling method in assessing the relative effectiveness of a number of alternative preparations used for disinfecting the surgeon's hands (alcoholic 0.5% chlorhexidine, alcoholic 0.1% tetrabrom-o-methyl phenol, a 4% chlorhexidine detergent solution, aqueous 0.5% chlorhexidine, 2% 'Irgasan' detergent solution and, as control, bar soap). There was a fairly good correlation between the results of assessment by the two methods after a single disinfection and after six disinfections, three on one day and three on the next. Significant differences were shown in 21 comparisons between treatments when the hand-wash sampling test was used, and 16 of these comparisons also showed a significant difference by the finger-streak test. *Staphylococcus aureus* was found in hand samplings from 5 out of 8 nurses in the Burns Unit of Birmingham Accident Hospital by the hand-wash sampling method and from 2 of the same 8

- nurses by the finger-streak method; the numbers were small, and no *Staph. aureus* were isolated from the same hands after 1 min. wash in 70% ethyl alcohol. Similar sampling on 29 nurses in other wards showed *Staph. aureus* on 3 nurses (one in large numbers) by the hand-wash technique and on 1 nurse by the finger-streak test; in only 1 nurse whose hands showed *Staph. aureus* before disinfection was the organism found, by hand-wash sampling, after disinfection. Parallel sampling of nurses' hands after washing with soap and water and after disinfection with 95% ethanol showed larger numbers of *Staph. aureus* in a hospital for skin diseases than in a general hospital, and a lower incidence and somewhat lower density of *Staph. aureus* after ethanol treatment than after washing with soap and water; Gram-negative bacilli, on the other hand, were commoner on hands in the general than in the skin hospital, and present in much smaller numbers after disinfection with ethanol than after washing with soap and water. Antibiotic sensitivity tests showed the frequent recurrence on the hands of some nurses of multi-resistant *Staph. aureus* with resistance patterns similar to those found in infective lesions in some of the patients; different sensitivity patterns were usually found in staphylococci isolated from the nose. Even in wards where many patients were infected, carriage by nurses' hands of a particular strain of *Staph. aureus* did not seem to last for more than a few days.
28. Ayliffe, G.A.J., Babb, J.R., and Quoraishi, A.H., Test for hygienic hand disinfection. *J. Clin. Pathol.*, 1978. 31: p. 923-928. Handwashing - Binder.
- A standardized test procedure is described in which finger tips are inoculated with broth cultures of organisms (*S. aureus*, *S. saprophyticus*, *E. coli* and *Pseudomonas aeruginosa*). Counts were made from washing of hands after disinfection with various antiseptic-detergents, alcoholic solutions or unmediated soap. 70% alcohol, with or without chlorhexidine was the most effective preparation. The two antiseptic detergents showed variable results, but against Gram-negative bacilli neither was significantly more effective than plain soap. Some tests were also made on the death rate of organisms dried on skin without disinfection.
29. Bailey, R., et al., Air quality issues associated with hand drying devices in food processing, food service and public facility handwash stations. *J Food Protect*, 2003. 66(Sup A): p. 164. Handwashing - Michaels.
- Air quality is seen to be influenced by the presence or absence of hot air dryers vs. cloth or paper towels. A trend towards higher aerobic plate counts, yeast and mold as well as *Staphylococcus* spp. were found in facilities with hot air dryers. Abstract Only.
30. Bannan, E.A. and Judge, L.F., Bacteriological studies relating to handwashing i. The inability of soap bars to transmit bacteria. *Am. J. Public Health*, 1965. 55(6): p. 915-921. Handwashing - Binder.
- A study is reported to determine whether bar soaps, without antibacterial additives, spread bacteria. The results reveal that bacteria are not transferred by this means from person to person, nor does the soap support bacterial growth.
31. Bardell, D., Herpes simplex virus type 1 applied experimentally to gloves used for food preparation. *J of Food Protection*, 1995. 58(10): p. 1150-1152. Handwashing - Gloves.
- Droplets of saliva containing herpes simplex virus type 1 were placed on latex disposable gloves. The temperature at the surface of the gloved hand was 34°C. There was no loss of infectious virus before 15 min. Between 15 and 30 min there was a 2-log-cycle drop in titer, and infectious virus could still be recovered after 1 h, the longest period tested. The drop in titer was due to drying of the saliva, which occurred at approximately 21 min. Infectious virus was transferred by touch to lettuce and ham at 0 min when the virus-containing droplets were in a liquid condition, and after 30 and 60 min when the droplets were dry.
32. Beloian, A., Aoc official methods for e2 test. Book Chapter, 1995. Handwashing - Antimicrobial.
- AOAC Official Methods of Analysis Chapter 6. Disinfectants.
33. Berthelot, P., et al., Bacterial contamination of nonsterile disposable gloves before use. *Am J Infect Control*, 2006. 34: p. 128-130. Handwashing - Gloves.
- Background: After *Bacillus cereus* recovery in opened boxes of disposable gloves, the bacteriological contamination of disposable nonsterile gloves kept stored in native packages was investigated prospectively. Methods: Thirty-six commercially available nonsterile non-powdered disposable gloves made of latex, vinyl, or nitrile were cultured. Results: A large variety of spore-forming and non-spore-forming bacteria was recovered, including *Bacillus cereus* and *Clostridium perfringens*. Conclusion: This finding must be taken into consideration for care involving gloves in very immuno-compromised patients. 2.
34. Bibel, D.J., Ecological effects of a deodorant and a plain soap upon human skin bacteria. *J. Hyg., Camb.*, 1977. 78: p. 1-10. Handwashing - Binder.
- The effects of a commercial trichlorocarbamide-containing deodorant soap and a commercial plain soap upon the cutaneous flora of individuals were compared. Using a cross-over design, 21 volunteers, (10 women and 11 men) washed their forearms at least once a day with one soap for 3 weeks and then switched soaps for another 4 weeks use. By analysis of variance, no significant differences in total colony counts was noted among individuals in their use of the two soaps. With the exception of individual variation, neither sequence of use, sex, nor any combination was influential. However, in 20 of 21 subjects an alteration in the composition of skin flora was observed. The deodorant soap, which in six cases increased total flora, tended to reduce or eliminate diphtheroids in 12 of 17 carriers (71%). Fewer kinds of bacteria were also noted. More *S. epidermidis* was seen with plain soap, but washing with the deodorant soap seemed to favor *Acinetobacter calcoaceticus* and *Micrococcus luteus*. The impact of this alteration and the use of total counts to measure effectiveness of deodorant soaps were brought into question.
35. Bidawid, S., et al., Norovirus cross-contamination during food handling and interruption of virus transfer by hand antiseptics: Experiments with feline calicivirus as a surrogate. *J Food Protect*, 2004. 67(1): p. 103-109. Handwashing - Antimicrobial.
- While there is good epidemiological evidence for foods as vehicles for norovirus transmission, the precise means of spread and its control remain unknown. The feline calicivirus was used as a surrogate for noroviruses to study infectious virus transfer between hands and selected types of foods and environmental surfaces. Assessment of the potential of selected topicals in interrupting such virus transfer was also made. Ten microliters of inoculum of feline calicivirus deposited onto each fingerpad

of adult subjects was allowed to air dry and the contaminated area on individual fingerpads was pressed (10 s at a pressure of 0.2 to 0.4 kg/cm<sup>2</sup>) onto 1-cm-diameter disks of ham, lettuce, or brushed stainless steel. The virus remaining on the donor and that transferred to the recipient surfaces was eluted and plaque assayed. Virus transfer to clean hands from experimentally contaminated disks of ham, lettuce, and stainless steel was also tested. Nearly 46 ± 20.3, 18 ± 5.7, and 13 ± 3.6% of infectious virus was transferred from contaminated fingerpads to ham, lettuce, and metal disks, respectively. In contrast, approximately 6 ± 1.8, 14 ± 3.5, and 7 ± 1.9% virus transfer occurred, respectively, from ham, lettuce, and metal disks to hands. One-way analysis of variance test showed that pretreatment (washing) of the fingerpads either with water or with both topical agent and water significantly ( $P < 0.05$ ) reduced virus transfer to 1e0.9%, as compared with 1e2.3 and 1e3.4% transfer following treatments with either 75% (vol/vol) ethanol or a commercial hand gel containing 62% ethanol, respectively. Despite wide variations in virus transfer among the targeted items used, intervention agents tested reduced virus transfer significantly ( $P < 0.05$ ) when compared with that without such treatments (71 ± 8.9%). These findings should help in a better assessment of the potential for cross-contamination of foods during handling and also assist in developing more effective approaches to foodborne spread of norovirus infections.

36. Black, R.E., et al., Handwashing to prevent diarrhea in day-care centers. *Am. J. Epidemiol.*, 1981. 113: p. 445-451. Handwashing - Binder.

Diarrhea has been recognized as a frequent health problem among children enrolled in day-care centers. Thus, we evaluated the effect of a handwashing program in two day-care centers (HWC) on the incidence of diarrhea among children when compared to children in two control centers (CC). After the program was begun, the incidence of diarrhea at the HWC began to fall and after the second month of the study was consistently lower than that at the CC. The incidence of diarrhea in the HWC was approximately half that of the CC for the entire 35-week study period. Adenoviruses, rotavirus, *Giardia lamblia*, and enteropathogenic *Escherichia coli* were found in the stools of a small number of ill children, but no pathogen was identified in the stools of most children with diarrhea. These results suggest that a handwashing program will probably prevent at least some of the diarrhea in day-care centers.

37. Blackmore, M., Hand-drying methods. *Nursing times*, 1987(September): p. 71-74. Handwashing - Michaels.

As the hands are a serious source of contamination, the washing and drying of them are important aspects in the reduction of pathogen transmission. Maureen Blackmore assesses four hand-drying methods commonly available. Continuous towels are unsuitable for clinical areas, but may be appropriate for toilets and non-clinical areas if properly maintained. Warm-air dryers are too slow to use in clinical areas and their hygienic efficiency is questionable; they are not recommended. In clinical areas, suitable paper towels provide an efficient means of hand drying and can also be used for other purposes, such as cleaning up spillages. 2.

38. Blackmore, M.A., Comparison of hand drying methods. *Catering and Health*, 1989. 1: p. 189-198. Handwashing - Michaels.

A comparison of the numbers of bacteria remaining on hands after drying with warm air driers, cotton towels or paper towels has revealed that warm air driers do not remove bacteria from hands yet significant numbers are removed when hands are dried with either cotton or paper towels.

39. Blackmore, M.A. and Prisk, E.M., Is hot air hygienic? A comparison of the efficiency of hot air, cotton and paper towels. *Home Economist*, 1984. 4: p. 14-15. Handwashing - Michaels.

Cotton towels provided the best percentage removal of bacteria (68%) while paper towels removed 55% and the hot air dryer removed only 9%.

40. BNA, Food handlers can transmit disease, gloves not foolproof, researchers tell FDA. *Food Safety Report*, 1999. 1(20): p. 572-573. Handwashing - Gloves.

Evidence exists that food handlers may be transmitting foodborne illnesses to consumers, and the safety margins derived from using protective gloves could be overestimated, researchers tell the Food and Drug Administration in a report.

41. Borgatta, L., Fisher, M., and N., R., Hand protection and protection from hands: Hand-washing, germicides and gloves. *Woman & Health*, 1989. 15(4): p. 77-92. Handwashing - Gloves.

A variety of soaps, detergents, germicides and protective gloves are available for use by health care workers. Appropriate handwashing and glove use will reduce the possibility of spread of infectious organisms from patient to staff, from patient to patient and from staff to patient. Both hand washing and glove use can have adverse effects. Excessive hand-washing, mechanical irritation from scuffing, use of germicides, and wearing of gloves can result in an increased risk of infection to both the worker and the patient. Has bibliography on contact dermatitis due to gloves.

42. Bowker, S.A., Hand sanitizers no substitute for soap and water. Online Article, 2000. Handwashing - Antimicrobial.

From Purdue News. Instant hand sanitizers may not be everything consumers expect, according to a Purdue university professor who teaches sanitation practices for food service workers. Almanza says a hand sanitizer can't take the place of old-fashioned soap and water at home or anywhere else.

43. Boyce, J.M., Antiseptic technology: Access, affordability, and acceptance. *Emerging Infectious Diseases*, 2001. 7(2): p. 231-233. Handwashing - Antimicrobial.

Factors other than antimicrobial activity of soaps and antiseptic agents used for hand hygiene by health personnel play a role in compliance with recommendations. Hand hygiene products differ considerably in acceptance by hospital personnel. If switching from a non-medicated soap to an antiseptic agent or increased use of an existing antiseptic agent for hand hygiene prevented a few more infections per year, additional expenditures for antiseptic agents would be offset by cost savings.

44. Boyce, J.M. and Pittet, D., Guideline for hand hygiene in health-care settings. *MMWR*, 2002. 51(RR-16): p. 1-46. Handwashing - Antimicrobial.

The Guideline for Hand Hygiene in Health-Care Settings provides health-care workers (HCWs) with a review of data regarding handwashing and hand antisepsis in health-care settings. In addition, it provides specific recommendations to promote improved hand-hygiene practices and reduce transmission of pathogenic microorganisms to patients and personnel in health-care settings. This report reviews studies published since the 1985 CDC guideline (Garner JS, Favero MS. CDC guideline for handwashing and hospital environmental control, 1985. *Infect Control* 1986;7:231-43) and the 1995 APIC guideline (Larson EL, APIC Guidelines Committee. APIC guideline for handwashing and hand antisepsis in health care settings. *Am J Infect Control* 1995;23:251-69) were issued and provides an in-depth review of hand-hygiene practices of HCWs, levels of adherence of personnel to recommended handwashing practices, and factors adversely affecting adherence. New studies of the in vivo efficacy of alcohol-based hand rubs and the low incidence of dermatitis associated with their use are reviewed. Recent studies demonstrating the value of multidisciplinary hand-hygiene promotion programs and the potential role of alcohol-based hand rubs in improving hand-hygiene practices are summarized. Recommendations concerning related issues (e.g., the use of surgical hand antiseptics, hand lotions or creams, and wearing of artificial fingernails) are also included. 2.

45. Brodie, J., Hand hygiene. *Scot. Med. J.*, 1965. 10: p. 115-125. Handwashing.

Need to find method that is likely to give reasonable reliable information regarding the bacterial cleanliness of the hands of whose fingers come into direct contact with food, especially those foods to be eaten without further cooking or processing.

Investigations concerning the bacterial flora of hands before and after washing with soap and water alone, or supplemented by antiseptic treatment on a short-term basis, show that with both, total bacterial counts are of little use in assessing the value of such procedures; Coliform bacteria are adequately controlled using a soap and water technique only, but staphylococci are not; and supplementation of the soap and water wash with antiseptic treatment does not produce the dramatic results one would be lead to expect from the test-tube efficacies of the antiseptics tested.

46. Brown, J.M., et al., Survey of consumer attitudes and the effectiveness of hand cleansers in the home. *Food Protection Trends*, 2007. 27(8): p. 603-611. Handwashing - Antimicrobial.

Although frequent hand washing reduces microbial load, the best hand cleansing agents and hand washing methodologies to employ to reduce microbial load on hands are not obvious. The objectives of this study were to determine public attitudes about available hand cleansers and to determine the effectiveness of three hand cleansers in reducing bacteria on hands. A survey was distributed to ascertain the rationale used to select specific hand cleansers for use in the home. Most respondents believed that regular hand soaps (no active ingredient) were not as effective as antibacterial soaps in reducing bacteria on hands. Liquid hand soap, antibacterial liquid hand soap, and an alcohol gel sanitizer were evaluated to determine their effectiveness in reducing bacteria on hands. Comparisons made between pre-wash agar touch plates and post-wash agar touch plates showed that all three hand cleansers reduced bacteria on hands when a 20 s hand wash procedure was used. No significant differences ( $P > 0.05$ ) were detected between relative colony numbers (RCN), defined as a visible range of bacterial or fungal colonies, obtained with liquid hand soap with antibacterial ingredients and liquid hand soap without such ingredients. However, alcohol gel significantly reduced ( $P \leq 0.05$ ) RCN on hands, compared to results with liquid hand soap and antibacterial hand soap.

47. Bryan, J.L., Cohran, J., and Larson, E.L., Hand washing: A ritual revisited. *Critical Care Nursing Clinics of North America*, 1995. 7(4): p. 617-625. Handwashing.

This article summarizes a critical analysis of 18 studies that examined the link between hand washing and infection. Although several factors made it difficult to evaluate the effect of hand washing, the authors conclude that (1) hand washing can add incremental value to infection-control strategies in acute care settings, (2) patient hand hygiene may influence infection rates, and (3) the effect of "ideal" hand washing on nosocomial infection rates is unlikely to be quantifiable.

48. Bubak, M.E., et al., Allergic reaction to latex among health-care workers. *Mayo Clinic Proc*, 1992. 67(November): p. 1075-1079. Handwashing - Gloves.

With the emergence of the acquired immunodeficiency syndrome (AIDS) epidemic and the practice of protecting health-care workers from all body fluids, the use of rubber gloves has increased, as has occupational allergy to latex among health-care workers. During 1991, 49 Mayo Medical Center employees sought assessment and treatment of rhinitis, conjunctivitis, contact urticaria, contact dermatitis, asthma, or eczema thought to be related to exposure to latex. Most of these persons had a history of atrophy and worked in areas where rubber gloves were used and changed frequently. Of the 49 subjects, 34 had positive results of skin tests to latex products, and the sera from 19 of 35 persons tested contained increased latex-specific IgE antibodies.

Employees with sensitivity to latex (and co-workers in the immediate areas) should use vinyl gloves and should notify their own health-care providers of their sensitization. Changes in job assignment may be necessary for some persons.

49. C.-M., L., et al., Comparison of hand washing techniques to remove e. coli and calicivirus under natural or artificial nails. *J Food Protect*, 2003. 66(12): p. 2296-2301. Handwashing.

Compared with other parts of the hand, the area beneath fingernails harbors the most microorganisms and is most difficult to clean. Artificial fingernails, which are usually long and polished, reportedly harbor higher microbial populations than natural nails. Hence, the efficacy of different hand washing methods for removing microbes from natural and artificial fingernails was evaluated. Strains of nonpathogenic *Escherichia coli* JM109 and feline calicivirus (FCV) strain F9 were used as bacterial and viral indicators, respectively. Volunteers with artificial or natural nails were artificially contaminated with ground beef containing *E. coli* JM109 or artificial feces containing FCV. Volunteers washed their hands with tap water, regular liquid soap, antibacterial liquid soap, alcohol-based hand sanitizer gel, regular liquid soap followed by alcohol gel, or regular liquid soap plus a nailbrush. The greatest reduction of inoculated microbial populations was obtained by washing with liquid soap plus a nailbrush, and the least reduction was obtained by rubbing hands with alcohol gel. Lower but not significantly different ( $P > 0.05$ ) reductions of *E. coli* and FCV counts were obtained from beneath artificial than from natural fingernails. However, significantly ( $P \leq 0.05$ ) higher *E. coli* and FCV counts were recovered from hands with artificial nails than from natural nails

- before and after hand washing. In addition, microbial cell numbers were correlated with fingernail length, with greater numbers beneath fingernails with longer nails. These results indicate that best practices for fingernail sanitation of food handlers are to maintain short fingernails and scrub fingernails with soap and a nailbrush when washing hands. Abstract Only and first page. .
50. Case, C.L., Handwashing: Access excellence classic collection. Online Article, 2005. Handwashing. [[http://www.accessexcellence.org/AE/AEC/CC/hand\\_background.html](http://www.accessexcellence.org/AE/AEC/CC/hand_background.html)]. 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.
51. Casewell, M. and Philips, I., Hands as route of transmission of klebsiella species. *Brit. Med. J.*, 1977. 2: p. 1315-1317. Handwashing. Seventeen percent of the staff of an intensive care ward were found to have Klebsiella spp. contaminating their hands, and these strains could be related to the serotypes infecting or colonizing patients in the ward on the same day. Some simple ward procedures were identified that resulted in contamination of nurses' hands with 100 to 1000 Klebsiella per hand. The Klebsiella survived on artificially inoculated hands for up to 150 minutes. Handwashing with chlorhexidine hand cleanser reliable gave 98 to 100% reduction in hand counts, and the introduction of routine handwashing was associated with a significant and sustained reduction in the number of patients colonized or infected with Klebsiella spp. Staff clothing was occasionally contaminated, but ward air and dust rarely contained klebsiellae.
52. Cassell, G. and Osterholm, M., Simple approach to a complex problem. *ASM News*, 1996. 62(10): p. 516-517. Handwashing. Related to ASM's "Don't Get Caught Dirty Handed" campaign. Basically repeats the previous ASM information - Fact Sheet, Tips, Survey Results, and Paper.
53. Cassidy, A., Toilet training for adults. *Redbook*, 1987(October): p. 118-119, 198-200. Handwashing. Article on the dangers of public bathroom. Don't have to worry about AIDS, should worry about Salmonella and Shigella, cold and Flu viruses. Use paper to touch the toilet seat handle, and avoid using hot air dryers. Tells you other information as well but is occasionally paranoid about the bathroom.
54. CDC, Survey of U.S. Stores reveals widespread availability of soaps containing potentially harmful antibacterial agents. Article, 2000. Handwashing - Antimicrobial. Report that more than 75 % of all liquid hand soaps and nearly 30% of bar soaps contain antibacterial agents. Nearly 1/2 of all commercial soaps contain the antibacterial agents triclosan or, to a lesser extent, triclocarban. Research into the action of triclosan has raised the concern that these products may encourage resistance to triclosan and other antimicrobial agents. (2 copies).
55. CDC, Hand hygiene guidelines fact sheet. Fact Sheet, 2002. Handwashing - Antimicrobial. (<http://www.cdc.gov/od/oc/media/pressrel/fs021025.htm>). Improved adherence to hand hygiene has been shown to terminate outbreaks in health care facilities. CDC is releasing guidelines to improve adherence to hand hygiene in health care settings. CDC is recommending the use of alcohol-based handrubs by health care personnel for patient care. Handwashing with soap and water remains a sensible strategy for hand hygiene in non-health care settings. The use of gloves does not eliminate the need for hand hygiene. Likewise, the use of hand hygiene does not eliminate the need for gloves. As part of these recommendations, CDC is asking health care facilities to develop and implement a system for measuring improvements in adherence to these hand hygiene recommendations.
56. CDC, New study demonstrates simple handwashing with soap can save children's lives. Online Article, 2005. Handwashing. Handwashing with soap can reduce the number of pneumonia-related infections in children under the age of five by more than 50 percent, according to a study published in the *Lancet*. The research, conducted in Pakistan by the Centers for Disease Control and Prevention and P&G Beauty, a division of the Procter & Gamble Company, is the first field study to show that handwashing can help prevent pneumonia, the leading killer of children under age 5 worldwide.
57. CDC, Draft guideline for hand hygiene in healthcare settings. Guidelines, n.d. Handwashing. Abstract: Evidence-based hand hygiene guideline to promote new strategies for improving hand hygiene practices in healthcare facilities and reduce healthcare-acquired infections. Based on review of articles published from 1966 through early 2001 dealing with handwashing and related topics. Outcome measures: Log10 reductions in bacterial counts achieved in vitro and in vivo by hand hygiene agents, percent adherence of healthcare personnel to recommended hand hygiene practices and prevalence and incidence rates of healthcare-acquired infections. Results: alcohol-based handrubs reduce bacterial counts on the hands more effectively than plain o antimicrobial soaps, are easier to use, and gentler on the hands. Long-term multimodal, multidisciplinary programs that address individual and institutional barriers are necessary to achieve enduring improvements in hand hygiene adherence. Conclusions: Promote use of alcohol-based handrubs combined with multidisciplinary educational and motivational programs. (Email, personal notes, and comments on draft are included.).
58. Charnock, C., Antibacterial efficacy of Norwegian hand dishwashing detergents. *Food Protect Trends*, 2003. 23(10): p. 790-796. Handwashing - Antimicrobial. The antibacterial efficacy of the standard and antibacterial variants of Zalo®, the leading name brand hand dishwashing detergent in Norway, was investigated by a variety of techniques. Tests were chosen to simulate possible applications of the detergents that were expected to have relevance to kitchen hygiene. According to the manufacturer, the antibacterial detergent is designed

for use as a bacterial inhibitor in cloths, sponges and brushes. This claim was investigated by inoculating commercially available kitchen sponges with test strains and detergent and then determining the number of cells surviving this treatment. The antibacterial formulation significantly reduced (> 4 log) numbers of both Gram negative bacteria and *Staphylococcus aureus*, whereas Gram negative bacteria increased by approximately equal numbers in control sponges (no detergent) and in sponges containing the standard version of the detergent. The standard detergent reduced the numbers of *Staphylococcus aureus* by > 2 log. The MIC of each formulation was determined by the pour plate technique, and growth curves (suspension tests) in broth containing detergents were generated for culture c23ollection strains and for a bacterial population present in dishwashing water. Both analyses showed that the antibacterial product was usually the most efficacious. *Pseudomonas aeruginosa* was able to grow on a minimal agar medium including either detergent as a sole source of carbon and energy. *P. aeruginosa* was subcultured at least 10 times on minimal medium containing detergent over a period of about 2 months. In addition, *Salmonella Typhimurium* and *P. aeruginosa* were grown in tryptone soya broth containing the antibacterial detergent for 15 generations over a similar time period. Neither treatment had an effect on bacterial antibiotic resistance.

59. Chuanchuen, R., Karkhoff-Schweizer, R.R., and Schweizer, H.T., High-level triclosan resistance in *Pseudomonas aeruginosa* is solely a result of efflux. *Am J Infect Control*, 2003. 31: p. 124-127. Handwashing - Antimicrobial.

The results show that the ability of *Pseudomonas aeruginosa* to survive in the presence of triclosan concentrations (used in surgical scrubs, disinfectants, soaps and toothpastes) in excess of 1000 mg/ML is solely attributable to the expression of efflux pumps.

60. CIDRAP, Food handlers' gloves may not mean cleaner food. Online Article, 2005. Handwashing - Gloves.

<http://www.cidrap.umn.edu/cidrap/content/fs/food-disease/news/feb0705gloves.html>.

61. Cimiotti, J.P., et al., Adverse reactions associated with an alcohol-based hand antiseptic among nurses in a neonatal intensive care unit. *American Journal of Infect. Control.*, 2003. 31(1): p. 43-48. Handwashing - Antimicrobial.

**BACKGROUND:** Alcohol-based hand antiseptics are strongly recommended in the 2002 Centers for Disease Control and Prevention's hand-hygiene guideline. In a study comparing 2 hand-hygiene regimes, an alcohol-based (61% ethyl) antiseptic and a detergent containing 2% chlorhexidine gluconate in 2 neonatal intensive care units, we noted adverse reactions associated with the alcohol-based antiseptic. **METHODS:** A prospective study was conducted of the skin condition of 58 nurses using an alcohol-based product from March 2001 to January 2002. Adverse reactions to the alcohol-based product were noted and the Fisher exact test was used to determine factors associated with these reactions. Nurses with reactions to the alcohol product who were available to follow-up were patch tested to the product. **RESULTS:** Of 58 (1.1/100 nursing mo) nurses, 7 were evaluated by occupational health services for dermatologic symptoms that varied from mild to severe after use of the alcohol product, but 4 of 7 have resumed use. Nurses who had adverse reactions develop had been employed on the study unit and in the nursing profession for significantly less time than those with no reactions ( $P = .037$  and  $P = .002$ , respectively), and were significantly more likely to report a history of itchy, sore skin ( $P = .047$ ). A positive patch-test result was noted in 3 of 4 nurses with a previous reaction to the product. **CONCLUSION:** This case series will alert users in the United States and elsewhere to the nature of reactions to alcohol products and how these reactions differ from reactions to traditional hand antiseptic products.

62. Cliver, D.O. and Kostenbader, K.D., Disinfection of virus on hands for prevention of food-borne disease. *Int. J. Food Microbiol.*, 1984. 1(2): p. 75-87. Handwashing - Antimicrobial.

Various ways in which virus could be transferred from contaminated hands to other persons through foods and fomites were examined. Methods of disinfecting contaminated hands were studied using in vitro (tube) tests, as well as both swine skin and human fingers as models. Almost all chemical hand disinfectants except a 500 ppm NaOCl solution were either ineffective against virus or were too harsh for normal hand use. Surprisingly, one of the most antiviral substances tested was ordinary tap water collected from two locations on a University campus; water from surrounding municipalities, private wells, and lakes did not show the same antiviral activity. The use of plastic disposable gloves as a preventive measure is discussed.

63. Clulow, M., Closer look at disposable gloves: An assessment of the value of vinyl, latex and plastic gloves. *Professional Nurse*, 1994(February): p. 324-329. Handwashing - Gloves.

Research has shown that people with broken skin can be at serious risk of cross infection. A study was undertaken to assess the relative benefits of wearing vinyl, latex and plastic gloves during invasive procedures. Key points: Plastic gloves are no longer recommended for use where there is contact with body fluids; Handwashing technique should be monitored with the same diligence as resuscitation technique; Infection control nurses need to present all the facts to ensure adequate protection for healthcare staff and patients. This is an evaluation of past practices.

64. Coates, D., Hutchinson, D.N., and Bolton, F.J., Survival of thermophilic campylobacter on fingertips and their elimination by washing and disinfection. *Epidem. Inf.*, 1987. 99: p. 265-274. Handwashing - Antimicrobials.

A simple impression-plate technique was used to investigate the survival of four thermophilic campylobacter strains applied to the fingertips. Campylobacters suspended in 0.1% peptone water and dried on the fingertips survived for different periods of time ranging from < 1 min. to 4 min or more. However, campylobacters suspended in chicken liquid or blood survived for much longer periods of time. One strain suspended in horse blood survived for an hour. Suspensions containing 106 to 107 organisms prepared in 50% blood and dried on to fingertips were removed by thorough hand washing with either soap and water or water alone followed by drying on paper towels, but persisted on wet hands. The organisms were also eliminated by wiping the hands with a tissue saturated with 70% isopropyl alcohol for 15 seconds. 2.

65. Collins, C.H., et al., Disinfectants: Their use and evaluation of effectiveness. Book, 1981. Handwashing - Binder.

Table of Contents of Book only. ToC: Effect of Temperature and Concentration on the Antimicrobial Effect of UK Pine Fluids; History and Efficacy of Skin Disinfectants and Skin Bacteria; Use and Evaluation of Antiseptics for Treatment of Intact and Broken Skin in Hospital; Comparative Assessment of Swimming Pool Disinfectants.

66. Compliance Control, Hand washing research - studies & abstracts. Online Compilation, 1999. Handwashing.

- Lists abstracts and studies into handwashing. (<http://users.aol.com/comcontrol/cci6.htm>).
67. Cookson, B., et al., Hand washing: A modest measure with big effects. *BMJ*, 1999. 318: p. 686-686. Handwashing. Discussion on the poor handwashing practices of doctors. .
68. Courtenay, M., et al., Effects of various hand hygiene regimes on removal and/or destruction of escherichia coli on hands. *Food Service Technology*, 2005. 5(2-4): p. 77. Handwashing - Antimicrobial.
- Various hand hygiene techniques have been recommended by sanitarians. In the USA, the National Restaurant Association (NRA) ServSafe® program guidelines include a recommended hand washing regime. The ServSafe regime was compared to rinsing with warm and cool water and no washing/rinsing for bare hands and gloves after exposure to ground beef (approximately 106 cells/g) or liquid solution (approximately 106 cells/mL) contaminated with an ampicillin-resistant *Escherichia coli* JM 109 strain. The efficacy of alcohol-based hand sanitizers to replace hand washing was also evaluated. ServSafe, warm water rinse and cool water rinse reduced *E. coli* cells on hands by 98.0, 64.4 and 42.8% log<sub>10</sub> cfu/mL, resulting in <1, 1.4, and 2.1 log<sub>10</sub> cfu/mL *E. coli* on hands, respectively, from 3.6 log<sub>10</sub> cfu/mL on unwashed hands. When vinyl food service gloves were worn during the hand washing treatments, gloves retained more bacteria than when only hands were rinsed or washed. From 2.9 to 3.4 log<sub>10</sub> cfu/mL remained on hands when ethanol-based sanitizers were used instead of hand washing. Of all hand washing treatments tested in these experiments, the US NRA recommended method was most effective ( $P < 0.05$ ) in removing *E. coli* from hands and the levels remaining after this method were below the threshold of detection (<10 cfu/hand). Abstract Only.
69. Craig, B.S., Information you can use: Handwashing research. Report, n.d. Handwashing. Overview of recent handwashing research studies with references.
70. Crawford, L., et al., Comparison of commonly used surface disinfectants: Alcohol-, phenol-, chlorine-, and quaternary amine-based disinfectants. Online Article, 2000. Handwashing - Antimicrobial. (<http://www.infectioncontrolday.com/articles/0b1feat2.html>) Using proper surface disinfection can prevent infections that develop during hospitalization that are neither present nor incubating at the time of a patient's admission. There are important factors to consider when selecting a surface disinfectant. This paper discusses a comparison of the product types on the basis of the health-related issues of infection prevention, compatibility with equipment and gloves, as well as the safety of the disinfectant to hospital personnel. Conclusion: Significant differences exist between the ten surface disinfectants examined including antimicrobial activity, toxicity, instrument corrosion and material and glove compatibility. The maintenance of a good barrier function of gloves requires regular changing and the proper selection of glove material for the surface disinfectant being used. Universal precautions, such as changing gloves after each patient contact and thorough handwashing after using gloves, should be carefully observed. No-touch techniques and choosing the right glove for the particular surface disinfectant decrease the possibility of microorganisms in blood or toxic chemical contact during surface disinfection.
71. Crisley, F.D. and Foter, M.J., Use of antimicrobial soaps and detergents for hand washing in food service establishments. *J. Milk Food Technol.*, 1965. 28: p. 278-284. Handwashing - Binder.
- Very good review of hand microflora, handwashing agents (antibacterial soaps, iodine preparations, quats). Final recommendation seems to be: have a conveniently located handwash area in work area; frequent use of soap and water handwash; foodservice workers are not necessarily benefited by use of antibacterial soaps.
72. Crow, S., Air hand dryer or paper towel dispensers. *Infection Control*, 1985. 6(1): p. 4-5. Handwashing - Michaels.
- Letters to the Editor - Question and Answer. Question: An air hand dryer has been requested to replace paper towel dispensers, for clean and dirty utility rooms on patient units in our hospital. The doors to these rooms are supposed to be closed at all times, but many times they are found propped open. Please comment on this from an infection standpoint. Answer: summary - several manufactures of air hand dryers did not recommend their use for hospitals but only in public restrooms. 1) They take 30 seconds to dry hands. 2) no way to turn off faucet without using hands. 3) temperature of hot air does not offer antiseptic advantage. .
73. CTFA, Healthcare continuum model. Online article, 1999. Handwashing - Antimicrobial. (Cosmetic, Toiletry, and Fragrance Association). Healthcare Personal Handwash, Foodhandler Handwash, General Population Products, Antimicrobial Handwashes, Tables A-B, Test Method Tables, Appendices, References. .
74. Curtis, V. and Cairncross, S., Effect of washing hands with soap on diarrhoea risk in the community: A systematic review. *Lancet Infect Dis*, 2003. 3: p. 275-81. Handwashing.
- We set out to determine the impact of washing hands with soap on the risk of diarrhoeal diseases in the community with a systematic review with random effects meta-analysis. Our data sources were studies linking handwashing with diarrhoeal diseases. Seven intervention studies, six case-control, two cross-sectional, and two cohort studies were located from electronic databases, hand searching, and the authors' collections. The pooled relative risk of diarrhoeal disease associated with not washing hands from the intervention trials was 1.88 (95% CI 1.31–2.68), implying that handwashing could reduce diarrhoea risk by 47%. When all studies, when only those of high quality, and when only those studies specifically mentioning soap were pooled, risk reduction ranged from 42–44%. The risks of severe intestinal infections and of shigellosis were associated with reductions of 48% and 59%, respectively. In the absence of adequate mortality studies, we extrapolate the potential number of diarrhoea deaths that could be averted by handwashing at about a million (1.1 million, lower estimate 0.5 million, upper estimate 1.4 million). Results may be affected by the poor quality of many of the studies and may be inflated by publication bias. On current evidence, washing hands with soap can reduce the risk of diarrhoeal diseases by 42–47% and interventions to promote handwashing might save a million lives. More and better-designed trials are needed to measure the impact of washing hands on diarrhoea and acute respiratory infections in developing countries. <http://infection.thelancet.com>.
75. Daffron, D.R., Bacterial contamination of money. *E.N.D.*, 1973(July-August): p. 14-15. Handwashing.

- The study that was performed indicated that money is not as heavily laden with microorganisms as commonly believed. Foods are usually contaminated by the hands of carriers or by persons in the early stages of disease, and sometimes by the use of improperly cleaned and sanitized utensils. Good personal hygiene practices, including frequent handwashings, should always be practiced by food handling personnel.
76. Dalglish, A.G. and Malkovsky, M., Surgical gloves as a mechanical barrier against human immunodeficiency viruses. *Brit. J. Surg.*, 1988. 75(2): p. 171-172. Handwashing - Gloves.
- Seven different types of surgical gloves were investigated for the ability to prevent transmission of the human immunodeficiency virus (HIV). Six types of gloves withstood severe compression tests and also exhibited direct antiviral properties. No penetration of HIV through the intact gloves was detected.
77. Dankert, J. and Schut, I.K., Antibacterial activity of chloroxylenol in combination with ethylenediaminetetra-acetic acid. *J. Hyg. (Camb.)*, 1976. 76: p. 11-22. Handwashing - Binder.
- The bactericidal activity of RBA 777 has been found to vary with both the cultural and environmental test conditions against *Pseudomonas aeruginosa* and to a lesser extent against *Staphylococcus aureus*. These variations may explain certain anomalies in earlier work regarding the activity of chloroxylenol based products. The addition of EDTA to RBA 777 has brought about an improvement in the performance against *P. aeruginosa* and this activity is confirmed in vivo. Previous reports have already illustrated this potential and the evaluations of the new antibacterial agent DA 136 confirms and extends these results to its performance under adverse conditions, often associated with the hospital environment.
78. Darrah, R.M. and Eilers, J.R., Hand cleaning automated. *Food Processing*, 1992(April): p. 122-124. Handwashing.
- Safeway Inc recently participated in field testing of monitorable automated hand-cleaning machines. The machines automatically begins a washing and sanitizing cycle when workers insert their hands. The cleaning cycle, set to about 10 seconds for evaluation purposes, requires about a half gallon of water. Worker use of the machines was at first very high, but it declined as the machines' novelty wore off. (However daily readings leveled and remained at nearly three times the rate of traditional manual washing.)
79. Davies, J.G., et al., Preliminary study of test methods to assess the virucidal activity of skin disinfectants using poliovirus and bacteriophages. *J. Hosp. Infect.*, 1993. 23: p. 125-131. Handwashing - Antimicrobial.
- Two tests for assessing the virucidal activity of antiseptics are proposed. These involve applying either poliovirus (vaccine strain Sabin 1 an) or *Escherichia coli* bacteriophage (MS2 or K1-5) to the fingertips. Both test viruses are considered safe although poliovirus may be unacceptably tolerant to antiseptics. The use of bacteriophages as test organisms precludes the need for sophisticated recovery systems and can be undertaken readily by any bacteriology laboratory. The virucidal activity of 70%, 80% and 90% ethanol, 7.5% povidone-iodine, and soap and water was assessed using these tests. Thorough cleansing, followed by disinfection with 90% ethanol, was the most effective treatment. Removal of viruses from the gloved hand was also assessed and this was found to be more easily achieved than cleaning and disinfecting the ungloved hand. Wearing gloves protects the hands from viral contamination but changing them after each patient or contact is expensive.
80. Davies, J.G., et al., Types and numbers of bacteria left on hands after normal washing and drying by various common methods. *Medical Officer*, 1969(October): p. 235-238. Handwashing - Michaels.
- Summary: There were no appreciable differences between the four methods of drying. From the hygienic point of view it is immaterial which method of drying hands is used. Frequent and thorough washing with soap and hot water is the important thing in hand hygiene.
81. de Wit, J.C. and Kampelmacher, E.H., Some aspects of bacterial contamination of hands of workers in food service establishments. *Zbl. Bakt. Hyg. B.*, 1988. 186: p. 45-54. Handwashing.
- In 28 kitchens of restaurants and 10 kitchens of institutions, the hands of 280 persons were sampled in order to determine the role which hands play in contaminating food during preparation. The presence of salmonellae and the number of Enterobacteriaceae and *Staphylococcus aureus* in these samples was examined. No salmonellae could be isolated. However, large numbers (greater than 10(5)/hand) of Enterobacteriaceae and *Staphylococcus aureus* occurred on about 8% of the hands. "Normal" washing of the hands resulted in a lower number of transient micro-organisms. Since washing did not influence the number of *Staphylococcus aureus* on the hands, this organism seems to behave more as a resident organism. Prepared foods such as salads, fried meat and bread were often handled with relatively highly contaminated hands. 2.
82. de Wit, J.C. and Rombouts, F.M., Faecal micro-organisms on the hands of carriers: *Escherichia coli* as model for salmonella. *Zbl. Hyg.*, 1992. 193: p. 230-236. Handwashing.
- To evaluate the public health hazard caused by *Salmonella* carriers as food handlers, a study was carried out to gather more quantitative data about fecal contamination of hands after stools. Fecal *E. coli* was used as a model bacterium for *Salmonella*. In total 92 subjects cooperated in this study. The hand was sampled before toilet use, and also after stools, with or without washing of the hands. Besides *E. coli* the number of Enterobacteriaceae were also determined. It appeared that hands may be contaminated with Enterobacteriaceae, regardless of toilet use, for as well before as after stools about 60% of the sampled hands carried a detectable number of Enterobacteriaceae. That is why the presence of Enterobacteriaceae is not a good indicator for toilet hygiene. In 4% of the samples before stools and in 25% of the samples taken after stools *E. coli* could be detected (>20 CFU/sample) The average log<sub>10</sub> CFU in the positive samples taken before and after stools were about the same: 2.30 per sample. Hand washing after stools reduced the numbers of Enterobacteriaceae and *E. coli* on the hands. It was concluded that symptomless *Salmonella* excretors in the periods starting two weeks after infection form only a low risk in carrying over *Salmonella* by their hands to food. Especially if normal hygiene is practiced like washing hands after stools, the number of contaminated hands will be very low and furthermore the number of fecal micro-organisms will be very small. This conclusion does not apply to persons in the first two weeks after infection (in the period of diarrhea and shortly thereafter).

83. DeGroot-Kosolcharien, J. and Jones, J.M., Permeability of latex and vinyl gloves to water and blood. *Am. J. Infect. Control*, 1989. 17(4): p. 196-201. Handwashing - Gloves.  
2400 medical gloves were evaluated for leakage. Types of gloves examined (number of brands) included: sterile latex (7), sterile vinyl (4), nonsterile latex (6), and nonsterile vinyl (7). Sampling was done from one box of each brand. Fifty gloves from each box were filled with 300 ml. water (the standard test used by the American Society for Testing and Materials). An additional 25 cm pressure was applied to water filled gloves. Another 50 gloves of each box were donned and dipped into a basin that contained heparinized human blood. Only 4 brands of sterile latex surgeon's gloves proved nonpermeable to water or blood. Other brands showed leakage that ranged from 1% to 52%. Analysis of proportions of pairs of gloves permeable to water or blood indicated a strong statistical association of nonsterile packaging or packaging in suction kits with increased leakage rates. These findings affirm that gloves can be regarded only as a means of reducing the gross soil from blood or body fluids. Quality control standards are needed to ensure more uniform glove quality are needed.
84. Doebbeling, B.N., et al., Removal of nosocomial pathogens from the contaminated glove: Implications for glove reuse and handwashing. *Annal. Int. Med.*, 1988. 109: p. 394-398. Handwashing - Gloves.  
Effectiveness of three different types of hand cleansing agents in decontaminating gloved hands that were inoculated with a series of four nosocomial pathogens were placed on the gloved hands that were inoculated with a series of four nosocomial pathogens. A standard concentration of one of four representative nosocomial pathogens was placed on the gloved hand, spread, and allowed to dry. One of three different hand cleansing agents - a nonmedicated, a 60% isopropyl alcohol preparation, or 4% chlorhexidine gluconate - was used to cleanse the gloves, which were cultured using a broth bag technique. The gloves were then removed and the hands were cultured in a similar manner. Results: The handwashing agents reduced the media to log<sub>10</sub> counts of organisms to 2.1 to 3.9 after an inoculation of 10<sup>7</sup> colony forming units. The proportion of positive glove cultures for *S. aureus* ranged from 8% to 100%; *Serratia marcescens*, 16 to 100%; and *Candida albicans*, 4 to 60%; varied greatly after the use of hand cleansers and varied considerably for *Pseudomonas aeruginosa*, 20 to 48%. After the gloves were removed, the differences among the observed proportions of hands contaminated with the test organisms varied from 5% to 50%, depending on the hand cleansing agent used. It was concluded that it may not be prudent to wash and reuse gloves between patients. Further handwashing is strongly encouraged after removal of gloves.
85. Doyle, M.P., et al., Reducing transmission of infectious agents in the home: Part 1 - sources of infection. *Dairy, Food and Environmental Sanitation*, 2000. 20(5): p. 330-337. Handwashing - Michaels.  
This paper examines the factors that contribute to illness in the home, evaluates high-hazard zones in the home environment, and reviews the evidence on methods of solving common problems of household hygiene. Risks of microbiological infections within the home and sources of infection are reviewed. Transmission of potential pathogens originating from foods, gastrointestinal tract, respiratory tract, skin and mucous membranes, pets and pests are described together with methods for reducing infection risks and improving hygiene. 2.
86. Drankiewicz, D. and Dundes, L., Handwashing among female college students. *Am J Infect. Control.*, 2003. 31(2): p. 67-71. Handwashing.  
Handwashing has been recognized as a critical factor in infection control policies. Whereas handwashing compliance among health care workers and school-aged students has been previously documented, practices among college students remain relatively unknown. The objective of this study was to determine handwashing compliance of female college students after using the bathroom. A researcher situated in a toilet stall unobtrusively observed handwashing compliance among 100 female students. Most students (63%) washed their hands, 38% used soap, 32% washed with soap for 5 or more seconds, but only 2% washed their hands with soap for 10 or more seconds. Fewer students left without handwashing when someone else was present in the sink area (9%) than when they were alone (45%) ( $P = .002$ ). Substantial bacterial colony counts were found on a female bathroom sink faucet and toilet seat confirming the need for programs to increase handwashing compliance. Potential strategies to optimize infection control include harnessing the influence of peer pressure on handwashing and the installation of motion-activated faucets, disposable seat covers, and exit doors that can be pushed open. These results should be confirmed in a larger study that includes both male and female college students.
87. Dubbert, P.M., et al., Increasing ICU staff handwashing: Effects of education and group feedback. *Infect. Control Hosp. Epidemiol*, 1990. 11(4): p. 191-193. Handwashing.  
This study provides an evaluation of the effectiveness of methods to increase handwashing (HW) by nurses working in an intensive care unit. After baseline observations, two interventions were implemented in sequence: three series of classes conducted by the infection control nurse (ICN); and feedback to staff about handwashing errors on the previous day. Staff were aware that handwashing was being observed throughout the study. The educational intervention produced an immediate increase in HW that was followed by a decline to baseline rates over four weeks. Feedback produced an improvement to 97% compliance that was sustained until completion of the study. Improvement in HW compliance following specified critical procedures was also observed following interventions.
88. Duncan, W.C., Dodge, B.G., and Knox, J.M., Prevention of superficial pyogenic skin infections. *Arch. Derm.*, 1969. 99: p. 465-468. Handwashing - Binder.  
Four populations comprising 2,550 men were studied over nine months to determine the efficacy of an antibacterial bar soap in preventing superficial pyogenic skin infections. A double-blind study with cross-over was used. Statistically significant differences between the rates of infect while using the active and the placebo soaps were found. In the two largest populations, regression analysis indicated there is a significant trend for the rate of infection to decline during the period of antibacterial soap usage. No instance of allergic photocontact dermatitis was observed.

89. Early, E., et al., Effect of several interventions on the frequency of handwashing among elementary public school children. *Am J Infect Control*, 1998. 26(3): p. 263-269. Handwashing.
- BACKGROUND: The purpose of this educational project was to assess the effect of several interventions on the frequency of handwashing among elementary public school children. METHODS: Participants in this project were first-graders and fourth-graders from jurisdictions within a mid-Atlantic metropolitan area. Phase I included a baseline assessment of bathroom cleanliness as well as adequacy of supplies for handwashing in each school. During phase 2, the frequency of handwashing before lunch or after bathroom use was monitored and recorded during a 2-month period. The schools were separated into four groups: a peer education group, a hand wipes and instructional poster group, a combination of the education and hand wipes/poster groups, and a (control) comparison school. RESULTS: Overall, a significant increase occurred in the proportion of handwashing frequency from preintervention to postintervention for each intervention group (wipes: 0.50 vs 0.66,  $p = 0.03$ ; education only: 0.64 vs 0.72,  $p = 0.02$ ; and education and wipes: 0.45 vs 0.67,  $p = 0.03$ ) but not in the control group (0.42 vs 0.46,  $p = 0.26$ ). When the first 3 weeks and the last 3 weeks after intervention were compared, handwashing frequency remained unchanged in the wipes only group (0.66 vs 0.66,  $p = 0.96$ ), decreased in the education group (0.77 vs 0.65,  $p = 0.006$ ), and increased in the education and wipes group (0.58 vs 0.75,  $p = 0.003$ ), as well as in the control group (0.37 vs 0.52,  $p = 0.01$ ). CONCLUSION: Education combined with accessible convenient hand hygiene may result in a sustainable increase in the frequency of handwashing among elementary school children.
90. Eberhart, R., Goetz, M.L., and LaVillaureix, J., Bacteriological risk relative to the utilization of hot air dryer to dry hands. *Journées Regionales D'Hygiène Hospitalière*, 1983(November). Handwashing - Michaels.
- Conclusion: The use of the hot-air-hand-dryer is a source of air contamination. Its importance is not foreseen because it depends not only on the user but also on the technique used for the hand washing. The aim of this study is to know which part is being played by using the hot-air-hand-drying in the air contamination. Original article is in French. English translation provided.
91. Ehrenkranz, N.J., Bland soap handwash or hand antisepsis? The pressing need for clarity. *Infect. Control Hosp. Epidemiol.*, 1992. 13(5): p. 299-301. Handwashing - Antimicrobial.
- Discussion of hand washing with regular soaps and hand antisepsis. Hand washing with bland soap reduces transient bacterial numbers by approximately 2 to 3 log<sub>10</sub>. In contrast hand antisepsis is able to reduce these number by 1 to 2 log<sub>10</sub> more. Workers in clinical settings should use products that produce antisepsis. This article also discusses the false sense of security that exists when health care workers use gloves. Improperly donned gloves, failure to wash hands, and failure to change gloves leads to transmission of bacteria from patient to patient.
92. Emery, H.C., Changing poor hand washing habits - a continuing challenge for sanitarians. *Dairy Food Environ. Sanitation*, 1990. 10(1): p. 8-9. Handwashing.
- Review article. "Studies indicate that personnel in both the health care and food service industries have poor handwashing habits. (60% of food service personnel in one study were reported to not wash their hands after using the toilet.) Need for training and education of food service personnel.
93. Emmerson, R., Bacterial control problems in faucet aerators. Article, n.d. Handwashing - Binder.
- The journal title and date are not visible in this photocopy.
94. Estlander, T., Jolanki, R., and Kanerva, L., Dermatitis and urticaria from rubber and plastic gloves. *Contact Dermatitis*, 1986. 14: p. 20-25. Handwashing - Gloves.
- The number and nature of allergic occupational glove dermatoses were analyzed. 542 cases of allergic contact dermatosis were diagnosed during 1974–1983. Amongst these, 68 (12.5%) were caused by rubber or plastic gloves. 2 patients had contact urticaria due to rubber gloves. Gloves were the main cause of occupational allergic rubber eczema, inducing 63 (58.3%) of 108 rubber eczema cases. 38 of them had positive reactions to rubber chemicals and glove material. 14 to glove material only, and 11 to rubber chemicals. 5 cases of allergic eczema from plastic gloves were diagnosed, all due to polyvinyl chloride (PVC). 2 cases of contact urticaria from natural rubber gloves were diagnosed by a provocation test. Epicutaneous testing with material of natural rubber gloves and rubber chemicals was negative. The present study shows that allergy to rubber gloves is usual, while allergy to plastic gloves is rare. Thus, plastic gloves should be used, when possible. Patch testing with protective gloves should always be used when patients develop prolonged hand dermatitis and where the possibility of glove eczema exists.
95. Faiola, N., Glove study. Draft Copy, 1994. Handwashing - Gloves.
- For Your Eyes Only Please! draft copy. Methods used to study gloves and handwashing techniques. Results not included.
96. Favero, M.S., Sterilization, disinfection and antisepsis in the hospital. Book Chapter, 1985. Handwashing - Binder.
- Chapter 13 of *The American Society for Microbiology Sterilization, Disinfection and Antisepsis in the Hospital* (p129-137) Edited by Lennette, E.H. Abstract: The Effective use of antiseptics, disinfectants, and sterilization procedures is important in the prevention of nosocomial infection. Physical agents, such as moist or dry heat play the major role in sterilization, and chemical germicides areas used primarily for disinfection and antisepsis. In recent years, there has been an explosion in the number of germicidal products available to hospitals in the U.S. In 1973, the American Society for Microbiology Ad Hoc Committee on Microbiological Standards of Disinfection in Hospitals surveyed 16 hospitals with a combined bed capacity of more than 9,000. The survey showed that the average number of different formulations per hospital was 14.5 with a range of 8 to 22. A total of 224 products were used in the 16 hospitals, and 125 of the products were proprietary products. The choice of agents and procedures to be used for hospital environmental sanitation and antisepsis depends on a variety of factors, and no single agent or procedure is adequate for all purposes. Factors to be considered in the selection of procedures included the degree of microbial killing, the nature of the items to be treated, and the cost and ease of using the available agents. This chapter discusses each of these factors and practical methods for evaluating the effectiveness of the various agents and procedures.
97. Fay, M.F., Hand dermatitis - the role of gloves. *AORN J*, 1991. 54(3): p. 451-467. Handwashing - Gloves.

- This article reviews the cause, cost and consequences of contact or allergic dermatitis for operating room nurses.
98. FDA, Florida's handwashing rule. Proposal, 1997. Handwashing.  
Proposed rule to allow certain exceptions to the "no bare hands" rule. In writing: justification of why establishment cannot comply with the "no bare hands" rule. Identify Ready-to-eat foods that will be in contact with bare hands. Training plan for all employees. Additional preventive measures such as vaccination, nail brushes, double handwashing.
  99. FDA, No bare hand contact. 2000. Handwashing.  
National Advisory Committee for the Microbiological Criteria for Food Report on "No Bare Hand Contact".
  100. FDA, Hand hygiene in retail and food service establishments. Fact Sheet, 2003. Handwashing - Antimicrobial.  
FDA Food Service Safety Fact. Includes bibliography.
  101. FDA, Hand washing, 2005 fda food code - preventing contamination by employees. Regulations, 2005. Handwashing.  
3.301.11 Preventing Contamination from Hands - Preventing Contamination by Employees. States when Food service workers should wash their hands, and handwashing procedures.
  102. FDA, Public health reasons/administrative guidelines. Regulations, 2005. Handwashing - Antimicrobial.  
Hands and Arms: 2-301.11 to 20391.16. Clean condition, Cleaning procedure, Special handwash procedures, When to wash, Where to wash, Hand antiseptics.
  103. Fendler, E.J., et al., Handwashing and gloving for food protection - part ii: Effectiveness. Dairy Food and Environmental Sanitation, 1998(December): p. 824-829. Handwashing - Gloves.  
Summary: Currently, there are insufficient scientific data to define and substantiate effective hand cleaning hygiene regimens for food protection and minimized risk of health hazards. No direct scientific evidence has been published to support the premise that use of a physical barrier (gloves) on the hands of food handling personnel prevents transfer of pathogens to food and, consequently, to support a requirement for no hand contact with ready-to-eat food. This study was carried out to obtain data under simulated food service conditions to define and support the most effective hand hygiene regimens for food protection and minimized risk of health hazards for the customer. 2 Original Report also owned.
  104. Fendler, E.J., Dolan, M.J., and Williams, R.A., Handwashing and gloving for food protection - part i: Examination of the evidence. Dairy Food and Environmental Sanitation, 1998. 18(12): p. 824-829. Handwashing - Gloves.  
Summary: The potential for foodhandlers to be a factor in transmitting foodborne disease continues to be a significant issue. In a number of situations, foodhandlers have been implicated as a primary vector in contributing to foodborne illness. The most effective method to break the contamination vector between foodhandlers and consumers is intensely debated. One view holds that food servers must eliminate bare hand contact with ready-to-eat food (by use of gloving) to insure protection, while the other position is that a well managed handwashing and hand sanitizing program is sufficient to insure protection. This paper explores the evidence for these widely differing options via a literature review. 2 Original Report also owned.
  105. Ferguson, R.L., Personal hygiene (chapter 1). Book Chapter, 1971. Handwashing - Binder.  
Chapter 1 of Hygiene and Food Production edited by Arnold Fox. Short discussion of personnel hygiene by employees. Not very detailed. Standards today; Working environment; Preventive measures; Physical conditions; Practical points; and References.
  106. Filho, P.P.G., Stumpf, M., and Cardoso, C.L., Survival of gram-negative and gram-positive bacteria artificially applied on the hands. J. Clin. Microbiol., 1985. 21(4): p. 552-653. Handwashing.  
We evaluated the survival of *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Serratia marcescens*, *Escherichia coli*, and *Staphylococcus aureus*, derived from either hospitalized patients or culture collections, on the fingertips of human volunteers. Over 99% of the bacteria died within 2 min. of application, and about 105 cells remained on the fingers for up to 90 min.
  107. FRA, Handwashing. Report, 1998. Handwashing.  
(Florida Restaurant Association). 10 Steps to Comply. 1) Introduction 2) Code of Professional Hygiene 3) Direct Hand contact permission statement 4) information you need to know 5) identification of specific work areas 6) Actual food preparation processes 7) specific employee procedures 8) Approved employee procedures 9) work exclusion and restriction 10) employee training. Appendix Forms and Reports. .
  108. Freyer, F.J., Simple soap and water useful in fighting germs. Saint Paul Pioneer Press, 1998(Wednesday, January 7). Handwashing.  
Overview of a recent study and interview with S.H. Zinner. One studying handwashing in children finding that children elementary school who washed their hands a minimum of four times a day were less likely to get sick with stomach and intestinal upsets, but did not reduce common cold infections. Zinner speaks of the natural flora that is your hands, the importance of washing lots when you are in a hospital. The overarching report is that soap and water and rubbing for more than a few seconds is considered a 'true' washing. Newspaper Article clipping.
  109. FSNET, What is the importance of hand washing? Article, 2003. Handwashing - Antimicrobial.  
From Food Safety Network: FSNET. What is the importance of hand washing? How do I wash my hands? Alcohol Hand rubs, gels or rinses. Food service personnel. Farm animals. Information sources.
  110. Gamsky, T.E., et al., Epidemiology of dermatitis among California farm workers. J 1992. 34(3): p. 304-310. Handwashing.  
To estimate the prevalence of dermatitis and risk factors for skin disease in California farm workers, a cross-sectional survey was conducted among grape, citrus, and tomato workers. The prevalence of contact dermatitis was 2% and lichenified hand dermatitis was 13%. Grape workers were more likely to report rashes in the last 12 months than were tomato workers or citrus workers. Grape workers were more likely to have contact dermatitis and lichenified hand dermatitis than were citrus or tomato workers. Increasing hours per week in agriculture, male sex, and not wearing gloves were associated with more lichenified hand dermatitis. We conclude that skin disease in agricultural workers may be causally associated with crop-specific exposures and lack of protective equipment.

111. Gangar, V., et al., Evaluation of household cutting board clean-up techniques. Report, n.d. Handwashing - Michaels.  
 Funding for this research was funded through a grant from the Georgia-Pacific HealthSmart Institute. Abstract: Cross-contamination is frequently cited as a factor in foodborne illness outbreaks. Cutting boards are believed to be a significant source of cross-contamination in consumer and commercial locations due to the common practice of cutting salad ingredients on a contaminated board previously used to cut raw meat. Various surveys show a lack of consumer knowledge concerning cutting board safety. Cutting board cross-contamination previous has been verified in consumer and commercial settings using marker bacteria. This study was designed to examine the dynamics of cutting board clean-up in consumer and commercial settings. Various types of cutting boards were inoculated with hamburger meat containing approximately 10<sup>8</sup> CFU *Serratia marcescens*, *Escherichia coli* O157:H7, *Salmonella typhimurium*, *Listeria monocytogens* or *Staphylococcus aureus*, and then were cleaned using a variety of methods. Baseline cleaning average of approximately three log reductions were observed, with no significant differences seen in type of soap used, board condition, cleaning/scrubbing tool, or the rinse water temperature. Cleanability did vary according to board type, with acrylic being easier to clean than wood. Wiping cutting boards with paper towels after washing resulted in a statistically significant improvement in hygiene when boards were washed imperfectly. Overall, it appears that the maximization of cleaning efficiency comes with the drying of cutting boards and bacterial die-off between uses.
112. Gardner, A.D. and Seddon, H.J., Rapid chemical disinfection of clean unwashed skin. *Lancet*, 1946. 1(May 11): p. 683-686.  
 Handwashing - Binder.  
 In spite of seventy years of investigation it is still very difficult to give a clear account of the chemicals and their concentrations that will disinfect the skin under any particular set of practical conditions. "The skin is a complex tissue of considerable thickness and can not be chemically sterilized without destroying it. The transient bacteria (Price, 1938) on the surface, can be destroyed by chemicals. However, after a period of time, resident bacteria emerge from below the surface of the skin. Resident bacteria are harmless and give no trouble when taken deeper into the skin, e.g. on a hypodermic needle. Pathogenic bacteria on the skin are generally transient, though some species, especially *S. aureus* and *Strep. pyogenes* occasionally become temporary residents, and their removal by chemicals may not be practical. The main object of the research effort was to find a simple, reproducible and roughly quantitative method to determine what solutions will "virtually disinfect" an unwashed artificially contaminated simple flat skin surface in a short time (15 sec. - 5 min.) Virtual disinfection means to destroy at least 99.9% of the organisms on the surface of the skin, excluding spores. Virtual disinfection was achieved in 15-20 sec. with a single application of 2% iodine in 70% alcohol.
113. Gardner, D. and Anderson-Manz, E., How to perform surgical hand scrubs. Online Article, 2001. Handwashing.  
 The procedure for the timed five minute scrub consists of: Remove all jewelry (rings, watches, bracelets). Wash hands and arms with antimicrobial soap. Excessively hot water is harder on the skin, dries the skin, and is too uncomfortable to wash with for the recommended amount of time. However, because cold water prevents soap from lathering properly, soil and germs may not be washed away. Clean subungual areas with a nail file. Start timing. Scrub each side of each finger, between the fingers, and the back and front of the hand for two minutes. Proceed to scrub the arms, keeping the hand higher than the arm at all times. This prevents bacteria-laden soap and water from contaminating the hand. Wash each side of the arm to three inches above the elbow for one minute. Repeat the process on the other hand and arm, keeping hands above elbows at all times. If the hand touches anything except the brush at any time, the scrub must be lengthened by one minute for the area that has been contaminated. Rinse hands and arms by passing them through the water in one direction only, from fingertips to elbow. Do not move the arm back and forth through the water. Proceed to the operating room suite holding hands above elbows. If the hands and arms are grossly soiled, the scrub time should be lengthened. However, vigorous scrubbing that causes the skin to become abraded should be avoided. At all times during the scrub procedure care should be taken not to splash water onto surgical attire. Once in the operating room suite, hands and arms should be dried using a sterile towel and aseptic technique. You are now ready to don your gown and sterile gloves. (<http://www.infectioncontroltoday.com/articles/151hpract.html>).
114. Garner, J.S. and Favero, M.S., Guideline for hand washing and hospital environmental control. Online Article, 1985.  
 Handwashing.  
 NTIS. Government publication for hospital infection control. Discusses Handwashing; Cleaning and disinfecting; Infective Waste; Housekeeping; and Laundry. Hand washing with plain soaps or detergents (in bar, granules, leaflet, or liquid form) suspends millions of microorganisms and allows them to be rinsed off; this process is often referred to as mechanical removal of microorganisms. This process removes transient microorganisms. Handwashing with antimicrobial-containing products kills or inhibits the growth of microorganisms; this process is often referred to as the chemical removal of microorganisms (both transient and some resident microorganisms). Hand washing with plain soap for 15 seconds or less appears to be sufficient for most routine activities. For invasive procedures within hospitals or health care settings antimicrobial products may be used. When gloves are used, hand washing is recommended because gloves may become perforated during use and because bacterial can multiply rapidly on gloved hands. (<http://www.cdc.gov/ncidod/hip/guide/handwash.html#housekeeping>). 2
115. Georgia-Pacific, Hot air dryer facts heat up health concerns. Fact Sheet, n.d. Handwashing - Michaels.  
 (Georgia-Pacific produces 'hands-free' towel dispensers.)Offers bacterial counts before and after drying with hot air dryers and paper towels. Shows percent of hand dryers (in UK) contaminated with different bacterias.
116. Gerberding, J.L., et al., Risk of exposure of surgical personnel to patients' blood during surgery at San Francisco general hospital. *New Eng. J. Med.*, 1990. 322(25): p. 1788-1793. Handwashing - Gloves.  
 An observational study of 1307 consecutive surgical procedures at San Francisco General Hospital. Description of intraoperative exposures to blood and other body fluids were recorded in order to determine the factors predictive of these exposures, and identify interventions that might reduce their frequency. Accidental exposure to blood occurred during 84 procedures (6.4%).

Parenteral exposure occurred in 1.7%. The risk of exposure was highest when the procedures lasted more than three hours, when blood loss exceeded 300 ml., and when major vascular and intra-abdominal gynecologic surgery was involved. Neither knowledge of diagnosed human immunodeficiency virus (HIV) infection or awareness of a patient's high-risk status for such infection influenced the rate of exposure. Double gloving prevented perforations of the inner glove and cutaneous exposure of the hands. It was concluded that all surgical personnel are at risk for intraoperative exposure to blood. .

117. Gill, C.O. and Jones, T., Effects of wearing knitted or rubber gloves on transfer of escherichia coli between hands and meat. J Food Protection, 2002. 65(6): p. 1045-1048. Handwashing - Gloves.

On eight occasions, five volunteers each handled five pieces of meat with bare hands or while wearing dry or wet knitted gloves or rubber gloves after hands had been inoculated with Escherichia coli or after handling a piece of meat inoculated with E. coli. On each occasion, after all meat was handled, each piece of meat, glove, and hand were sampled to recover E. coli. When hands were inoculated, E. coli was recovered from all meat handled with bare hands, in lesser numbers from some pieces handled with knitted gloves, and from only one piece handled with rubber gloves. When pieces of inoculated meat were handled, the numbers of E. coli transferred to uninoculated meat from bare hands or rubber gloves decreased substantially with each successive piece of uninoculated meat, but decreases were small with knitted gloves. The findings indicate that, compared with bare hands, the use of knitted gloves could reduce the transfer of bacteria from hands to meat but could increase the transfer of bacteria between meat pieces, whereas the use of rubber gloves could largely prevent the first and greatly reduce the second type of bacteria transfer.

118. Gill, C.O. and McGinnis, J.C., Microbiological effects of hand washing at a beef carcass-breaking facility. J. Food Prot., 2003. 66(3): p. 493-496. Handwashing - Antimicrobial.

The hands of workers in the carcass-breaking facility at a beef packing plant were sampled by rinsing. Total aerobes, coliforms, and Escherichia coli were enumerated for each sample. The numbers of bacteria recovered from duplicate groups of 25 hand samples collected before and after hands were washed with an antibacterial gel, rinsed in a disinfectant solution, washed with the gel and rinsed with the disinfectant, or washed in the disinfectant for 20 s were similar for samples collected before work began after breaks. The numbers of bacteria recovered from samples collected before and after hands were washed with the antibacterial gel and rinsed in the disinfectant solution were similar for samples collected after work as well. However, the mean numbers of aerobes recovered from the four groups of hand samples after work were all >6.5 log CFU per hand, while 9 of the 10 corresponding values for groups of hand samples collected before work were <6.5 log CFU per hand; the total numbers of coliforms recovered from three groups of hand samples collected after work were >4 log CFU/25 hands, while 9 of the corresponding values for groups of hand samples collected before work were <4 log CFU/25 hands. The total numbers of E. coli recovered from all groups of hand samples collected after work were >3.5 log CFU/25 hands, while 9 of the corresponding values for groups of hand samples collected before work were <3 log CFU/25 hands. Thus, although washing and/or rinsing apparently did not reduce the numbers of bacteria on hands, fewer bacteria were recovered from hands before than after work.

119. Girou, E., et al., Efficacy of handrubbing with alcohol based solution versus standard handwashing with antiseptic soap: Randomized clinical trial. British Medical Journal, 2002. 325. Handwashing - Antimicrobial.

Objective: To compare the efficacy of handrubbing with an alcohol based solution versus conventional handwashing with antiseptic soap in reducing hand contamination during routine patient care. Design: Randomized controlled trial during daily nursing sessions of 2 to 3 hours. Setting: Three intensive care units in a French university hospital. Participants: 23 healthcare workers. Interventions: Handrubbing with alcohol based solution (n=12) or handwashing with antiseptic soap (n=11) when hand hygiene was indicated before and after patient care. Imprints taken of fingertips and palm of dominant hand before and after hand hygiene procedure. Bacterial counts quantified blindly. Main outcome measures: Bacterial reduction of hand contamination. Results: With handrubbing the median percentage reduction in bacterial contamination was significantly higher than with handwashing (83% v 58%, P=0.012), with a median difference in the percentage reduction of 26% (95% confidence interval 8% to 44%). The median duration of hand hygiene was 30 seconds in each group. Conclusions: During routine patient care handrubbing with an alcohol based solution is significantly more efficient in reducing hand contamination than handwashing with antiseptic soap.

120. Gott, P.H., Mother's advice may not be right. Newspaper Article, 1994. Handwashing.

From the Observer-Dispatch on November 27, 1994. Article speaks about a report made by students that the professionals and professors at a Infectious Diseases Society meeting did not all wash their hands after using the restrooms. It continues on to report that urine is sterile and most bacteria in feces is harmless and so people in good health need not wash their hands after using the restroom.

121. Green, L.R., et al., Food worker hand washing practices: An observation study. J Food Prot., 2006. 69(10): p. 2417-2423. Handwashing.

Improvement of food worker hand washing practices is critical to the reduction of foodborne illness and is dependent upon a clear understanding of current hand washing practices. To that end, this study collected detailed observational data on food worker hand washing practices. Food workers (n = 321) were observed preparing food, and data were recorded on specific work activities for which hand washing is recommended (e.g., food preparation, handling dirty equipment). Data were also recorded on hand washing behaviors that occurred in conjunction with these work activities. Results indicated that workers engaged in approximately 8.6 work activities per hour for which hand washing is recommended. However, workers made hand washing attempts (i.e., removed gloves, if worn, and placed hands in running water) in only 32% of these activities and washed their hands appropriately (i.e., removed gloves, if worn, placed hands in running water, used soap, and dried hands) in only 27% of these work activities. Attempted and appropriate hand washing rates varied by work activity—they were significantly higher in

conjunction with food preparation than other work activities (46 versus 73% for attempted hand washing; 41 versus 70% for appropriate hand washing) and were significantly lower in conjunction with touching the body than other work activities (13 versus 27% for attempted hand washing; 10 versus 23% for appropriate hand washing). Attempted and appropriate hand washing rates were significantly lower when gloves were worn (18 and 16%) than when gloves were not worn (37 and 30%). These findings suggest that the hand washing practices of food workers need to be improved, glove use may reduce hand washing, and restaurants should consider reorganizing their food preparation activities to reduce the frequency with which hand washing is needed. Powerpoint Presentation and Paper.

122. Green, S., Hand hygiene in practice. Food Manufacture, 1974. 63: p. 19-20. Handwashing - Binder.

Discussion of hand washing practices for food hygiene in the United Kingdom. Discusses uses of soap, detergents and bactericides. Bactericides containing iodine, phenol and cresylic derivatives can cause extreme irritation to the skin surface. In healthy skin, there is a horny layer, and a thin film of a water repellent substance is secreted by the sebaceous glands. This keeps the skin supple and helps prevent the ingress of water and dirt. When this layer is removed by irritants, the skin becomes inflamed. If this layer is replaced by an artificial layer of lanolin or similar water repellent grease, irritation can be avoided. Such products (barrier creams) should be specially formulated for the food industry. They should be non-perfumed, and not excessively greasy.

123. Griffith, C.J., et al., Environmental surface cleanliness and the potential for contamination during handwashing. Am J Infect Control, 2003. 31: p. 93-96. Handwashing - Michaels.

Effective handwashing (including drying) is important in infection control. The ability of the various stages of handwashing to decrease skin-surface microbial counts has been documented. However, an important element, environmental surface cleanliness, and the potential for contamination of hands during the process has not been well studied or quantified. An examination of the adenosine triphosphate (a measure of residual organic soil), bacterial, and staphylococcal load on ward handwash station surfaces, which could be touched during handwashing, is reported. Hand contact surfaces tested consisted of approximately 620 each of: faucet handles, soap dispenser activator mechanisms, and folded paper-towel dispenser exits. Failure rates in excess of benchmark clean values were higher with adenosine triphosphate assays than microbial counts. This could indicate the presence of a higher level of general organic debris (eg, skin cells) as opposed to microbial contamination or could reflect greater assay sensitivity. Faucet handles were more likely to be contaminated and be in excess of benchmark values than paper-towel dispenser exits. However, the latter are likely to be the final surface touched during the handwashing process and overall nearly 20% were above microbiologic benchmark values. Many of the organisms isolated were staphylococci and the results are discussed within the context of microbial cross-contamination and potential pathogen spread.

124. Grove, G.L., et al., Methods for evaluating changes in skin condition due to the effects of antimicrobial hand cleansers: Two studies comparing a new waterless chlorhexidine gluconate/ethanol-emollient antiseptic preparation with a conventional water-applied product. Am J Infect Control, 2001. 29: p. 361-369. Handwashing - Antimicrobial.

Background: Hand-cleansing products that are milder to the skin of health care personnel are being developed, but the available methodologies to appropriately evaluate these products and quantify differences are not generally being applied in well-controlled studies. Methods: Two randomized, blinded, bilateral comparison studies evaluated skin condition during use of 2 antiseptic hand preparation products: a new 1% chlorhexidine gluconate (CHG)/61% wt/wt ethanol antiseptic hand preparation in a unique emollient system for waterless/brushless application and a conventional 4% CHG antimicrobial product that is applied with water and a scrub brush. Trained technicians applied treatments 6 times (for a surgical scrub study) or 24 times (for a personnel handwash study) daily to the hands of healthy volunteers during 5 days of controlled washing. An expert grader evaluated skin for dryness, erythema, and roughness. Subjects completed a self-assessment questionnaire on skin condition. Transepidermal water loss was measured by an evaporimeter, and the skin surface hydration level was measured by an electrical conductance meter. Results: Fifty-eight subjects were enrolled in the 2 studies and received both treatments. In general, skin treated with the waterless CHG/ethanol product scored significantly ( $P < .004$ ) better on evaluations of visual dryness and erythema and showed greater improvement in the level of hydration ( $P < .003$ ). In the health care personnel handwash study, transepidermal water loss was less than that for skin treated with the conventional CHG product ( $P < .002$ ). Subject assessments showed similar results (total score,  $P < .007$ ). Conclusions: All 3 approaches of expert grader evaluation, subject assessment, and instrumentation were in concordance, demonstrating that the waterless CHG/ethanol product was gentler to skin than the conventional CHG product.

125. Grover, S.F., Bare-hand contact of ready-to-eat foods. Article, 1999. Handwashing.

Speaks on the upcoming regulatory plan to ban bare hand contact and how it is impossible to comply with and the rule is not supported by scientific data. Attached are two Florida Alternate operating checklists from 2002.

126. Gustafson, D.R., et al., Effects of 4 hand-drying methods for removing bacteria from washed hands: A randomized trial. Mayo-Clinic-Proceedings, 2000. 75(7): p. 705-708. Handwashing.

Objective: To evaluate the effects of 4 different drying methods to remove bacteria from washed hands. Subjects and Methods: One hundred adult volunteers participated in this randomized prospective study. All bacterial counts were determined using a modified glove-juice sampling procedure. The difference was determined between the amounts of bacteria on hands artificially contaminated with the bacterium *Micrococcus luteus* before washing with a nonantibacterial soap and after drying by 4 different methods (cloth towels accessed by a rotary dispenser, paper towels from a stack on the hand-washing sink, warm forced air from a mechanical hand-activated dryer, and spontaneous room air evaporation). The results were analyzed using a nonparametric analysis (the Friedman test). By this method, changes in bacterial colony-forming unit values for each drying method were ranked for each subject. Results: The results for 99 subjects were evaluable. No statistically significant

- differences were noted in the numbers of colony-forming units for each drying method ( $P=.72$ ). Conclusion: These data demonstrate no statistically significant differences in the efficiency of 4 different hand-drying methods for removing bacteria from washed hands.
127. Guzewich, J. and Ross, M.P., Evaluation of risks related to microbiological contamination of ready-to-eat food by food preparation workers and the effectiveness of interventions to minimize those risks. Report, 1999. Handwashing. FDA Report. (<http://www.cfsan.fda.gov/~ear/rterisk.html>) A summary of current information from scientific literature or provided to FDA that evaluates the factors related to contamination of foods by food workers and the effectiveness of interventions to prevent or minimize contamination of ready-to-eat food by food workers. Three major intervention areas are addressed: exclusion of ill food workers from the workplace, removal of pathogens from the hands of food workers, and the use of barriers to prevent bare-hand contact with ready-to-eat foods. Information provided in this review includes all applicable submissions that were received in response to Federal Register Notice, Vol. 64, No. 63, Friday, April 2, 1999. On September 16, 1999, CDC released data on the incidence of foodborne disease in the United States.
128. Guzewich, J.J., Anatomy of a "Glove rule". E.N.D., 1995. LXI(2): p. 4-13. Handwashing - Gloves.  
New York State prohibits bare hand contact with ready-to-eat foods. This was the first such statewide policy in the U.S. and the forerunner of the no-hands requirement in the FDA Food Code. In a presentation at the 1995 annual meeting of IAMFES, New York's food protection chief, Jack Guzewich, described the state's rationale for what many in both government and industry consider to be a radical policy. Article points out that it is not easy to monitor hand washing. However, it is easy for managers, co-workers, and customer to monitor glove use, because gloves can be seen.
129. H&R, Guide to preventing contamination from hands. Pamphlet, 2002. Handwashing.  
From H&R: Division of Hotels and Restaurants and from the Florida Department of Business and Professional Regulation. [[www.hospitalityeducation.org](http://www.hospitalityeducation.org)]. Discusses: 1999 Food Code: Preventing Contamination from Hands (3-301.11); Florida Administration Code: Sanitation and Safety Requirements; and Industry Guidelines - Written Alternative Operational procedures - Professional hygiene training - hand sanitizer - hand sinks - employee exclusions and restrictions - employee monitoring and correction - procedures available and reviewed at least annually - maintaining the alternative procedure; Why has the Food and Drug Administration Increased the Barriers to Foodborne Illness? What is a Ready-to-eat Food? and also lists the CDC reports. Pamphlet also includes a 'sign' for washing hands to be used in hotels and restaurants.
130. Hall, R., Degerming the hands of surgeons and nurses. Book Chapter, 1980. Handwashing - Binder.  
Chapter from the book: Problems in the Control of Hospital Infection edited by Newsoms, S.W.B. and Caldwell, A.D.S. Part of the International Congress and Symposium Series. No. 23. Pre-operative procedures for preparing hands of surgeons and nurses is reviewed and current methods for evaluating the efficiency of degerming agents such as chlorhexidine are compared. The method used involves a 3 min. hand treatment with chlorhexidine and showed that there was both immediate and persistent effectiveness and that the traditional 10 min scrubbing procedure added nothing in the way of extra degerming. Both an alcoholic and an aqueous solution of chlorhexidine were found to be effective against *S. aureus* and *Pseudomonas aeruginosa*.
131. Hamann, C.P., Latex allergy update. Online Article, 2001. Handwashing - Gloves.  
<http://www.vpico.com/articlemanager/printerfriendly.aspx?article=61127>. Posted on 03/01/2001. Defines Latex allergy, allergic contact dermatitis, management of latex allergy, protocols and procedures, symptom management and product avoidance. Tables included list the characteristics of rubber-based allergies, diagnostic test methods, and critical components.
132. Hammer, K.A., Carson, C.F., and Riley, T.V., Susceptibility of transient and commensal skin flora to the essential oil of *Melaleuca alternifolia* (tea tree oil). *Am. J. Infect. Control*, 1996. 24(3): p. 186-189. Handwashing - Antimicrobial.  
Tea tree oil, or *Melaleuca* oil, is the essential oil produced by steam distillation of the leaves of the Australian native plant *Melaleuca alternifolia* or tea tree. Tea tree oil is known to possess antibacterial and antifungal activity. The purpose of this study was to determine the susceptibility of a range of transient and commensal skin flora to the essential oil of *Melaleuca alternifolia* or tea tree. Results: *S. aureus* and most of the gram-negative bacteria tested were more susceptible to tea tree oil than the coagulase-negative staphylococci and micrococci. These results suggest that tea tree oil may be useful in removing transient skin flora while suppressing by maintaining resident flora.
133. Harrison, W.A., et al., Bacterial transfer and cross-contamination potential associated with paper-towel dispensing. *Am J Infect Control*, 2003. 31: p. 387-391. Handwashing - Michaels.  
Background: The role of hands in disease transmission is well established, and the importance of handwashing is recognized. However, the exits of paper-towel dispensers used in hand drying may be contaminated, and the functionality of handwashing equipment increasingly is being questioned. Objectives: We sought to study the transfer and cross-contamination potential between hands, towels, and dispenser exits if one or more is contaminated using bacteria representative of the skin's flora. Materials and method: A generic wall-mounted paper-towel dispenser and a range of different paper towels were used. Volunteers with either clean or contaminated hands were asked to remove, using a range of protocols, towels from dispensers which themselves were either clean or contaminated. Previously clean surfaces were then microbiologically tested. Results: Recoverable bacterial transfer rates from a contaminated hand to clean dispenser exits ranged from 0.01% to 0.64% depending on the bacteria used with an even higher transfer rate for clean towels. The reverse transfer (ie, from contaminated exits to clean hands) was between 12.4% and 13.1%. Conclusions: The results indicate that zig-zag transfer of bacteria between paper-towel dispensers and hands can take place if either one is contaminated. This potential should be considered in the design, construction, and use of paper-towel dispensers. . 2.
134. Harrison, W.A., et al., Technique to determine contamination exposure routes and the economic efficiency of folded paper-towel dispensing. *Am J Infect Control*, 2003. 31: p. 104-108. Handwashing - Michaels.

Handwashing and hand drying are key elements of infection control. Paper towels are generally accepted as the most hygienic means of drying hands and are often distributed from generic dispensers. Effective dispensing of towels is of importance economically and may influence infection control objectives if hands become contaminated during hand drying. In this study, a method to identify potential exposure routes for hand contamination and evaluate the efficiency of paper-towel dispensing is described and applied to 5 different folded paper towels using a generic wall-mounted dispenser. A total of 18 male and female participants of varying heights participated in pull testing of 400 paper towels each, in controlled hand-drying simulations. All events having the potential for hand contamination, including towel jamming, towels falling onto the floor, and incidental contact of paper exits, were monitored and documented. There was considerable variation in dispensing efficiency between different towel brands. One towel (Z) had significantly ( $P < .05$ ) superior dispensing properties from the generic dispenser. Participants of a shorter height obtained a lower incidence of dispensing malfunctions using all towel products and type. The results indicated likely contamination exposure routes and wastage levels for each towel type. Environmental service managers and infection control practitioners should carefully consider, for economic and infection control reasons, the siting and design of towel dispensers and the types of towel purchased. 2.

135. Health Education, Handwashing with soap and water. Online Article, 2005. Handwashing.

From Health Education to Villages. Program to promote handwashing in Maharashtra, India. .

136. Hilburn, J., et al., Use of alcohol hand sanitizer as an infection control strategy in an acute care facility. *Am J Infect Control*, 2003. 31: p. 109-116. Handwashing - Antimicrobial.

Background: Nosocomial infections are a major problem in health care facilities, resulting in extended durations of care, substantial morbidity and mortality, and excess costs. Since alcohol gel hand sanitizers combine high immediate antimicrobial efficacy with ease of use, this study was carried out to determine the effect of the use of an alcohol gel hand sanitizer by caregivers on infection types and rates in an acute care facility. Patients were educated about the study through a poster on the unit, and teachable patients were given portable bottles of the alcohol hand gel for bedside use, along with an educational brochure explaining how and why to practice good hand hygiene. Methods: Infection rate and type data were collected in 1 unit of a 498-bed acute care facility for 16 months (February 2000 to May 2001). An alcohol gel hand sanitizer was provided and used by caregivers in the orthopedic surgical unit of the facility during this period. Results: The primary infection types (more than 80%) found were urinary tract (UTI) and surgical site (SSI) infections. Infection types and rates for the unit during the period the alcohol hand sanitizer (intervention) was used were compared with the infection types and rates for the same unit when the alcohol hand sanitizer was not used (baseline); the results demonstrated a 36.1% decrease in infection rates for the 10-month period that the hand sanitizer was used. Conclusion: This study indicates that use of an alcohol gel hand sanitizer can decrease infection rates and provide an additional tool for an effective infection control program in acute care facilities.

137. Hobson, D.W., et al., Development and evaluation of a new alcohol-based surgical hand scrub formulation with persistent antimicrobial characteristics and brushless application. *Am J Infect Control*, 1998. 26(5): p. 507-512. Handwashing - Antimicrobial.

Background: Since the introduction in the 1970s of surgical hand scrub formulations that contain 4% chlorhexidine gluconate (CHG), new surgical scrub formulations that have improved efficacy, persistence, or significantly improved use characteristics have not been forthcoming. In addition, the manufacturer's labeling for popular hand scrub products generally requires scrub times in excess of 6 minutes, whereas current practical needs call for products with substantially shorter scrub times. A new alcohol-based surgical scrub formulation, which has ingredients that provide emollient, surfactant, and antimicrobial persistence characteristics to complement the rapid and broad-spectrum antiseptic qualities of alcohol, has been developed in an effort to address these current practical needs. Methods: The relative efficacy of a new alcohol-based surgical scrub formulation that contains ingredients that provide surfactant and antimicrobial persistence characteristics was compared with that of commercial 4% CHG and 7.5% povidone iodine (PVPI) formulations with use of human subjects. Hand antimicrobial count sampling was performed by using standardized "glove juice" methodology. Results: The efficacy and persistence results of the new formulation showed statistically significant improvement over both CHG and PVPI at a substantially lessened scrub time (3 minutes). In addition, use of the new formulation without a scrub brush produced results statistically similar to 3-minute applications with either a brush or a sponge. Conclusions: The new alcohol-based formulation demonstrates promise as a new surgical hand scrub formulation with antimicrobial and use characteristics that are significantly improved over current CHG and PVPI formulations. These studies demonstrate the suitability of this formulation for use as a surgical hand scrub and for brushless application. (*AJIC Am J Infect Control* 1998;26:507-12).

138. Horn, W.A., et al., Microbial flora on the hands of health care personnel: Differences in composition and antibacterial resistance. *Infect. Control Hosp. Epidemiol.*, 1988. 9(5): p. 189-193. Handwashing - Antimicrobial.

The composition and antibiotic sensitivity pattern of bacteria recovered from the hands of nurses and physicians in two service units of a major teaching hospital were compared with those found in a control population. Significant differences in the composition of bacteria were found in dermatology and oncology unit personnel. *S. aureus* was recovered from 31% of dermatology nurses and 37% if dermatology physicians, and 17% of controls. Oncology personnel had a significantly higher carriage of gram-negative bacteria, yeast, and multiple antibiotic-resistant, aerobic coryneforms (group JK bacteria). Both dermatology and oncology nursing personnel were colonized by organisms resistant to multiple antibiotics. Methicillin resistance was found in 26% and 66% of the staphylococci recovered from dermatology and oncology nurses respectively. Flora from physician on the two units has sensitivity patterns similar to controls.

139. Horwood, M.P. and Minch, V.A., Numbers and types of bacteria found on the hands of food handlers. *Food Res.*, 1951. 16: p. 133-136. Handwashing - Binder.

The study dealt with the collection and bacteriological examination of hand washed samples derived from the hands of food handlers selected at random from 22 eating establishments in the Boston and Cambridge, Mass. area. The large numbers of bacteria isolated from the hands of food handlers in this investigation and the frequency with which *E. coli*, hemolytic streptococci and staphylococci and aerobic spore formers were isolated indicates the magnitude of the problem of hand hygiene among food handlers and the need for a greatly accentuated campaign of health education for this large and important group of workers. While it is recognized that many of the organisms isolated in this study were derived from the foods being handled or processed, observation of food handlers has indicated that the hands are frequently soiled with the discharges from nose and mouth and in other ways. Frequently, food handlers bring the hands in contact with food when the use of an implement is indicated. This investigation discloses the bacterial conditions of the hands of food handlers as found. No attempt was made to discover how they got there. The data justify the conclusion that the hands of food handlers should be kept clean and that they should avoid contact with food whenever possible. Suggested preliminary instruction for food handlers followed by examination prior to licensing. Management must assume the responsibility for daily education and supervision.

140. Hyde, B. and Sliwa, J., American's caught dirty handed. Press Release, 1996. Handwashing.

By ASM: American Society for Microbiology. Paper written based on the information gathered in ASM's Handwashing Fact Sheet. Summarizes the same findings.

141. Jacobson, G., et al., Handwashing: Ring-wearing and number of microorganisms. *Nursing Res.*, 1985. 34(3): p. 186-188. Handwashing.

A statistically significant difference was found between the bacterial count before scrubbing while wearing and the counts obtained when not wearing rings. However, after scrubbing the hands thoroughly, the difference in bacterial counts was not statistically significant. Thorough handwashing substantially lowers the number of microorganisms present on the hands. While wearing rings increased the number of microorganisms on the hands, thorough handwashing reduced this number to a count similar to that obtained when rings were not worn. In this study, stimed standardized handwashing procedure was used. Shortening this procedure or not thoroughly washing the hands may result in greater numbers of microorganisms on the hands of person who wear ring in patient contact areas. In this study, the researchers observed that wearing hand lotion increased the bacterial count. Only bacterial counts were obtained in this study; no attempt was made to identify the organisms. This study was conducted in a laboratory setting.

142. Jones, R.D., et al., Triclosan: A review of effectiveness and safety in health care settings. *Am J Infect Control*, 2000. 28: p. 184-196. Handwashing - Antimicrobial.

Triclosan is a widely accepted antimicrobial ingredient because of its safety and antimicrobial efficacy. Triclosan is a unique antimicrobial well suited for use in the health care industry in which mildness is a necessity to protect the health care worker during repeated use and antimicrobial activity is a necessity to protect public health. Triclosan has demonstrated immediate, persistent, broad-spectrum antimicrobial effectiveness and utility in clinical health care settings. This review highlights the utility and effectiveness of a 1% triclosan formulation for use in high-risk, high-frequency handwashing.

143. Kaniwa, M., et al., Identification of causative chemicals of allergic contact dermatitis using a combination of patch testing in patients and chemical analysis: Application to cases from rubber gloves. *Contact Dermatitis*, 1994. 31: p. 65-71. Handwashing - Gloves.

Five cases of allergic contact dermatitis from rubber gloves were investigated by our recommended procedures using a combination of patch testing in patients and chemical analysis of causative rubber products by gas chromatography (GC) and high-performance liquid chromatography (HPLC). We previously confirmed that zinc ethylphenyldithiocarbamate (ZEPC), a dithiocarbamate-type accelerator (DTC), was causative in a case of allergic contact dermatitis from rubber work gloves. Subsequently, we have clarified that DTCs such as zinc dimethyldithiocarbamate (ZDMC), zinc diethyldithiocarbamate (ZDEC) and zinc dibutyldithiocarbamate (ZDBC) and amines such as dimethylamine (DMA), diethylamine (DEA) and piperidine (PIP) were also causative in cases from surgical rubber gloves. Thus, our investigative studies revealed that, although thiurams have been taken much more notice of as allergenic compounds than their corresponding DTCs and amines, not only DTCs such as ZDMC, ZDEC, ZDBC and ZEPC, but also amines such as DMA, DEA and PIP were noteworthy causative candidates of allergic contact dermatitis from rubber gloves.

144. Kaul, A.F. and Jewett, J.F., Agents and techniques for disinfection of the skin. *Surgery*, 1981. 152: p. 677-685. Handwashing - Antimicrobial.

Discusses use of hexachlorophene, iodophor, benzalkonium, and chlorhexidine preparations for disinfection of skin. "From mass of conflicting data, it is thus apparent that neither the ideal agent nor protocol for surgical scrubbing and skin preparation has yet been devised."

145. Khan, M.U., Interruption of shigellosis by hand washing. *Trans. Royal Soc. Trop. Med. & Hygiene.*, 1982. 76(2): p. 164-168. Handwashing - Binder.

*Shigella* is associated with poor hygiene. The effectiveness of the simple intervention of hand washing with soap and water was investigated, in preventing the spread of the disease. The study population was comprised of confirmed cases of shigellosis. These and matched controls were followed up for 10 days. Several pieces of soap and earthenware pitchers for storing water were provided to the study families and they were advised to wash their hands with soap and water after defecation and before meals. Compliance was monitored daily by observing the sized of the soap and residual water. Rectal swabs of contact of both of the groups were obtained daily for culture. The secondary infection rate was 10.1% in the study group and 32.4% in the control group. The secondary case (symptomatic) rate was 2.2% in the study group and 14.2% in the control group. These results suggest that handwashing has a positive interrupting effect, even in unsanitary environments.

146. Kim, P.W., et al., Rates of hand disinfection associated with glove use, patient isolation, and changes between exposure to various body sites. *Am J Infect Control*, 2002. 31: p. 97-103. Handwashing - Michaels.
- Background: Handwashing is the most effective and economic intervention shown to reduce nosocomial infection rates. However, studies have consistently documented low hand disinfection compliance. Literature regarding the roles that concomitant glove use and isolation precautions play in health care worker compliance with hand disinfection is limited. It is unclear whether workers change gloves and disinfect hands adequately between exposures to different body sites/secretions while caring for a patient. Methods: This was an observational study in which hand disinfection compliance and glove use among workers was evaluated in 2 intensive care units at a tertiary care hospital. Results: Five hundred eighty-nine opportunities for hand disinfection were recorded in 40 hours of observation. Overall compliance was 22.1%. We found a statistically significant, positive association between glove use and subsequent hand disinfection (relative risk [RR], 3.9 [95% CI, 2.5–6.0];  $P < .0001$ ). Isolation precautions did not significantly increase disinfection compliance. Only 4.8% (3/63) of workers appropriately complied with disinfection when hands were exposed to multiple body sites/secretions while caring for a patient. Conclusions: Glove use increases compliance with hand disinfection. Isolation precautions do not increase compliance. Workers do not appropriately comply with disinfection guidelines when attending to multiple body sites/secretions on the same patient. Compliance with hand disinfection remains low.
147. Kjolen, H. and Andersen, B.M., Handwashing and disinfection of heavily contaminated hands -- effective or ineffective? *J. Hosp. Infect.*, 1992. 21: p. 61-71. Handwashing - Antimicrobial.
- Hands are among the principal vehicles for transfer of nosocomial pathogens in hospitals. Often, outbreaks of infection are thought to be caused by a lack of compliance with handwashing guidelines, rather than due to the inadequacy of the handwashing agents used. In this study the effectiveness of proper hand washing and use of three different hand disinfectants (ethanol, 70% (E), isopropanol, 40% (I), and alcoholic chlorhexidine, 70% (AC) was compared using three volunteers whose fingertips were heavily contaminated with a succession of bacteria including: *Enterococcus faecalis*, *S. aureus*, *E. coli*, and *Enterobacter cloacae*. After each contamination, thorough hand washing and application of one disinfectant on the hands were performed three times. Fingerprint-samples were taken before and 1 min. after application of the disinfectants. Thorough handwashing with ordinary liquid soap (Sterisol) did not reduce the confluent growth of bacteria on fingertips for any of the species used (197 examinations). Only AC had a significant effect on fingers heavily contaminated with *S. aureus*, but did not completely eradicate the bacteria. After contamination with *Enterobacter cloacae*, none of the three agents were particularly effective but AC and E seemed to be somewhat more effective. When successive contamination was performed using all bacterial species, AC was the most effective decontaminant. However, *Enterobacter cloacae*, was still present on the fingertips after 15 repeated courses of handwashing and applications of disinfectants. Bathing hands in AC for 20 sec. completely eradicated all bacteria from the hands. This study demonstrated that, when heavily contaminated, an ordinary handwashing followed by disinfectants is not enough to eradicate potentially pathogenic bacteria from the hands.
148. Klein, R.C., Party, E., and Gershey, E.L., Virus penetration of examination gloves. *BioTechniques*, 1990. 9(2): p. 196-199. Handwashing - Gloves.
- Examination gloves worn for protection from biohazards were sampled and evaluated for their ability to exclude virus particles. We found that thin gloves manufactured from polyethylene or polyvinyl chloride are ineffective barriers while gloves of thin latex are superior but not without failure. Polyethylene and polyvinyl chloride gloves had failure rates of 40% and 22%, respectively. Following exposure to the common disinfectant, 70% ethanol, these failure rates increased to 94% and 56% for polyethylene and polyvinyl chloride gloves, respectively. Latex, although permeable to ethanol, was penetrated by virus less than 1% of the time regardless of whether the latex had been pre-exposed to disinfectant or not. This study highlights the need for caution on the part of those who rely upon examination gloves for protection from infectious agents as well as the need for establishing more adequate standards and testing procedures for their manufacture.
149. Kleinhans, D., Contact urticaria to rubber gloves. From chapter Short Communications, n.d. Handwashing - Gloves.
- Case reports of 3 people with contact urticaria.
150. Kligman, A.M., Leyden, J.J., and McGinley, K.J., Bacteriology. *J Investigative Dermatology*, 1976. 67: p. 160-168. Handwashing - Antimicrobial.
- Pros and Cons of having microflora on the skin and a look to what the future of skin microbiological investigation will bring.
151. Knights, B., et al., Hand drying: A survey of efficiency and hygiene. 1993. Handwashing - Michaels.
- Published by The Applied Ecology Research Group, University of Westminster. Summary: Observations of peoples' hand washing and drying habits under natural conditions have been carried out. The results show that disposable paper towels and cotton cabinet towels were a much quicker and more efficient means of drying the hands than hot air driers. People rarely use hot air driers long enough to insure more than 55-65% dryness and often complete drying by wiping hands on clothes, etc. Many women also use make-up and combs while hands are still damp. These activities can spread any bacteria left on the hands. Microbiological studies revealed that using paper towels were slightly more efficient than cotton, both with respect to cleaning the finger tips and in between the fingers. In contrast, hot air drying increased bacterial counts on the hands and in the local environment. Bacterially contaminated air was emitted whenever a machine was running, even when not being used for hand drying.
152. Korniewicz, D.M., In vitro versus in-use considerations for testing the permeability of gloves. *Am. J. Inf. Control*, 1996. 24(3): p. 158-159. Handwashing - Gloves.
- Proper gloving practices include taking into account: 1) material of the glove (vinyl, latex, nitrile); 2) task to be performed (clinical, mechanical); 3) length of time the glove is used (1 min. to 1 hour); 4) exposure of the glove to chemicals, blood, or body fluids; and 5) quality of the glove. In vitro testing is the most ideal because a variety of extraneous variables can be

controlled such as 1) contamination (viral, bacterial, chemical), 2) glove (type, size, quality), 3) environment (temperature, materials used, control of substances that would compromise the glove barrier), 4) amount of time for exposure to substances, 5) data collection methods (computer, specifically trained personnel), 6) type of test to be performed (prescribed method can be adhered to in a laboratory setting), and 7) decreased risk of human error as a result of a more controlled environment and more accurate test methods.

153. Korniewicz, D.M., et al., Barrier protection with examination gloves: Double versus single. *Am J Infect Control*, 1994. 22: p. 12-15. Handwashing - Gloves.

In a series of experiments, the barrier integrity of single and double vinyl and latex examination gloves were tested for dye and water leaks after being placed under stress. A total of 886 examination gloves (385 vinyl: single, 199; double, 186; and 501 latex: single, 290; double, 211) were tested with a standardized clinical protocol designed to mimic patient care activities. Leakage rates for single or double gloving were significantly higher for vinyl than for latex gloves. Single vinyl gloves were significantly more likely to leak than were double vinyl gloves (51.3% and 19.7%,  $p < 0.0001$ ). However, there were essentially no differences in leakage rates for single or double latex gloves (4.1% and 3.8%,  $p = 1$ ). Significantly higher rates of leakage were identified with the water leak test than with the dye test for vinyl ( $p < 0.001$ ) but not for latex ( $p = 0.22$ ) gloves. For vinyl but not latex gloves, there were significant differences in leakage rates by brand. We conclude that double gloving offers little advantage during routine procedures associated with minimal stress to the gloves or when latex gloves are worn.

154. Korniewicz, D.M., et al., Integrity of vinyl and latex procedure gloves. *Nursing Res.*, 1989. 39(3): p. 144-146. Handwashing - Gloves.

In a series of experiments, the integrity of vinyl and latex procedure gloves were tested under in-use conditions. Both types of gloves were tested by three methods: watertight (645 samples), bacterial penetration (50), and dye exclusion (90). Results of the water tight test demonstrated visible defects in 4.1% of vinyl and 2.7% in latex gloves. Twenty percent of latex gloves and 34% of vinyl gloves which had passed the water tight test allowed penetration of *Serratia marcescens* when worn by volunteers. A series of manipulations designed to simulate approximately 15 minutes of clinical activity in an intensive care unit resulted in failure rates as high as 66%. Using the dye penetration test, there was a statistically significant difference between vinyl and latex procedure gloves with full manipulations, with failure rates of 53% and 3%, respectively. Both types of gloves provided some barrier protection. However, latex gloves performed better when stressed.

155. Kotilainen, H.R., Avato, J.L., and Gantz, N.M., Latex and vinyl nonsterile examination gloves: Status report on laboratory evaluation of defects by physical and biological methods. *Appl. Environ. Microbiol*, 1990. 56(6): p. 1627-1630. Handwashing - Gloves.

We have reported previously (H. R. Kotilainen, J. P. Brinker, J. L. Avato, and N. M. Gantz, *Arch. Intern. Med.* 149:2749-2753, 1989) that the quality of nonsterile examination gloves available for clinical use may be extremely variable. In view of the concern over human immunodeficiency virus and hepatitis B virus transmission to health care workers, the continuing variability of gloves available for use, and the need for a simple and safe test, we have evaluated 2,500 vinyl (five brands) and 2,000 latex (four brands) gloves by the 300-ml and the newly proposed 1,000-ml water tests and for permeability to herpes simplex virus type 1 and poliovirus type 1, respectively. While all 300-ml watertight gloves were unlikely to leak herpes simplex virus type 1 (1.3% vinyl; 0.5% latex), poliovirus was recovered much more frequently (8.9% vinyl, 6.1% latex). In all gloves that passed the 1,000-ml test, herpes simplex virus type 1 was not recovered. Poliovirus was recovered infrequently (1.4% vinyl, 1.5% latex). Preliminary analyses suggest that the 1,000-ml water test has significantly increased sensitivity over the 300-ml water test in the detection of small holes in both vinyl and latex gloves that may allow the passage of viral particles. Gloves that pass a 1,000-ml water challenge are unlikely to allow the passage of a small virus such as poliovirus. Given that human immunodeficiency virus, hepatitis B virus and herpes simplex virus type 1 are larger particles than poliovirus, gloves that pass the 1,000-ml water test theoretically could provide better protection.

156. Kotilainen, H.R., et al., Latex and vinyl examination gloves: Quality control procedures and implications for health care workers. *Arch. Intern. Med.*, 1989. 149: p. 2749-2753. Handwashing - Gloves.

In December 1987, we investigated an increased number of cases of herpetic whitlow in medical intensive care unit nurses who routinely gloved for secretion contact. One particular brand of vinyl examination gloves had been used in the medical intensive care unit. Restriction endonuclease mapping established the similarity of employee isolates with one patient isolate of herpes simplex virus type 1. When initial viral assay demonstrated 2.5% to 10% penetration of herpes simplex virus type 1 across unused gloves and evaluation of glove quality was undertaken. In a 300-ml water-tightness test, seven brands of vinyl gloves failed 4% to 28% (average, 11.1%; 132/1200), while seven brands of latex gloves failed 0% to 2.6% (average 1.4%; 24/1750). The brands of vinyl glove that have been in used in the medical intensive care unit failed 28% of the time. Water tight gloves were then tested for permeability to herpes simplex virus type 1. None of the latex gloves failed (n=1726), while only 10 of the vinyl gloves failed (n=1068, (0.95%). Extreme variability in glove quality was observed. However, gloves made from intact vinyl may provide similar protectiveness as those made from intact latex. As the demand for gloves increases, emphasis should be placed on the production of plentiful, better quality latex and vinyl gloves.

157. Kovach, T.L., Maintaining intact skin during handwashing: The first line of defense against the chain of septic flow. Online Article, 2001. Handwashing - Antimicrobial.

Intact Skin - the first line of defense; Striving for balance; comparison testing data - effectiveness and skin moisture levels of various active ingredients now on the market; Table Results; Conclusions. 2.

158. La Rocca, M.A.K. and La Rocca, P.T., Evaluation of antimicrobial effect of a hand sponge-brush impregnated with 4% chlorhexidine gluconate (hibiclens). *Dev. Ind. Microbiol.*, 1982. 23(Chapter 51): p. 543-546. Handwashing - Binder.

- Reports study of effective use of a sponge brush containing chlorhexidine gluconate for washing and scrubbing hands. There were significant decreases of the numbers of bacteria on the hands. Significant reestablishment of the normal flora was prevented for over 6 hours. (Glove juice test was used for the assessment of bacterial population on the hands.)
159. Laboratories, R.F., Examination of cross-contamination and effect of glycorine against microbe on gloves. Protocol and Procedure, 1995. Handwashing - Gloves.  
Gloves are inoculated with ground beef and then tested. Compared to soaking a towel used to clean the gloves in sanitizer and Gycorine and testing.
160. LaBudde, R.A., Class action suit based on latex allergies. Email correspondence, 1997. Handwashing - Gloves.  
Article excerpts from the Fort Worth Star-Telegram in 1997 about a woman in Texas who lost her job after she suffered a severe allergic reaction to latex.
161. LaBudde, R.A. and Snyder, O.P., Two perspectives on gloves and handwashing: Everyone talks about handwashing, but nobody does it & why gloves are not the solution to the fingertip washing problem. Food Protection Report, 2001(April). Handwashing - Gloves.  
LaBudde writes that no one can be trusted to wash their hands and so gloves are necessary for food safety. Snyder writes that gloves provide a false sense of security that allow lax handwashing to prevail. HI-TM.
162. Lammintausta, K., Kalmo, K., and Havu, V.K., Occurrence of contact allergy and hand eczemas in hospital wet work. Contact Dermatitis, 1982. 8: p. 81-90. Handwashing.  
The occurrence of contact sensitivity and hand dermatitis was studied in hospital employees. The incidence of contact allergy was 21%. Nickel (9%) was the most common allergen followed by perfumes (6%). Present of previous hand dermatitis was detected in 46%. Of those with positive reactions, 53% had suffered from hand dermatitis as compared to 44% of those without positive reactions. 70% of those with sensitivity to fragrances had suffered from hand dermatitis. The occurrence of hand dermatitis was more frequent in persons, who had developed contact allergy to rubber chemicals or to both nickel and cobalt simultaneously.
163. Larson, E., Current handwashing issues. Infect. Control, 1984. 5(1): p. 15-17. Handwashing.  
This article is an update on the status of current issues regarding handwashing. Points out known issues: 5 min. surgical scrub is adequate; hands cannot be sterilized; flora of skin can cause nosocomial infections; handwashing is efficacious for preventing spread of infection. Points out areas that need more study: bacteriology of the hands; gram-negative as well as gram-positive cocci are present on the hands, even after "social" handwashing; there is tremendous individual variations in bacterial counts on skin, unexplained by current knowledge; methods to increase compliance with adequate handwashing.
164. Larson, E., Hand washing: It's essential -- even when you use gloves. Am. J. Nurs., 1989. 89: p. 934-939. Handwashing - Gloves.  
Review article. CDC recommends plain soap for most general patient care. When the sole purpose of handwashing is to remove soil and transient organisms from hands, plain soap is adequate. In critical care units, immunosuppressed units, day care centers and long-term care centers, antimicrobials are needed. Discusses use of alcohols, chlorhexidine gluconate, iodophors, para-chloro-meta-xyleneol and triclosan (Irgasan). (Hexachlorophene is no longer recommended because it acts primarily against gram-positive bacteria, and has little or not effect on other types of bacteria that cause infection. It has also been associated with a rare but serious neurological toxicity.) Handwashing can interrupt the skin's normal protective mechanisms by damaging or cracking the skin, altering its pH, or changing its normal flora. Recommends using hand lotions containing antimicrobial ingredient in small bottles. Gloving: Bacteria on hand multiply rapidly inside warm, moist environment of glove, even when no external contamination has occurred. Bacteria and viruses can leak through gloves. Gloving does not replace handwashing; handwashing is imperative after removing gloves.
165. Larson, E., Apic guideline for handwashing and hand antisepsis in health care settings. Report, 1995. Handwashing - Antimicrobial.  
2. APIC (Association for Professionals in Infection Control and Epidemiology, Inc.).
166. Larson, E., Hygiene of the skin: When is clean too clean? Emerging Infectious Diseases, 2001. 7(2): p. 225-230. Handwashing - Antimicrobial.  
Skin hygiene, particularly of the hands, is a primary mechanism for reducing contact and fecal-oral transmission of infectious agents. Widespread use of antimicrobial products has prompted concern about emergence of resistance to antiseptics and damage to the skin barrier associated with frequent washing. This article reviews evidence for the relationship between skin hygiene and infection, the effects of washing on skin integrity, and recommendations for skin care practices. 2.
167. Larson, E., et al., Quantity of soap as a variable in handwashing. Infection Control., 1987. 8(9): p. 371-375. Handwashing - Antimicrobial.  
The purposes of this study were to assess the effect of two quantities (1 mL or 3 mL) of four different handwashing products on reductions in log colony-forming units (CFU) from the hands and to determine the amount of liquid soap used for handwashing by personnel in one hospital. First, 40 subjects were assigned by block randomization to one of four handwashing products (4% chlorhexidine gluconate in a detergent base, two alcohol hand rinses, and a liquid, nonantimicrobial soap) to be used in either 1 mL or 3 mL amounts per wash. Each subject washed his or her hands 15 times per day for five days. After one and five days of handwashing there were significant reductions over baseline in log CFU between handwashing products (P less than 0.001). Additionally, subjects using 3 mL of antiseptic soap had significantly greater reductions in log CFU than those using 1 mL (P less than 0.001). Among subjects using control liquid soap there was no such dose response. Second, a survey of 47 members of a hospital nursing staff from nine specialty areas and ten individuals in the general population was conducted to measure amounts of two liquid soaps used for handwashing. Amount of soap ranged from 0.4 to 9 mL per handwash. Personnel working in clinical areas where patients were at high risk for nosocomial infection used significantly more soap than did others (P less

- than 0.05). We conclude that quantity of soap used for handwashing is one variable influencing the microbial counts on hands, and that the quantity of soap used by health care personnel varies considerably. 2.
168. Larson, E., et al., Physiologic and microbiologic changes in skin related to frequent handwashing. *Infect. Control*, 1986. 7(2): p. 59-63. Handwashing - Antimicrobial.
- Handwashing practices may be adversely influenced by the detrimental effects of handwashing on skin. A protocol was developed to assess the physiologic and microbiologic effects of frequent handwashing. Fifty-two female volunteers washed their hands 24 times per day for 5 days. Five agents were tested: water alone, non-medicated bar soap, a chlorhexidine-containing antiseptic, and two agents containing povidone-iodine (one currently available on the market and one being tested for possible marketing). Some damage to the outer membrane of skin, the stratum corneum, occurred in all groups. There were significant changes in the amount of evaporation water loss ( $p = .001$ ) and in self assessments of skin condition ( $p = .005$ ) from pre-to-post test for the entire group. Skin damage was also assessed by visualizing desquamating stratum corneum cells, which are shed in large aggregates when detergents injure skin. Significantly less such shedding occurred in subjects using water alone, bar soap, and the chlorhexidine formulation ( $p = .02$ ). Greater antimicrobial activity of an agent was not correlated with increased skin trauma. We have quantitated, using objective physiologic parameter, the skin damage that occurs during even a short period of frequent handwashing. We recommend that further studies using the methods described be conducted to quantitate skin damage over longer periods of time, more closely resembling handwashing practices of health care personnel.
169. Larson, E. and Lusk, E., Evaluating handwashing technique. *J. Adv. Nursing*, 1985. 10: p. 547- 552. Handwashing - Binder.
- Though standards for handwashing have been defined, little effort has been made to assess the quality of handwashing in clinical settings. This paper describes tests of reliability and validity of tools to evaluate two aspects of handwashing - appropriateness and technique. Based on these test, methods to evaluate handwashing are recommended.
170. Larson, E., Mayur, K., and Laughon, B.A., Influence of two handwashing frequencies on the reduction in colonizing flora with three handwashing products used by health care personnel. *Am. J. Infect. Control*, 1988. 17(2): p. 83-88. Handwashing - Antimicrobial.
- Four handwashing products (containing either 2% chlorhexidine gluconate, 0.6% parachlorometaxyleneol, 0.3% triclosan, or a nonantimicrobial control) at two handwashing frequencies (6 or 18 times/day) were compared with regard to their effectiveness in reducing colonizing hand flora. Eighty adult volunteers were assigned by block randomization to one of the four products and one of the two frequency schedules ( $n = 10$ /group) and washed their hands under supervision for 5 consecutive days. There were no significant differences between products in mean log<sub>10</sub> colony-forming units after the initial wash ( $p = 0.61$ ), nor were there significant differences in products after 5 days among subjects washing six times per day. For those who washed 18 times per day, however, the effectiveness of all three antimicrobial soaps was significantly better than that of the control soap ( $p < 0.05$ ). Chlorhexidine gluconate produced significantly greater reductions than triclosan or parachlorometaxyleneol ( $p < 0.05$ ), which were not significantly different from each other. On the basis of these findings an antimicrobial soap is recommended when handwashing frequency is high and a long-term reduction in colonizing flora is desirable. When handwashing frequency is low (6 times/day), there seems to be less advantage of one product over another, although the use of chlorhexidine gluconate resulted in greater reductions at both high and low handwashing frequencies. .
171. Larson, E., et al., Physiologic, microbiologic, and seasonal effects of handwashing on the skin of health care personnel. *Am. J. Infect. Control*, 1986. 14(2): p. 51-59. Handwashing.
- The handwashing practices of 22 personnel in an oncology unit in an urban medical center were studied for 2 months. During 891 person-hours of observation, 986 handwashes were observed. Subjects washed a mean of 1.1 times an hour for a mean of 13.2 seconds. A total of 558 isolates were recovered from 158 hand cultures. The mean log count was 4.88 with no significant difference between physicians and nurses. Coagulase negative staphylococci isolated from hands of physicians and nurses were significantly more resistant to antimicrobial agents than those of personnel with minimal patient contact. Subjects had more skin damage in winter than in summer, as indicated by increased shedding of skin squares. Concluded that handwashing practices vary significantly by profession and that reporting of handwashing practices by personnel is inaccurate.
172. Larson, E. and Talbot, G.H., Approach for selection of health care personnel handwashing agents. *Infect. Control*, 1986. 7(8): p. 419-424. Handwashing.
- Given the wide range of available health care personnel handwashing agents, selection of an appropriate product may be difficult. This decision may be made on the basis of user preference, cost, or other factors unrelated to product effectiveness. Four criteria--efficacy, safety, cost, and acceptability--are appropriate for systematic evaluation of handwashing products. These criteria are applied to para-chloro-meta-xyleneol (PCMX), a compound used with increasing frequency in health care personnel handwashing agents. Published data regarding the biochemical properties, efficacy, and safety of PCMX are summarized. We conclude that the substance appears to be safe and efficacious. However, the activity of PCMX is highly formula-dependent and many of the studies available in scientific literature have been conducted in Europe using a variety of testing conditions and formulations different from those currently available in the US. Clinical studies of marketed formulations are beginning to appear in the literature. Such studies will provide the data needed for adequate product evaluation. Selection of an appropriate handwashing product must be based on four criteria: efficacy, safety, cost and acceptability. Study reports evaluation of para-chloro-meta-xyleneol (PCMX) which is currently used by hospital personnel. Efficacy of this product is formula dependent.
173. Larson, E.L., et al., Microbial flora of hands of homemakers. *Am J Infect Control*, 2003. 31(2): p. 72-79. Handwashing.
- Objectives and methods: Because of increasing concern about antimicrobial resistance in the community, aerobic flora of hands of 224 healthy homemakers in northern Manhattan, New York, were examined. Results: Mean log colony-forming unit counts before and after handwashing were 5.72 and 5.69, respectively,  $P = .60$ ; mean number of species identified/sample was 3.6 before washing and 3.3 after ( $P = .02$ ). After handwashing gram-negative bacteria were isolated from 75.1% of subjects; yeast

from 32.9%; and *Staphylococcus aureus* from 18.5%, 1 of which (2.4%) was oxacillin-resistant. Generally, these community isolates were more sensitive than isolates from inpatients in the local hospital, although community isolates of *Pseudomonas aeruginosa* were significantly more resistant than inpatient isolates for 4/10 agents tested. Conclusions: Hands of healthy persons in the community were usually colonized with gram-negative bacteria, a single handwash had little impact on microbial counts, and hands of healthy adults may increasingly become one reservoir for antimicrobial resistance.

174. Larson, E.L., et al., Handwashing practices and resistance and density of bacterial hand flora on two pediatric units in Lima, Peru. *Am J Infect Control*, 1992. 20: p. 65-72. Handwashing - Antimicrobial.

The handwashing practices and bacterial hand flora of 62 pediatric staff members of a teaching hospital in Lima, Peru, were studied. Handwashing followed patient contact 29.3% of the time (204/697 contacts). Mean duration was 14.5 seconds, and significant differences in practices were found by unit (rehydration or neonatal intensive care), type of staff member (nurses or physicians), and type and duration of patient contact. Mean count of colony-forming units was  $\log_{10} 5.87 \pm 0.41$ , with significant differences in density of flora found between patient care and kitchen staffs. There was no significant effect of handwashing on counts of colony-forming units. Significant differences were also found by unit and by staff position with regard to species isolated and antimicrobial resistance of isolates. A more efficacious and cost-effective form of hand hygiene and a more prudent use of antimicrobial agents are indicated.

175. Larson, E.L., et al., Changes in bacterial flora associated with skin damage on hands of health care personnel. *Am J Infection Control*, 1998. 26(5): p. 513. Handwashing.

In a prospective observational study of 40 nurses (20 with diagnosed hand irritation and 20 without), nurses with damaged hands did not have higher microbial counts ( $P = .63$ ), but did have a greater number of colonizing species (means: 3.35 and 2.63,  $P = .03$ ). Although numbers were small, nurses with damaged hands were significantly more likely to be colonized with *Staphylococcus hominis* ( $P = .03$ ). Fifty-nine percent of *S hominis* isolates from nurses with damaged hands were resistant to methicillin compared with 27% of isolates from those with healthy skin ( $P = .14$ ). Twenty percent of nurses with damaged hands were colonized with *Staphylococcus aureus* compared with none of the nurses with normal hands ( $P = .11$ ). Nurses with damaged hands were also twice as likely to have gram-negative bacteria ( $P = .20$ ), enterococci ( $P = .13$ ), and *Candida* ( $P = .30$ ) present on the hands. Antimicrobial resistance of the coagulase-negative staphylococcal flora (with the exception of *S hominis*) did not differ between the 2 groups, nor did a trend toward increasing resistance exist when compared with other studies during the past decade. Skin moisturizers and protectant products were used almost universally by nurses at work, primarily products brought from home. Efforts to improve hand condition are warranted because skin damage can change microbial flora. Such efforts should include assessment or monitoring of hand care practices, formal institutional policy adoption and control of use of skin protectant products or lotions, and prudent use of latex gloves or more widespread use of powder-free and nonlatex products.

176. LeTexier, R., Preventing infection through handwashing. Article, n.d. Handwashing.

This article: discusses handwashing solutions for antibiotic-resistant organisms; Lists strategies for effective hand hygiene; and Provides an overview of CDC recommendations for handwashing.

177. Levy, S.B., Antibacterial household products: Cause for concern. *Current Issue*, 2001. 7(3). Handwashing - Antimicrobial. Proliferation of Antibacterial Products - Development of Resistance - Consequence of Resistance - Antibacterial Products/Allergy Link - References.

178. Lilly, H.A. and Lowbury, E.J.L., Transient skin flora: Their removal by cleansing or disinfection in relation to their mode of deposition. *J. Clin. Path.*, 1978. 31: p. 919-922. Handwashing - Binder.

A suspension of *Staphylococcus aureus* deposited on the skin was much more effectively removed by soap-and-water washing when it had been spread and allowed to dry (mean survival 2%) than when it had been rubbed onto the skin (mean survival 29.9%); when antiseptics (70% ethyl alcohol, Hibiscrub without added water) were used, there was no difference between their action against bacteria dried on and bacteria rubbed onto the skin: both of these methods, and especially alcohol, were more effective than soap and water. When a detergent-disinfectant method (washing with Hibiscrub and water) was used, there was a significantly greater effect against rubbed on than against dried-on bacteria; soap and water was slightly more effective than Hibiscrub and water against the latter. The need to reappraise methods of reducing transient skin flora in "hygienic" hand cleansing and tests for this purpose are discussed.

179. Lin, C.-M., et al., Influence of fingernail length and type on removing feline calicivirus from the nail regions using different hand washing interventions. *J Food Protect*, 2003. 66(Sup A): p. 137. Handwashing - Michaels.

These results indicate that the best practices for fingernail sanitation for food handlers are to maintain short fingernails and scrub nails with soap and a nailbrush. Abstract Only.

180. Lin, C.-M., et al., Removal of *Escherichia coli* on hands with natural or artificial fingernails. Report, 2002. Handwashing.

Part of a Poster Presentation - IAF Annual Meeting 2002. Based on the results of this study, physical elimination such as scrubbed by a nailbrush was a critical step to remove microorganisms from areas underneath fingernails.

181. Llatser, R., Zambrano, C., and Guillaumet, B., Anaphylaxis to natural rubber latex in a girl with food allergy. *Pediatrics*, 1994. 94: p. 736-737. Handwashing - Gloves.

Story is told of a young girl with several food allergies and a severe allergy to rubber.

182. London, U.O., Handwashing programmes could be intervention of choice for diarrhoeal diseases. Online Article, 2003. Handwashing.

From the London School of Hygiene & Tropical Medicine in the University of London.

183. Lowbury, E.J.L. and Lilly, H.A., Disinfection of the hands of surgeons and nurses. *Brit. Med J.*, 1960. 1(May 14): p. 1445-1450. Handwashing - Binder.

- Describe experiments on the relative merits of several preoperative antiseptic applications to the surgeon's hands with particular reference to the numbers of bacteria emerging through holes in gloves. Describe a study on the routine use of hexachlorophane soap and some other methods by nurses working in accident and burn wards.
184. Lowbury, E.J.L., Lilly, H.A., and Bull, J.P., Disinfection of hands: Removal of resident bacteria. *Brit. Med. J.*, 1963. 1(May 14): p. 1251-1256. Handwashing - Binder.
- In three series of experiment... a Latin square design was used for the comparative study of 12 antiseptic preparations; this method of assessment takes into account possible interfering effects of personal variation and of day to day changes of condition. The effects of a single application and of repeated use of the antiseptic preparation have been separately assessed. In two additional experiments, the removal of staphylococci and the value of a more recently available preparation were examined. .
185. Luby, S.P., et al., Effect of intensive handwashing promotion on childhood diarrhea in high-risk communities in Pakistan. *JAMA*, 2004. 291: p. 2547-2554. Handwashing - Antimicrobial.
- Context Washing hands with soap prevents diarrhea, but children at the highest risk of death from diarrhea are younger than 1 year, too young to wash their own hands. Previous studies lacked sufficient power to assess the impact of household handwashing on diarrhea in infants. Objective To evaluate the effect of promoting household handwashing with soap among children at the highest risk of death from diarrhea. Design, Setting, and Participants A cluster randomized controlled trial of 36 low-income neighborhoods in urban squatter settlements in Karachi, Pakistan. Field workers visited participating households at least weekly from April 15, 2002, to April 5, 2003. Eligible households located in the study area had at least 2 children younger than 15 years, at least 1 of whom was younger than 5 years. Interventions: Weekly visits in 25 neighborhoods to promote handwashing with soap after defecation and before preparing food, eating, and feeding a child. Within intervention neighborhoods, 300 households (1523 children) received a regular supply of antibacterial soap and 300 households (1640 children) received plain soap. Eleven neighborhoods (306 households and 1528 children) comprised the control group. Main Outcome Measure Incidence density of diarrhea among children, defined as the number of diarrheal episodes per 100 person-weeks of observation. Results: Children younger than 15 years living in households that received handwashing promotion and plain soap had a 53% lower incidence of diarrhea (95% confidence interval [CI], -65% to -41%) compared with children living in control neighborhoods. Infants living in households that received handwashing promotion and plain soap had 39% fewer days with diarrhea (95% CI, -61% to -16%) vs infants living in control neighborhoods. Severely malnourished children (weight for age z score, <-3.0) younger than 5 years living in households that received handwashing promotion and plain soap had 42% fewer days with diarrhea (95% CI, -69% to -16%) vs severely malnourished children in the control group. Similar reductions in diarrhea were observed among children living in households receiving antibacterial soap. Conclusion: In a setting in which diarrhea is a leading cause of child death, improvement in handwashing in the household reduced the incidence of diarrhea among children at high risk of death from diarrhea. Abstract only.
186. Lusk, M.L., For good or ill, the great unwashed are making a comeback. *Nation's Restaurant News*, 1996(July 29): p. 26, 66. Handwashing.
187. Lynch, R.A., et al., Preliminary evaluation of the effect of glove use by food handlers in fast food restaurants. *J Food Protect*, 2005. 2005(68): p. 187-190. Handwashing - Gloves.
- A study was conducted to determine whether the levels of selected microorganisms differed on foods handled by gloved and bare hands at fast food restaurants. Three hundred seventy-one plain flour tortillas were purchased from fast food restaurants and analyzed for *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* sp., coliform bacteria, and heterotrophic plate count bacteria. Approximately 46% of the samples were handled by workers wearing gloves compared with 52% of samples with bare hand contact. Coliform bacteria were found in 9.6% of samples handled by gloved workers and 4.4% of samples handled by bare hands, although this difference was not statistically significant. The distribution of heterotrophic plate count bacteria, a general measure of hygiene, was also higher in samples handled by gloved workers in one restaurant chain. The presence of *E. coli*, *Klebsiella* sp., and *S. aureus* was detected in one, two, and eight samples, respectively, and there were no significant differences between samples handled by gloved or bare hands. Neither direct contact of the tortilla with the food preparation surface nor gender of the worker affected the level of any organism tested. The observed tendency of food workers to wear the same pair of gloves for extended periods and complacency might account for the apparent failure of gloves to reduce or prevent bacterial contamination. The results further suggest that glove use might be counterproductive because workers might wash their hands less frequently when gloved. Abstract Only.
188. Madeline, P. and Tournade, F., Hand drying by means of disposable products and with hot air. *Prevention Bucco-dentaire*, 1980. Handwashing - Michaels.
- Conclusions: Hand drying is in our opinion, a critical moment in the washing process, as can be seen by comparing the palms after washing without wiping to palms that were simply moistened and not lathered but were carefully dried. On the other hand, the comparison of the different drying methods shows an advantage for disposable fabric as with not only hot air, but also paper, be it pulp fiber or crepe paper, considering not only comfort but efficiency. This advantage is much cleaner since the fabric to be treated as antibacterial would be remnant. Original article in French. Full translation to English provided.
189. Mahl, M., New method for determination of efficacy of health care personnel hand wash products. *J. Clin. Microbiol.*, 1989. 27(10): p. 2295-2299. Handwashing.
- A method of studying the effects of health care personnel hand wash products is described. The fingernail regions of the hands of colunteeer are inoculated with a mixture of *Escherichia coli* and *Serratia marcescens*, and the areas are dried for a standard time. After routine hand washing, each fingernail region is individually scrubbed with an electric toothbrush which moves longitudinally to the handle in to collection fluid contained in a petri dish. The test bacteria in the fluid are then enumerated. (*Bacillus subtilis* spores may be included as tracers to show degree of physical removal of the procedure.) This method has

- several advantages over the frequently used glove juice technique. Experimental designs with large numbers of volunteers, multiple sampling sites, and many hand wash products may be performed. Ten sampling sites (fingers) are available versus the two gloved hands for testing products. (Efficiency is almost 100% in the recovery of spore traces placed on the fingernails.) Many commercial health care personnel hand wash products containing antimicrobial agents substantive to the skin do not rapidly reduce numbers of inoculated bacteria in fingernail regions to any greater extent than nonantimicrobial hand washes. Products containing isopropanol or ethanol are very effective in decreasing bacteria in areas around and under the fingernails. Used ivory liquid hand soap. Good data.
190. Makulowich, G.S., Fda establishes new quality standards for gloves. *Aids Patient Care*, 1991. 5(3): p. 143-145. Handwashing - Binder.
- FDA Acceptable Quality Levels (AQL) for Gloves : Surgical gloves: batches of latex or vinyl with less than 25 defects per 1000 gloves. Examining gloves: batches with less than 40 defects per 1000 gloves.
191. Malone, N. and Larson, E., Factors associated with a significant reduction in hospital-wide infection rates. *Am J Invect Control*, 1996. 24(3): p. 180-185. Handwashing - Gloves.
- OBJECTIVE: The purpose of this study was to identify factors associated with a significant reduction in hospital-wide nosocomial infection rates. RESULTS: Infection rates averaged 3.9% over a decade and dropped in 1993 to 2.6% ( $p < 0.001$ ). This change was unexplained by changes in surveillance methods. Slightly shorter lengths of stay and fewer inpatient surgeries may have had some impact. Additionally, two factors were temporally and statistically associated with the reduction: hospital-wide introduction of the Occupational Health and Safety Administration (OSHA) Blood-borne Pathogen Exposure Control Plan and Body Substance Isolation and a barrier hand foam. CONCLUSIONS: Introduction of the OSHA Control Plan, with concomitant increase in glove use and widespread use of a barrier hand foam were associated with a significant reduction in nosocomial infection rates. Other demographic variables (shorter hospital stays and less inpatient surgery) probably also played a role. Risk-adjusted rates are necessary to make within-hospital comparisons over time. .
192. Mann, J., Lerman, D., and Falkenstein, D., Handwashing on trial: Avoiding legal action with a five step hand hygiene system. Powerpoint, 2007. Handwashing.
- From HandwashingforlifeR. Powerpoint Presentation and Online Article similar to the powerpoint. Slides include: Hand Hygiene: A game of Change -The Courtroom Trial, outbreak results from "CasuaLee's" and preventing court cases.
193. Marino, C. and Cohen, M., Washington state hospital survey 2000: Gloves, handwashing agents, and moisturizers. *Am J Infect Control*, 2001. 3+: p. 422-424. Handwashing - Gloves.
- Hand dermatitis as a result of frequent exposure to water and cleansing agents is a significant problem in the health care industry. In developing prevention efforts to address this problem, it is necessary to make appropriate recommendations for moisturizers that are compatible with latex gloves and/or handwashing agents that contain chlorhexidine gluconate (CHG). Infection control personnel or employee health nurses in all 106 Washington hospitals were interviewed to determine what types of gloves, handwashing agents, and moisturizers are in current use in the hospital setting. The interview also addressed awareness of skin care issues involving the compatibility of moisturizers with latex gloves and handwashing agents that contain CHG. Latex gloves were available in 90% of the hospitals. Handwashing agents containing CHG were available in 33% of the hospitals. Moisturizers were supplied for the nursing personnel in 61% of the hospitals; most of these moisturizers were compatible with latex gloves and agents containing CHG. Seventy-four percent of the infection control personnel were aware of the compatibility issues of petroleum-based moisturizers with latex gloves, and 48% were aware of the need to avoid the use of anionic moisturizers in combination with CHG handwashing agents.
194. Markey, J., Latex allergy - implications for healthcare personnel and infusion therapy patients. *J Intravenous Nursing*, 1994. 17(1): p. 35-39. Handwashing - Gloves.
- The health care arena has been dramatically impacted by the implementation of universal precautions and OSHA standards, mandating the use of disposable gloves. These directives promote the judicious use of gloves as a barrier against contact with blood and body fluids. An increasing number of hypersensitivity reactions to latex are being reported by the medical community. The FDA cites that 6%-7% of surgical personnel are latex sensitive as well as 18%-40% of spina bifida patients. Sensitivity reactions range from mild delayed symptomatology in the form of eczematous contact dermatitis, to severe systemic reactions including death. Besides gloves, latex is found in catheters, i.v. tubing, injection caps and anesthesia masks. Latex sensitivity creates yet another infusion therapy challenge for the i.v. clinician.
195. Marler, B., Make a habit of proper hand washing. Online Blog, 2006. Handwashing.
- Marler Blog - Food Poison Blog. An article from the Lindsay Daily Post written by Catherine Whitnall about Handwashing.
196. Martin, R., Food-borne disease threatens industry. *Nation's Restaurant News*, 1990(January 8): p. 27, 30. Handwashing.
- Foodservice experts agree that lax standards of hygiene and other microbiological pitfalls pose growing threats to public health and the image of the restaurant industry. .
197. Matthews, J.A., and Newsom, S.W.B., Hot air electric hand driers compared with paper towels for potential spread of airborne bacteria. *J. Hosp. Inf.*, 1987. 9: p. 85-88. Handwashing - Michaels.
- Hot air hand driers are used both in public areas and hospitals. Four units were examined by comparing the bacterial aerosols released from hands during use by sets of twelve subjects with those released by paper towels. Tests on two units also included hand imprints of agar plates for detection of residual bacteria. No significant difference between aerosols released by towels and driers were observed for two units, while two units had significantly fewer aerosols than towels. Impression plates revealed similar numbers of bacteria on the hands after drying by either method. Hot air hand driers appear safe from a bacteriological viewpoint. 2.
198. Mayo Clinic, Handwashing: A simple way to prevent infection. Online Article, 2006. Handwashing - Antimicrobial.

[<http://edition.cnn.com/HEALTH/library/HQ/00407.html>]. Hand washing is a simple habit — one that requires minimal training and no special equipment. Yet it's one of the best ways to avoid getting sick. This simple habit requires only soap and warm water or an alcohol-based hand sanitizer — a cleanser that doesn't require water. Do you know the benefits of good hand hygiene and when and how to wash your hands properly? Dangers of not washing your hands; Proper hand-washing techniques; Proper hand washing with soap and water; Proper use of an alcohol-based hand sanitizer; When should you wash your hands; Kids need clean hands too; A simple way to stay healthy.

199. Mbith, J.N., Springthorpe, V.S., and Sattar, S.A., Comparative in vivo efficiencies of hand-washing agents against hepatitis A virus (hm-175) and poliovirus type 1 (sabin). *Appl Environ Microbiol*, 1993. 59(10): p. 3463-3469. Handwashing.

The abilities of 10 hygienic hand-washing agents and tap water (containing approximately 0.5 ppm of free chlorine) to eliminate strain HM-175 of hepatitis A virus (HAV) and poliovirus (PV) type 1 (Sabin) were compared by using finger pad and whole-hand protocols with three adult volunteers. A mixture of the two viruses was prepared in a 10% suspension of feces, and 10 microliters of the mixture was placed on each finger pad. The inoculum was allowed to dry for 20 min, and the contaminated area was exposed to a hand-washing agent for 10 s, rinsed in tap water, and dried with a paper towel. In the whole-hand protocol, the hands were contaminated with 0.5 ml of the virus mixture, exposed for 10 s to a hand-washing agent, washed, and dried as described above. Tryptose phosphate broth was used to elute any virus remaining on the finger pads or hands. One part of the eluate was assayed directly for PV with FRhK-4 cells, while the other part was first treated with a PV-neutralizing serum and then assayed for HAV with the same cell line. The results are reported as mean percentages of reduction in PFU compared with the amount of infectious virus detectable after initial drying. (ABSTRACT TRUNCATED AT 250 WORDS) More work is needed to determine the health implications of residual infectious viruses on washed hands, but our findings reinforce the need to determine the virus-eliminating efficiencies of hand-washing products, particularly those used in health care settings, day-care centers, and food establishments.

200. McCormick, R.D., Buchman, T.L., and Maki, D.G., Double-blind, randomized trial of scheduled use of a novel barrier cream and an oil-containing lotion for protecting the hands of health care workers. *Am J Infect Control*, 2000. 28(4): p. 302-310. Handwashing - Antimicrobial.

Context: Many health care workers suffer severe hand irritation, with cracking and bleeding, as a consequence of frequent handwashing and glove use. Integumentary breakdown has major implications for nosocomial infection control and promotes the spread of bloodborne viruses. The potential benefits of scheduled use of hand-care agents—lotions or creams—in health care workers has not been established by controlled trial. Objective: To compare the value of an oil-containing lotion with a novel barrier skin cream in health care workers with severe hand irritation. Design: Prospective, randomized, double-blind trial. Setting: University medical center. Participants: Fifty-four health care workers from multiple departments with severe hand irritation, 74% with one or more full-thickness cracks or other integumentary breaks. Main Outcome Measures: Objective and subjective parameters for scaling, cracking, weeping, bleeding, and pain were scored by two blinded investigators weekly for 4 weeks, and the hands of subjects were cultured quantitatively at the onset and after 2 weeks and 4 weeks. Results: Subjects in both groups experienced marked improvement in overall hand condition (each,  $P < .02$ ), particularly in scaling, cracking, and pain. Persons randomized to use of the oil-containing lotion showed greater improvement (mean score, from 6.5 to 2.7 vs 6.8 to 4.7,  $P = .006$ ). In 18 (69%) of 26 persons who used the control lotion, all full-thickness integumentary breaks were healed and pain was totally resolved, compared with 14 (52%) of 27 persons who used the barrier cream ( $P = .26$ ). Use of the two agents in a scheduled fashion had no effect on the levels or profile of the transient hand flora. However, by the fourth week of use, handwashing frequency was 50% higher in subjects randomized to use the control lotion than it was in subjects randomized to use the barrier cream (17.8 vs 11.7 times per day,  $P = .04$ ). Conclusion: Use of an oil-containing lotion or a barrier cream on a scheduled basis can substantially protect the hands of vulnerable health care workers against drying and chemical irritation, preventing skin breakdown and promoting more frequent handwashing. (*AJIC Am J Infect Control* 2000;28:302-10).

201. McGinley, K.J., Larson, E.L., and Leyden, J.J., Composition and density of the microflora in the subungula space of the hand. *J. Clin. Microbiol.*, 1988. 26(5): p. 950-953. Handwashing.

There were significant quantitative differences in the composition and density of microflora in different areas of the hands of 26 adult volunteers. The subungual spaces had an average log<sub>10</sub> CFU of 5.39, compared with a range from 2.55 to 3.53 for other hand sites. In quantitative cultures from five subungual spaces in 26 subjects, coagulase-negative staphylococci were the dominant organisms with *S. epidermidis*, *S. haemolyticus* and *S. hominis* being the most frequently isolated species. Other bacteria recovered from subungual spaces included gram-negative bacilli in 42.3% of subjects with *Pseudomonas* species composing 31.3% of this group, and coryneforms making up 12.5%. Yeasts were isolated from 69.0% of subjects samples, with 51.3% of the yeasts identified as *Candida parasilosis*. The subungual coagulase-negative staphylococci were susceptible to most antibiotics, with resistance to penicillin, ampicillin, and erythromycin detected in 23 to 38% of isolates.

202. McGuckin, M., et al., Evaluation of a patient education model for increasing hand hygiene compliance in an inpatient rehabilitation unit. *Am J Infect Control*, 2004. 32(4): p. 235-238. Handwashing.

Background: Transmission of microorganisms from the hands of health care workers is the main cause of health care-acquired infections. Recent studies on bacterial contamination of hands by medical care specialty found the highest bacterial contamination on the hands of health care workers from rehabilitation units. The objective of this study is to determine the effect of a patient education model on hand hygiene (HH) compliance in a rehabilitation unit. Methods: A 6-week pre- and post-intervention study with a 3-month follow-up using a patient education model was conducted in a 24-bed inpatient rehabilitation unit located in an acute care hospital. Thirty-five patients were enrolled in the intervention phase of the study after agreeing to ask all health care workers who had direct contact with them, "Did you wash/sanitize your hands?" Compliance with the program was measured through soap/sanitizer usage per resident-day before, during, and after the

- intervention. Results: Usage increased from 5 HH per resident-day during the preintervention to 9.7 HH per resident-day during the intervention ( $P < .001$ ), 6.7 HH per resident-day postintervention (6 weeks) ( $P < .001$ ), and 7.0 HH per resident-day at 3 months ( $P < .001$ ). Conclusions: Patient education increased HH compliance in an inpatient rehabilitation unit by 94% during the 6-week intervention, 34% during the 6 week post intervention, and 40% at 3-month follow-up. This program empowers patients with responsibility for their own care and provides ongoing HH education. Article Outline: 1. Methods 1.1. Setting 1.2. Study design 1.3. Intervention 1.4. Components of the Partners in Your Care program 1.5. Health care worker 1.6. Family 1.7. Data collection/analysis 2. Results 3. Discussion Acknowledgements References.
203. MDA, Hand sanitizers and single-use gloves. Fact Sheet, 2001. Handwashing - Gloves.  
Hand sanitizers, Single use gloves - when to use single-use gloves. Produced by the Minnesota Department of Agriculture, Dairy and Food Division. (<http://www.mda.state.mn.us/dairyfood/factsheets/gloves.html>).
204. Meers, P.D. and Leong, K.Y., Hot-air hand driers. *J. Hosp. Infect.*, 1989. 14: p. 169-171. Handwashing - Michaels.  
(In letters to the Editor section.) Although hot air hand driers may be criticized for being noisy or for taking too long to complete their task, our experiment leads us to agree with Matthews and Newsom (1987) that there is not bacteriological reason to exclude them from clinical areas. 2.
205. Mellstrom, G., Protective gloves of polymeric materials - experimental permeation testing and clinical study of side effects. *Acta Derm Venerol Suppli (Stockh)*, 1991. 163: p. 1-54. Handwashing - Gloves.  
In the occupational use and handling of hazardous chemicals and infectious materials, exposure must be minimized. To diminish the risk of direct skin contact and percutaneous toxicity, the use of protective gloves is one of the most important measures to consider. For effective protection, the selection process must include evaluation of permeation test data as well as the risk of side effects possibly caused by the glove materials. In permeation testing (in vitro), breakthrough time and permeation rate are key values measured. Test conditions such as size and design of the permeation test cell, flow rate of the collecting medium through the test cell, measurement systems, testing procedures and analytical equipment can vary and can have crucial influence on the test results. In the present investigation, five permeation test cells of different sizes and design were used, the collecting gas flow rate was varied between 60 and 120 ml/min and 120 to 500 ml/min, the ASTM F 739 and ISO/DIS standard test procedures were performed using two different measurement systems, and in vitro versus in vivo testing techniques were studied. Gloves and glove materials of neoprene were exposed to four organic solvents. The breakthrough times (in vitro) for the test chemicals were slightly influenced by variations in cell size and design, flow rate and test procedure. The only significant influence on the breakthrough time values was between the two measurement systems, direct flow and automatic sampling. On the other hand, the permeation rate values were affected to a much greater extent, in most cases significantly. The test conditions in the in vitro and in vivo procedures differed in many ways and the test results were therefore compared on a relative basis. The breakthrough time values for the solvents through gloves of vinyl, natural rubber and butyl rubber were in the same rank order in both in vitro and in vivo testing. There was no evident correlation between the relative permeation rate values (in vitro) and the relative absorption rate values (in vivo). Disposable gloves of latex or plastic materials are also commonly used in health care as protection against microorganisms. Therefore contact with disinfectants is frequent. The resistance of gloves made of natural rubber latex, vinyl (PVC) and polyethylene to permeation by ethanol, isopropanol, m-chlorocresol and glutaraldehyde-based disinfectant was studied mainly according to the ISO/DIS permeation test procedure. In addition, glove pieces exposed to isopropanol and ethanol were studied with the scanning electron microscope (SEM). (ABSTRACT TRUNCATED AT 400 WORDS) When selecting protective gloves, both permeation test data and the risk of side effects must be considered. Knowledge in both these areas is important, as this may result in recommendations on the use of gloves that will prolong the protection and reduce the risk of side effects. Introduction, Glove types and materials, Rules and regulations, Testing of the protective effect against chemicals, Protection against blood-borne infections, Side effects of using protective gloves, Information on test results; Aims of the study; Investigations; Materials and Methods, Results; General discussion; Conclusions. Summary.
206. Mendes, M.F. and Lynch, D.J., Bacteriological survey of washrooms and toilets. *J. Hyg. Camb.*, 1976. 76: p. 183-190.  
Handwashing.  
A survey of the bacterial flora present at various positions in 130 male and female washrooms and toilets is reported. Several bacteria of faecal origin were found in large numbers: the areas likely to be the most important sources of cross-infection from faecal contamination are indicated. The results are used to assess priorities for disinfection.
207. Michaels, B., Personal hygiene hazard analysis. Report, 1999. Handwashing - Michaels.  
We hope that this presentation makes it apparent how personal hygiene is more than wash hands, clean fingernails and use sanitizers or gloves. The process is much more complicated than that and fraught with negative endpoints which have been documented in nearly 140 years of continuous advancements in the area of handwashing/personal hygiene microbiology. Ultimately, the success of a personal hygiene process depends on validation and verification and tools are now available to help achieve that. Effective Personal Hygiene - Navigating Around Negative Endpoints.
208. Michaels, B., Focus on personal hygiene through HACCP. *International Food Hygiene*, 2002. 12(7): p. 17-19. Handwashing - Michaels.  
The importance of personal hygiene in the food industry is discussed, with particular reference to incorporation of effective hand washing procedures in HACCP systems. Aspects considered include: evidence that a significant proportion of foodborne disease outbreaks are caused by contamination from handling (particularly in food service establishments); the need to consider effective hand washing as a critical control point in systems involving handling of foods; transmission of microorganisms between handler and food; the need for standardized and thorough hand washing procedures; and a description of the key elements for an effective sanitary hand washing technique, including performance aspects and correct steps to take with regard

- to the hand washing station, hand washing process, rinsing, hand drying, fingernail cleaning, use of gloves, hand washing frequency, skin condition and use of instant hand sanitizers. <http://www.highfield.co.uk/docs/papers/BarryMichaels.htm>.
209. Michaels, B., Handling money and serving ready-to-eat food. *Food Service Technology*, 2002. 2(1): p. 1-3. Handwashing - Michaels.
- Abstract Handling money and ready-to-eat food with the same gloved hands or without hygiene intervention between these activities can introduce the risk of cross-contamination to foods provided in food service establishments. Accumulated data obtained over the last 20 years on the microbial status and survival of pathogens on coins and currency notes indicates that this could represent a potential cause of sporadic cases of food borne illness. Survival of various microorganisms of concern on money is such that it could serve as a vehicle for transmission of disease and represents an often overlooked enteric disease reservoir. With low infectious doses capable of causing illness noted for a number of different infectious intestinal diseases, failure to adequately sanitize hands, or use food handling tools (tongs, spoons, utensils or bakery/serving papers) between handling money and serving food, could put patrons at risk. [ABSTRACT FROM AUTHOR].
210. Michaels, B., Handwashing: An effective tool in the food safety arsenal. *Food Quality*, 2002. 9(5): p. 45-53. Handwashing - Michaels.
- The importance of handwashing by food handlers is discussed. Aspects considered include: contribution of lax personal hygiene to food poisoning outbreaks; development of hygiene-related handwashing practices by different cultures since ancient times; effectiveness of proper handwashing and drying in protection against foodborne illness risk; and methods for encouraging handwashing compliance among food workers.
211. Michaels, B., Skin sampling techniques. *Handbook of Topical Antimicrobials*, 2002. Handwashing - Antimicrobial.
- From the *Handbook of Topical Antimicrobials: Industrial Applications in Consumer Products and Pharmaceuticals* #26. This is an review of skin sampling tests. "Methods used to sample the microbial status of human skin can be conveniently grouped into four main categories in which eight principal test methods are employed. Each of these methods may be performed with modifications, some of which link and integrate two or more of these methods. They include: Methods Involving Skin/Stratum Corneum Removal, Nondestructive Direct Sampling, Washing Methods and Other."
212. Michaels, B., Understanding the glove risk paradigm: Part 1 and part 2. *Food Safety Magazine*, 2004(August-September). Handwashing - Michaels.
- Overarching article on gloves proper use, problems, and review of brand gloves in relation to food service. Suggestions: 1) Consider working load and tensile strength of the gloves you are using. 2) Check for allergic reaction potential and insure skin health. 3) Size gloves properly and consider ease of donning and comfort of fit. 4) Ensure proper hand washing and glove-changing protocols. 6) Single-use and multi-use gloves are mutually exclusive. 2. Both Part 1 and Part 2 of this article are included. .
213. Michaels, B., There's more to it at hand: Glove effectiveness at reducing risk is built on the solid prerequisite of good hand hygiene. *Food Quality*, 2005(Feb-Mar): p. 71-75. Handwashing - Michaels.
- Different types of gloves available for food handlers are discussed, together with criteria that should be considered when deciding which type to use, including: effectiveness of barrier properties; alternatives to latex, to avoid allergy problems; durability; compliance with US regulations; single and multi-use options; and physical properties. Advantages and disadvantages associated with different types of glove materials used in the food industry are also described.
214. Michaels, B., Sanitary hazards associated with hot air hand dryers. Report, n.d. Handwashing - Michaels.
- In summary, the number of bacteria present after hand washing and drying with paper towels is significantly reduced, while the use of hot air hand dryers actually increases this number.
215. Michaels, B., et al., Efficacy of alcohol gel instant hand sanitizer when used in conjunction with normal handwashing. *J Food Protect*, 2002. 65: p. 110. Handwashing - Michaels.
- In this study, 3 subjects on each of 6 days contaminated hands with *Serratia marcescens* in Tryptone Soya Broth. One hand was sampled to establish normal microflora and transient microflora baseline counts using the glove juice technique. While there were significant increases in efficacy in almost all instances, as quality of alcohol gel instant hand sanitizers increased, a significant difference in efficacy over handwashing alone is seen only when larger quantities (3ml & 6ml) of alcohol gel are employed. Abstract Only.
216. Michaels, B. and Ayers, T., Handwashing (and drying) - the most effective means of reducing the risk of infection. Report, 2002. Handwashing - Michaels.
- Proceedings Book: *Food Safety MMII*. Pages 151-168. Abstract: The benefit of handwashing (HW) has been known for thousands of years, yet preventable morbidity and mortality due to infectious diseases remain extremely high in all sectors of the global society. Experiments show normal HW to be very effective at removing transient microflora from hands. Symbiotic resident flora is more difficult to remove. HW efficacy of 2-3 Log<sub>10</sub> and 0.2 -0.4 log<sub>10</sub> reductions against transient and resident floras, respectively, are commonly demonstrated. Through metaanalysis of similarly conducted experiments designed to show the hygienic efficacy of HW, models can be constructed quantifying the effectiveness of each component. A number of studies have shown a reduction in diseases rates and hospital infections as well as interruption of outbreaks in progress by basic HW, yet overall, HW compliance (HWC) is low. Over the years, many different approaches have been used to improve HWC, with each venue unique. While social marketing is useful at the household level, commitment and training on the part of commercial and institutional management must address reasons for poor HWC, such as lack of time, education, and motivation or supply availability, as well as complaints of skin damage. Use of Glo-Germ and UV light works well for training at all levels, improving efficacy and motivation. The most promising intervention measure discovered to date consist of hygiene monitoring

- devices. These have the ability to satisfy HACCP guidelines by monitoring, documenting and verifying (MDV) worker hygiene HWC.
217. Michaels, B., Ayers, T., and Birbari, W., Hygiene issues associated with food service potholders and oven mitts. *Food Service Tech*, 2002. 2: p. 81-86. Handwashing - Michael.
- Food service kitchen oven mitts and potholders are indispensable forms of personal protective equipment (PPE). As mitts and potholders are often contaminated with both raw and cooked food soils that support microbial survival and growth, it has been suggested that they present a possible risk to food safety. To ascertain the extent to which these items might contribute to cross-contamination, 10 dirty oven mitts and 3 dirty potholders obtained from a variety of establishments in the US were surveyed for microbial populations. Aerobic plate counts (APC) as high as  $7 \times 10^6$  colony forming units (CFU) were found on outer surfaces. Potholders taken from a hospital kitchen were found to have approximately  $10^6$  CFU coliforms and *B. cereus*. Overall, samples examined were seen to have high coliform, *B. cereus*, and *Pseudomonas* spp. counts with occasional *C. perfringens* found. Interior surfaces of mitts, while lower than exterior (geometric mean APC  $1.2 \times 10^5$  versus  $6.0 \times 10^4$ ), were also found to be contaminated with *S. aureus*. While no *E. coli*, *Listeria* spp. or *Salmonella* spp. were found, indications are that food service PPE offering thermal protection can become contaminated and may, in turn, contaminate hands and food, unless frequently cleaned or sanitized. [ABSTRACT FROM AUTHOR].
218. Michaels, B., et al., Inactivation of refrigerator biofilm bacteria for application in the food service environment. *Food Service Tech*, 2001. 1: p. 169-179. Handwashing - Michaels.
- Refrigerator biofilm formation in food environments can result in spoilage and food safety problems. Biofouling of food contact surfaces are difficult to combat, and while there are significant risks involved with tolerating their presence, methods for their removal are not commonly available. In this study, biofilms were grown on plastic refrigerator trays. Cultures of mixed wild strains were started using kitchen scraps suspended in nutrient broth. Biofilms were allowed to mature with approx. 109 cfu/tray test area. Spoilage species identified included *Pseudomonas putida*, *Sphingobacterium multivorum*, *Citrobacter freundii* and *Proteus vulgaris*. A series of 39 different treatment interventions were trialed during 3 different biofilm test runs. Results obtained from treatments ranged from a  $<1 \log_{10}$  reduction for light duty cleaning operations to a  $>5 \log_{10}$  reduction involving more complex treatment methods. The latter included combinations of hot soapy water (75 degrees C), scrubbing treatment with high pH (12.0) cleaners followed by acetic acid (vinegar) exposure, and pre- and post-treatment wiping with paper towels.
219. Michaels, B., et al., Relevance of healthcare handwashing water temperature to hygienic efficiency and skin condition when bland or antimicrobial soaps are used. Conference Abstract, 2003. Handwashing - Michaels.
- Abstract Only - From APIC 30th Annual Conference and International Meeting. Conclusion: Water temperature had no effect on hand hygiene efficacy of bland soap. Antimicrobial soaps are slightly more active as water temperature increases; however, resultant skin damage represents a potential barrier to hand hygiene compliance. To maximize compliance, hand hygiene recommendation should only recognize that water be running or adjusted to a comfortable water temperature.
220. Michaels, B., et al., Evaluation of selective handwashing water temperatures & antimicrobial soaps on hygienic efficiency and skin irritation. Powerpoint, 2001. Handwashing - Michaels.
- IAFP 88th Annual Meeting Presentation.
221. Michaels, B., et al., Tribute to bath tissues. Powerpoint, 2001. Handwashing - Michaels.
- IAFP 88th Annual Meeting Presentation.
222. Michaels, B., et al., Microbiological survey of hot-air hand dryers. Powerpoint, 2001. Handwashing - Michaels.
- IAFP 88th Annual Meeting Presentation.
223. Michaels, B., et al., Optimization of paper towel hand drying during normal handwashing processes. Conference Abstract, 2003. Handwashing - Michaels.
- Abstract Only - From APIC 30th Annual Conference and International Meeting. Conclusion: Research described demonstrates the critical importance of hand drying in maximizing reduction of transient and resident bacteria. The effects of hand drying are rapid based more on friction than absorbency and paper towel dispenser mechanisms can represent infectious hazards contributing to cross-contamination.
224. Michaels, B., et al., Significance of hand drying after hand washing. Report, n.d. Handwashing - Michaels.
- The effective removal of microorganisms from hands during the handwashing process has been termed "hygienic efficiency", and is the result of mechanical friction (scrubbing), the lifting action of soap, effects of thorough rinsing, and drying. While various aspects of this hygiene process have been studied, hand drying for the most part has been overlooked. In this handwashing experiment, the hands of test subjects were contaminated artificially with *Serratia marcescens*, which, along with resident flora counts, were used to evaluate the efficacy of the handwashing and drying process. Using an experimental procedure calling for a pre-wash hand rinse, a 98% and 35% reduction of transient and resident bacteria, respectively, was shown when hands were washed with an E1 antimicrobial soap and dried with paper towels. In experiments using the same pre-wash rinse and paper towel drying only, a 90% reduction in transient and 35% reduction in resident flora was seen. This confirms earlier work quantifying the effectiveness of paper towels in reducing bacterial counts on hands. This data, in combination with results from similar handwashing and drying experiments, allows the construction of a hygiene model, which demonstrates the critical importance of hand drying in maximizing reduction of transient and resident bacteria.
225. Michaels, B., et al., Effectiveness of cleaning methodologies used for removal of physical, chemical and microbiological residues from produce. *Food Service Tech*, 2003. 3: p. 9-15. Handwashing - Michaels.
- An increasing number of disease outbreaks have been associated with produce, while pesticide levels continue to be a safety concern. With increased health awareness, fresh produce consumption has increased. As there is a need for microbial and pesticide removal intervention measures of proven efficacy to maintain confidence in food service produce preparation, a series

of experiments were undertaken. Produce cleaning methods were tested by measuring removal of gross dirt, wax and environmental contaminants present on produce surface. Tests were performed on apples, cucumbers and lemons using water wash, produce brush, produce cleaner, produce cleaner with paper towel wipe, and water wash and paper towel wipe. Water rinse and paper towel dry was found superior to all other methods tested. Apples contaminated with a cocktail of pesticides were tested in waxed and unwaxed state. Following cleaning by various methods, including produce wash and produce brush, pesticides on skins were extracted and analyzed to determine concentrations of organophosphorous and organochlorine pesticides. In these experiments, it was shown that any treatment that included wiping with paper towels showed increased effectiveness over similar treatments or controls. Microbial efficacy experiments were performed involving 21 different types of laboratory inoculated produce. Two types of inoculum were employed, Tryptone Soya broth (TSB) and ground beef. After inoculation, produce was cleaned by dry wiping with paper towel, using water wash air dry, water wash paper towel dry or dipped in 200 p.p.m. chlorine dip for either 5 s or 1 min and compared to baseline values. One-minute dip in 200 p.p.m. chlorine solution was more effective than rinsing and drying with a paper towel when TSB inoculum was used ( $P < 0.05$ ). The effectiveness of the 200 p.p.m. chlorine dip diminished if ground beef was used as a test inoculum, with water rinse and paper towel providing significantly ( $P < 0.05$ ) improved results. The efficacy shown by paper towels usage in this diverse set of experiments is based on frictional removal of offending soils.

226. Michaels, B., et al., Handwashing water temperature effects on the reduction of resident and transient (*Serratia marcescens*) flora when using bland soap. Dairy Food and Environmental Sanitation, 2001. 21(12): p. 997-1007. Handwashing - Michaels.

For many years, sanitarians have specified that hands be washed using warm or hot water to reduce cross-contamination risks, with various authors indicating temperatures between 38°C and 48.9°C. However, it has been suggested that these temperatures may contribute to skin damage when frequent handwashing is necessitated (in health care and food service). This study evaluates the bacterial reduction efficacy of water temperature during normal handwashing. The hands of two groups of four experimental subjects were soiled with sterile or contaminated substances (tryptic soy broth and hamburger meat). Uninoculated menstruum was used to study the effects of treatment temperatures on resident microflora reduction, while *Serratia marcescens*-inoculated menstruum was used to study treatment effects on transient microorganism reduction. Following contamination with appropriate media, one hand was immediately sampled to obtain baseline (control) data, using the "glove-juice" technique for microorganism recovery. Hands were then moistened with water at the assigned temperature (4.4°C, 12.8°C, 21.1°C, 35°C or 48.9°C), washed 15 s with bland soap, and rinsed 10 seconds at the same temperature as was used before; and the opposing hand was then sampled. Results indicate that water temperature has no effect on transient or resident bacterial reduction during normal handwashing when bland soap is used. 2. Original Report also owned.

227. Michaels, B., et al., Water temperature as a factor in handwashing efficacy. Food Service Technology-Food Service Techniques, 2002. 2(3): p. 139-144. Handwashing - Michaels.

For many years, sanitarians have specified that the hands of food service workers should be washed and rinsed in warm or hot water to reduce the risk of cross contamination and disease transmission. In the food service environment, it has been suggested that handwashing with water at higher temperatures contributes to skin damage when frequent handwashing is necessitated, and that insistence on hot water usage is a deterrent to handwashing compliance. Separate handwashing studies involving different water temperatures and soap types (antibacterial versus nonantibacterial) were performed. The 'glove-juice' technique was employed for microbial recovery from hands in both studies. Initial work evaluated antimicrobial efficacy based on water temperature during normal handwashing with bland soap. Uninoculated, sterile menstrua (tryptic soy broth or hamburger meat) was used to study the effects of treatment temperatures (4.4°C, 12.8°C, 21.1°C, 35°C or 48.9°C) on the reduction of resident microflora, while *Serratia marcescens*-inoculated menstrua was used to evaluate treatment effects on the reduction of transient contamination. Results of this first study indicated that water temperature exhibits no effect on transient or resident bacterial reduction during normal handwashing with bland soap. The follow-up study examined the efficacy and skin irritation potential involving water temperatures with antimicrobial soaps. Hands of participants were contaminated with *Escherichia coli* inoculated ground beef, washed at one of two water temperatures (29°C or 43°C) using one of four highly active (USDA E2 equivalency) antibacterial soaps having different active ingredients (PCMX, Iodophor, Quat or Triclosan). Skin condition was recorded visually and with specialized instrumentation before and after repeated washing (12 times daily), measuring total moisture content, transepidermal water loss and erythema. Overall, the four soap products produced similar efficacy results. Although there were slight increases in Log<sub>10</sub> reductions, visual skin irritation, loss of skin moisture content and transepidermal water loss at higher temperatures, results were not statistically significant for any parameter.

228. Michaels, B., et al., Prevention of food worker transmission of foodborne pathogens: Risk assessment and evaluation of effective hygiene intervention strategies. Food Service Technology, 2004. 4(1): p. 31-49. Handwashing.

The infected food handler can be responsible for the transmission of infectious intestinal diseases (IID) caused by foodborne pathogens. It is believed that personal hygiene practices with varying levels of complexity can help prevent foodborne pathogens from entering the food chain. Overall, it has been difficult to reach a consensus among stakeholders on precisely which intervention measures should be employed in food handling environments to effectively reduce IID rates. Through a study of over 300 reports of outbreaks attributed to ill or asymptomatic food handlers, hazards and contributory factors responsible for foodborne illness outbreaks were identified. With the use of the risk analysis software platforms of Analytica®, @Risk, and GoldSim®, models were created to explore measures of hygiene effectiveness. Through the use of appropriate models, results of various personal hygiene intervention measures were explored for the development of preventive management strategies, designed to improve food-handling practices at various levels of the food chain. These included exclusion of ill food handlers, vaccination for hepatitis A virus, handwashing combined with drying, wearing of gloves, and use of instant hand sanitizers and fingernail brushes. This was accomplished by modeling pathogen transfer and transmission routes

- from food handler via foods, beverages and common contact surfaces using GoldSim® and Monte Carlo simulations. A lottery model was also created to understand risk as an interrelated overlapping extremes driven system, comprised of the three components of hygiene frequency, efficacy and cross-contamination. Data gaps were identified with respect to areas where considerable variability and uncertainty exists in order to establish research priorities. Abstract Only.
229. Michaels, B., et al., Effective food worker hygiene interventions: A risk assessment approach. *J Food Protection*, 2003. 66(Sup. A): p. 59-191. Handwashing - Michaels.
- Commercial food workers play a significant role in transmission of infection caused by foodborne pathogens. This symposium reviews results from a number of studies related to foodworker hygiene, including EHS-net focus group data obtained from food workers and managers concerning facilitators and barriers to safe food handling. Abstract Only.
230. Michaud, R.N., McGrath, M.B., and Goss, W.A., Application of a gloved-hand model for multiparameter measurements of skin-degerming activity. *J. Clin. Microbiol.*, 1976. 3(4): p. 406-413. Handwashing - Binder.
- The application of an established gloved-hand model to multiparameter measurements of skin-degerming activity is described. In particular, appropriate experimental designs are illustrated which allow characterization of the performance of topical skin-cleansing preparations in terms of rapid, sustained, cumulative, and persistent skin-degerming effects on the hand. Single-contact studies were used to define the degerming activity profiles of selected commercial surgical scrub preparations, and to establish the optimal post-treatment sampling interval for individual preparations. Rapid and sustained skin-degerming effects were measured and contrasted. Rapid skin degerming activity, namely, that occurring on the gloved hand during a post-contact interval, was shown and characterized for two hexachlorophene preparations. Multiple-contact studies with a 3% hexachlorophene preparation were used to illustrate cumulative and persistent skin-degerming effect. Cumulative skin-degerming activity was demonstrated in terms of progressive bacterial reductions after repeated contacts within a single day. Persistent skin-degerming activity was shown in terms of the profile of daily pretreatment bacterial counts after multiple contacts over successive days. Uniformity of treatment response was established for a broad range of pretreatment bacterial counts extending from approximately log 4 to log 7 per hand. The importance of the pretreatment bacterial count measurement and of adequate neutralization of hand extract samples is stressed. A randomized-hand experimental design is discussed relative to its versatility and amenability to statistical analysis.
231. Miller, M.L., James-Davis, L.A., and Milanese, L.E., Field study evaluating the effectiveness of different hand soaps and sanitizers. *Dairy, Food, and Environmental Sanitation*, 1994. 14(3): p. 155-160. Handwashing - Antimicrobial.
- Plain hand soaps, antimicrobial hand soaps, E2 rated hand soaps, and instant hand sanitizers were evaluated in a foodservice setting to determine their effectiveness in reducing bacteria on hands. The results showed that the three types of hand soaps were effective using a twenty second handwash procedure. The E2 rated hand soaps were significantly (90% confidence) more effective in reducing bacterial numbers than the plain or antimicrobial hand soaps. The instant hand sanitizers resulted in a significant increase in bacterial numbers on hand and may, therefore, be counterproductive for use in the foodservice industry.
2. 232. Montville, R., Washing away misconceptions about gloves and handwashing. Fact Sheet, 2003. Handwashing - Gloves.
- Answers questions about when you should wash you hands and ow you should wash your hand. Produced by Rutgers Cooperative Extension part of the State University of New Jersey (<http://www.rce.rutgers.edu/pubs/pdfs/fs991.pdf>).
233. Montville, R., Chen, Y., and Schaffner, D.W., Glove barriers to bacterial cross-contamination between hands to food. *J Food Prot.*, 2001. 64(6): p. 845-849. Handwashing - Gloves.
- Human hands are an important source of microbial contamination of foods. However, published data on the effectiveness of handwashing and glove use in a foodservice setting are limited. Bacterial transfer through foodservice quality gloves was quantified using nalidixic acid-resistant *Enterobacter aerogenes* (a nonpathogenic surrogate with attachment characteristics similar to *Salmonella*). Five transfer rates were determined: chicken to bare hand, chicken to hand through gloves, bare hand to lettuce, hand to lettuce through gloves (with low inoculum on hands), and hand to lettuce through gloves (with high inoculum on hands). At least 30 observations were made for each percent transfer rate using 30 individual volunteers. The logarithm of percent transfer data were then fit to distributions: chicken to bare hand, normal (0.71, 0.42); chicken to hand through gloves, gamma (5.91, 0.40, -5.00); bare hand to lettuce, logistic (1.16, 0.30); hand to lettuce through gloves (low inoculum), normal (0.35, 0.88); hand to lettuce through gloves (high inoculum), normal (-2.52, 0.61). A 0.01% transfer was observed from food to hands and from hands to food when subjects wore gloves and a 10% transfer was observed without a glove barrier. These results indicate that gloves are permeable to bacteria although transfer from hands to food through a glove barrier was less than without a glove barrier. Our results indicate that gloves may reduce both bacterial transfer from food to the hands of foodservice workers and in subsequent transfer from hands back to food.
234. Murray, P.R., Antisepsis, disinfection, and sterilization. Book Chapter 19, 1995. Handwashing - Antimicrobial.
- Control Methods - Hand washing, Semicritical items, Noncritical items, Changes since 1981; Problems with Disinfection of Hospital Equipment - Concerns with spaulding scheme, Surgical hand scrub, Preoperative patient skin preparation, Patient skin preparation at catheter site, Gloving, Hand lotions; Rational Approach to Disinfection and Sterilization - Critical items, Epidemiology, Antiseptic agents; Conclusion; References.
235. Muto, C.A., Sistrom, M.G., and Farr, B.M., Hand hygiene rates unaffected by installation of dispensers of rapidly acting hand antiseptic. *Am J Infect Control*, 2000. 28: p. 273-276. Handwashing - Antimicrobial.
- Objective: The objective of the study was to improve health care workers' compliance with hand hygiene after patient contact by use of an alcohol-based hand antiseptic. Design and Methods: Six commercially available alcohol-based hand antiseptics were evaluated. The one most pleasing to the evaluators' hands was selected for the study. Baseline handwashing rates were assessed on 2 medical wards. Alcohol dispensers were mounted by every door on the 2 wards. An educational campaign was conducted

with 4 weekly visits to these floors to remind and reinstruct staff about the use of the alcohol dispensers and to address questions. After 2 months handwashing rates were reassessed. Setting: The study was set in a university hospital. Results: The baseline handwashing rate was 60% (76/126). Physicians were most compliant (83%), followed by nurses (60%), technologists (56%), and housekeepers (36%). Two months later overall hand hygiene rates had decreased to 52% (P = .26). Nurses were most compliant (67%), followed by technologists (57%), physicians (29%), and housekeepers (25%). Physician compliance was associated with compliance by attending physicians whose example was usually followed by all other physicians on rounds. Conclusions: A brief educational campaign and installation of dispensers containing a rapidly acting hand hygiene product near hospital rooms did not affect hand hygiene compliance. The behavior of attending physicians was predictive of handwashing rates for all others in the attending's retinue. Compliance with handwashing after half of all patient contacts was a result of perfect compliance by some and total noncompliance by others being observed. (AJIC Am J Infect Control 2000;28:273-6).

236. Myers, J., Antibacterial versus regular soaps. Report, 2001. Handwashing - Antimicrobial.

Science Fair Report. Conclusion: "I learned from my experiment that the regular soaps were just as 'good' as the antibacterial soaps. My hypothesis was correct. All of the other scientists that performed the same results. They say, and I agree, that it is the amount of time and method of hand washing you use that determines the amount of bacteria left on your hands."

237. Namura, S., et al., Study of the efficacy of antimicrobial detergents for hand washing: Using the full-hand touch plates method. J Dermatol, 1993. 20: p. 88-93. Handwashing - Antimicrobial.

We studied the effects of four kinds of antimicrobial detergents, 4% chlorhexidine gluconate (CHG), chlorbenzarconium (CBC), 10% povidone-iodine (PVI), 0.3% triclosan (TRI), and one non-medicated detergent (NMD) using the full-hand touch plates method. Before and after 3 minutes of hand scrubbing with a brush, bacterial colonies on the hand surface and subungual bacteria were counted. CHG, CBC, and PVI were excellent antimicrobial detergents against hand surface bacteria, but most of the subungual bacteria remained. The subungual space was the most difficult region from which to eradicate bacteria. TRI was much less effective than hand soap against hand surface bacteria.

238. Negeow, Y.F., Ong, H.W., and Tan, P., Dispersal of bacteria by an electric air hand dryer. Malays J Pathol, 1989. 11: p. 53-6. Handwashing - Michaels.

The potential risk of an electric air hand dryer contributing to airborne infection in a hospital was investigated using a strain of *Serratia marcescens* and a strain of coagulase-negative, streptomycin-resistant *Staphylococcus*. Dispersal of marker bacteria by the air dryer was demonstrated within a radius of about 3 feet from the dryer and to the investigator's laboratory coat. When paper towels were used for hand drying, no dispersal of marker bacteria was demonstrated. It is suggested that air hand dryers are unsuitable for use in critical patient care areas as they may contribute to cross infection either via airborne dissemination or via contaminated personnel. Original article is in Dutch. But English translation also in Handwashing - Michaels box.

239. Neiburger, E.J., Latex gloves and manual dexterity: A study of 50 Midwest dentists. New York State Dental Journal, 1992(January): p. 24-28. Handwashing - Gloves.

Fifty practicing dentists were each given a series of tests to perform in their own offices with and without gloves on to determine how the use of gloves affected the performance of dental operations. While wearing gloves did not appreciably influence speed, it significantly reduced manual dexterity and light touch perceptions. And there was a high correlation between wearing gloves and hand dermatitis. Increased age was associated with a slight loss in speed and dexterity but not light touch perceptions. Women produced better scores than men in all tests.

240. Newsom, S.W.B. and Rowland, C., Application of the hygienic hand-disinfection test to the gloved hand. J Hospital Infection, 1989. 14: p. 245-247. Handwashing - Gloves.

The Austrian Standard Hygienic Hand-Disinfection Test was adapted for comparing the effect of washing artificially contaminated hands (using *Escherichia coli*) with contaminated gloved hands, using liquid soap and rinsing with water. Tests showed that a single soap wash completely removed all the bacteria from the glove, and was more than 1000 times more effective on the glove than on the hand.

241. Nicoletti, G., Boghossian, V., and Borland, R., Hygienic hand disinfection: A comparative study with chlorhexidine detergents and soap. J. Hosp. Infect., 1990. 15(323-337). Handwashing - Antimicrobial.

The efficacy of two chlorhexidine hand-wash detergents and liquid soap was compared in a laboratory trial using artificial contamination of fingers with *Micrococcus* and *Serratia*. Agents were assessed for both a rapid and sustained effect after a single contact, and for a cumulative persistent effect after multiple contact over four days. Disinfectant activities were compared by statistical analysis of log reduction factors and log count time gradients (decimal reduction times). The later analysis attempted accommodate significant subject variation in response to both agent and organism. All hand washing methods significantly reduced contamination levels. Both chlorhexidine formulations were significantly better than soap in their activity against *Micrococcus* but were not more effective than soap in removing contamination with *Serratia*. Both chlorhexidine preparations showed significant skin persistence and were generally acceptable to subjects after prolonged use. Some effect of the formulation of the hand-wash on chlorhexidine activity was demonstrated.

242. Noble, W.C., Dispersal of skin microorganisms. British J Dermatology, 1975. 93: p. 477-485. Handwashing.

Headlines: Skin as a source of organisms; Definition of a disperser; Dispersal as a hazard; Dispersal from hair; Reduction of dispersal; Intrinsic interest in dispersal.

243. Noble, W.C., Carriage of micro-organisms on skin. Book Chapter, 1980. Handwashing - Binder.

Chapter from Problems in the Control of Hospital Infection edited by Newsom, B., and Caldwell, A.D.S. part of the International Congress and Symposium Series No. 23. This chapter is a discussion of skin structure and predominant flora: *Staphylococcus*,

- Micrococcus, Peptococcus, Corynebacteria, Brevibacterium, Propionibacterium. Minority flora include: Streptococcus, Neisseria, Bacillus, Acinetobacter.
244. Nye, B., Ask Bill Nye: Antibacterial anything. onLine Article, 2007. Handwashing - Antimicrobial.  
Q&A: Q: There are so many antibacterial Items on the shelves these days, I'm not sure which to choose. Should I even use antibacterial anything? A: No. Mostly, no. Almost always no. Miracle of antibiotics - Old-fashioned way - Tougher Germs. (<http://encarta.msn.com/encnet/features/columns/?article=BNAntibacterialAnything>).
245. O'Boyle, C.A., Henly, S.J., and Larson, E., Understanding adherence to hand hygiene recommendations: The theory of planned behavior. *Am J Infect Control*, 2001. 29: p. 352-360. Handwashing.  
Background: Most health care workers (HCWs) are aware of the rationale for hand hygiene procedures, yet failure to adhere to guidelines is common. Little is known about factors that motivate HCWs to practice hand hygiene. Purpose: The purposes of this study were to (1) estimate adherence to hand hygiene recommendations; (2) describe relationships among motivational factors, adherence, and intensity of nursing unit activity; and (3) test an explanatory model for adherence to hand hygiene guidelines based on the theory of planned behavior (TPB). Method: A longitudinal, observational design was used to collect data from 120 registered nurses employed in critical care and postcritical care units. Nurses provided information about motivational factors and intentions and a self-report of the proportion of time they followed guidelines. At least 2 weeks later, the nurses' hand hygiene performance was observed while they provided patient care. Structural equation modeling was used to test the TPB-based model. Results: Rate of adherence to recommendations for 1248 hand hygiene indications was 70%. The correlation between self-reported and observed adherence to handwashing recommendations was low ( $r = 0.21$ ). TPB variables predicted intention to handwash, and intention was related to self-reported hand hygiene. Intensity of activity in the nursing unit, rather than TPB variables, predicted observed adherence to hand hygiene recommendations. Conclusions: The limited association between self-reported and observed hand hygiene scores remains an enigma to be explained. Actual hand hygiene behavior may be more sensitive to the intensity of work activity in the clinical setting than to internal motivational factors.
246. Ojajarvi, J., Evaluation of antiseptics used for hand disinfection in wards. *J. Hyg. (Camb.)*, 1976. 76: p. 75-82. Handwashing - Binder.  
The antibacterial effectiveness of hand antiseptics commonly used in wards was studied by laboratory and in-use tests and their acceptability assessed by means of a questionnaire passed to hospital staff. To determine the immediate and long-term antibacterial effects of the preparations, the in-use tests were performed by groups of students. The greatest immediate reduction in bacterial counts on has was obtained by products containing chlorhexidine. The long term antibacterial effect was recorded with emulsions containing 3% hexachlorophane, 2% Irgasan CRF3R or 4% chlorhexidine when used constantly on several consecutive days. Considerable discrepancies were recorded in the antibacterial effectiveness of some preparations when comparing laboratory and in-use test results. Therefore it is suggested that antiseptics should be tested by in-use tests which more closely resemble practical conditions before their use, or further trial, in hospital.
247. Ojajarvi, J., Effectiveness of hand washing and disinfection methods in removing transient bacteria after patient nursing. *J. Hyg. (Camb.)*, 1980. 85: p. 193-203. Handwashing - Binder.  
The effectiveness of various hand washing and disinfection methods in removing transient skin bacteria was studied in hospital after dry or moist contamination of the hands when nursing burn patients. The results were compared with those of laboratory tests with volunteers. A fairly good correlation of the bacterial reductions existed between hospital and laboratory tests. All other methods removed *S. aureus* from the hands more effectively than liquid soap. Gram-negative bacilli were more easily removed than staphylococci, even with soap wash alone. In hospital, none of the washing and disinfection methods always removed all patient-borne bacteria from the hands. After dry or moist contamination and subsequent washing with soap only, colonies of *S. aureus* were after detected in finger-print samples. Staphylococci were more often completely removed by a 4% chlorhexidine detergent scrub and alcoholic solutions (either with or without previous soap wash) than by liquid soap, hexachlorophene or iodophor preparations. Gram-negative bacilli were more easily removed by all the washing and disinfection methods. After moist contamination, Gram-negative bacilli were more completely removed from the hands by ethanol than by other treatments. The results of the present study emphasize the importance of always using gloves when nursing a profuse spreader of bacteria or one who must be protected from infection.
248. Ojajarvi, J., Importance of soap selection for routine hand hygiene in hospitals. *J. Hyg. Camb.*. 1981. 86: p. 275-283. Handwashing - Antimicrobial.  
Five different types of liquid soap were studied in hospital wards, each during two month's use. Altogether 1306 finger print samples were taken from the hands of the staff by sampling twice a week and the acceptability of the soaps was measured by a questionnaire. During the use of different soaps, only slight differences were found in the numbers of total bacteria or in the occurrence of *S. aureus* and gram-negative bacilli on the hands. During the use of the emulsion-type product studied, several persons who had dermatological problems had lower mean bacterial counts of the fingers than during the use of the other soaps. This soap was favorably accepted by the staff. After over 1 year's use of pine oil soap and alcohol, the staff was satisfied with the method. However, several persons with skin problems admitted to using no soap or alcohol. The considerable differences found in the acceptability of soaps imply that for use in hospital the choice of a soap acceptable to the nursing staff is important in promoting proper hand hygiene.
249. Oldenburg, D., Wash up! Dirty hands can have tragic, deadly consequences. Newspaper Article, 1996. Handwashing. *Washington Post*, April 30, 1996. Article effectively describes the importance of hand washing in every day life, for medical personnel and for personnel in the food service industry.
250. Oldenburg, D., Issues: The hand-washing doctor is in. Newspaper Article, 1999. Handwashing.

- Washington Post, July 1, 1999. Americans do not wash their hands well or consistently. Discusses "Hand washing Olympics" and automatic washers as well.
251. Ontario Public Health, Hand washing. Online Article, 2006. Handwashing - Antimicrobial.  
From Ontario's Ministry of Health and Long-Term Care's Public Information. Why is hand washing Important? What is good hand washing technique? What type of soap should be used? Hand disinfection. What are alcohol rubs/gels/rinses? How do I use alcohol based hand disinfectants? How safe are alcohol based hand disinfectants? Is safe to use alcohol-based disinfectants for the hands of children? What are some mistakes I should avoid regarding hand washing? What are some ways to help children with good hand washing technique?
252. Oteri, T. and Ekanem, E.E., Food hygiene behavior among hospital food handlers. *Public Health*, 1989. 103: p. 153-159.  
Handwashing.  
One hundred and sixty one food handlers in two hospital settings were evaluated for their knowledge and practice of certain aspects of food hygiene. They were also screened for nasal carriage of *Staphylococcus aureus* as well as for enteric pathogens and parasites. Positive responses to selected food hygiene behaviors such as handwashing before handling food and daily change of clothes were very high and encouraging. However, only a very small proportion (28.6%) were observed to have actually washed their hands especially between handling cooked and uncooked foods. The nasal carriage of *Staphylococcus aureus* was 24%. The significance of the isolation of the different enteropathogens is discussed. From an epidemiologic perspective, the foodhandlers were individuals from the lower socioeconomic class with low level of education. Because of their unique role in the hospital community, there is a need for continuous medical surveillance of this group of employees. Also a periodic in-service programme of health education on food safety and hygiene should be introduced to alert them of their responsibilities.
253. Parson, R., Finding the glove protection that meets your needs: This article discusses glove selection and latex-free environments. Online Article, 2000. Handwashing - Gloves.  
<http://www.vpico.com/articlemanager/printerfriendly.aspx?article60024>. Posted on 09-01-2000. Discusses different types of Latex allergic reactions and strategies for reducing and preventing allergic reactions and latex sensitization.
254. Patrick, D.R., Findon, G., and Miller, T.E., Residual moisture determines the level of touch-contact-associated bacterial transfer following hand washing. *Epidemiol Infect*, 1997. 006: p. 319-325. Handwashing.  
We report here a new and critical determinant of the effectiveness of hand hygiene procedures, namely the amount of residual moisture left on the hands after washing and drying. When samples of skin, food and utilities were touched with wet, undried hands, microbial numbers in the order of 68000, 31000 and 1900 respectively translocated to these representative surfaces. Bacterial numbers translocating on touch contact decreased progressively as drying with an air or cloth towel system removed residual moisture from the hands. A 10 s cloth towel-20 s air towel protocol reduced the bacterial numbers translocating to skin, food and utilities on touch contact to 140, 655 and 28 respectively and achieved a 99.8, 94 and 99% reduction in the level of bacterial translocation associated with wet hands. Careful hand drying is a critical factor determining the level of touch-contact-associated bacterial transfer after hand washing and its recognition could make a significant contribution towards improving handcare practices in clinical and public health sectors. 2.
255. Patrick, D.R., Findon, G., and Miller, T.E., Hand drying after washing is critical factor in cross-contamination with microorganisms. *Food Safety Notebook*, n.d.: p. 6. Handwashing.  
The authors of this report from New Zealand were studying hand hygiene in relation to peritonitis induced by touch contamination in patients undergoing dialysis when they made "the serendipitous discovery" that the residual moisture remaining on hands after washing was the single most important determinant of the number of transferred microorganisms. A further investigation, reported here, quantified the effect of hand drying on touch-contact-associated translocation of microorganisms from fingers to several kinds of surfaces. Numbers of bacteria translocated decreased progressively as residual moisture was removed from the hands, either by cloth towels or an air dryer. Ten seconds of drying with a cloth towel removed 96% of the water from the subject's hands, but it took 45 seconds to achieve this level of dryness using an air dryer. Abstract Only.
256. Paulson, D., Get a handle on hand contamination: How to design a program to evaluate antimicrobial hand-cleansing products and assess the effectiveness of your handwashing and sanitizing procedures. *Food Quality*, 1996(April): p. 42-45. Handwashing - Antimicrobial.  
In any successful hand wash program, two main parameters must be considered: the immediate and persistent antimicrobial effects. the immediate antimicrobial effects depend on two attributes: the mechanical removal of contaminating microorganisms and the topical antimicrobial compounds ability to kill microorganisms upon contact. The persistent antimicrobial effects (the ability of the handwash to keep the microbial population at a low level after washing) are dependent upon the type of anti microbial product used. Immediate antimicrobial effectiveness depends upon the type and amount of antimicrobial hand sanitizer used, the amount of time spent washing the hands, the mechanical pressure and friction exerted in the wash, and the temperature of the water. Iodophor Iodine - good immediate and persistent effect. Remove both normal and contaminant organisms. Can irritate hands. Chlorhexidine gluconate - good immediate and persistent effect against both normal and contaminant organisms. Residual effect - binds to skin and retards microbial regrowth on the hands. Tends to irritate skin if used at the 4% level. At levels of 2% or lower, there is generally no problem. Triclosan - is effective against both resident and transient microorganisms, (not as effective as iodophors or chlorhexidine gluconate). Has both immediate and persistent antimicrobial effects as well as causing low level of skin irritation. Parachlorometaxylenol (PCMX) - effectiveness comparable to Triclosan. Effective for use in the food industry. Low potential for causing skin irritation. Alcohols - containing over 50% ethyl alcohol provide good immediate effect, but no persistent antimicrobial properties. Tend to irritate skin. Sodium hypochlorite - Dilute sodium hypochlorite (bleach) is antimicrobial to both resident and transient skin microorganisms, as well

- as bacterial spores. Very irritating to hands. Article describes the hand sampling procedures: swab, finger press, and glove juice method. Presents graphical evidence for the effectiveness of the glove juice method. 2.
257. Paulson, D.S., Evaluation of three handwash modalities commonly employed in the food processing industry. *Dairy Food Environ. Sanit.*, 1992. 12(10): p. 615-618. Handwashing.
- The study reported use of three methods: manual hand wash using Ivory bar soap; iodine dip using Zep-i-dine 20; automated handwash system using 2% chlorhexidine. *Serratia marcescens* was used as test microorganism. The glove juice sampling method was also used. Results indicated that washing hands manually or by machine resulted in greater number of log reductions than with the iodine dip. No subject in the study complained of skin irritation from any of the three wash procedures, not was it noticed by laboratory personnel.
258. Paulson, D.S., Variability evaluation of two handwash modalities employed in the food processing industry. Report, 1992. Handwashing.
259. Paulson, D.S., Evaluation of three microorganism recovery procedures used to determine handwash efficacy. *Dairy Food Environ. Sc.*, 1993. 13(9): p. 520-523. Handwashing.
- Compares glove juice test, swab method and finger press method for measuring hand contamination. Glove juice method is most accurate.
260. Paulson, D.S., Statistical approach to evaluating the effectiveness of hand-cleansing products used in the food-processing industry. *Dairy, Food and Environ Sanitation*, 1996(June): p. 389-392. Handwashing - Antimicrobial.
- Conclusion: It is important that each evaluation be designed to address the purpose of the evaluation. Additionally, it is important that investigators be familiar with a large selection of quantitative designs. This will prevent the investigator from trying to evaluate hand-washing products from a limited perspective with limited statistical ability, providing limited quality results. 2.
261. Paulson, D.S., To glove or to wash: A current controversy. *Food Quality*, 1996. 2(14): p. 60-63. Handwashing - Gloves.
- Both methods have their adherents and detractors. Using them in tandem may be the most effective solution, combined with vigorous enforcement and employee training, and an environmental sanitation program.
262. Paulson, D.S., Foodborne disease: Controlling the problem. *Environmental Health*, 1997(May): p. 15-19. Handwashing.
- The danger of foodborne disease continues to pose significant problems for the food industry. The main cause of foodborne illness is transmission of pathogenic microorganism from the hands of food service personnel to patrons via food served to them. There is an ongoing debate as to whether wearing protective barrier gloves or effective handwashing, alone, will best prevent food service personnel from contaminating the food served. It is suggested that relying solely on barrier gloves or handwashing is not prudent. Thorough training of personnel, routine retraining, consistent emphasis in the workplace on the need for safe food handling practices, and a vigorous internal program for assurance of compliance are the elements crucial to a program for prevention of foodborne illness, whether gloves are worn or not. 2.
263. Paulson, D.S., Handwashing, gloving, and disease transmission by the food preparer. *Dairy Food and Environmental Sanitation*, 2000. 20(11): p. 838-845. Handwashing - Gloves.
- SUMMARY: Issues of foodborne disease transmission continue to be of frontline importance to the restaurant industry. A well-designed, vigorously maintained program incorporating proper handwashing and/or gloving practices with control of the work environment can provide consistent assurance that patrons are served safe-to-eat food.
264. Paulson, D.S., et al., Close look at alcohol gel as an antimicrobial sanitizing agent. *Am J Infect Control*, 1999. 27: p. 332-338. Handwashing - Antimicrobial.
- Background: Hand transmission of microbes by health care workers is a primary cause of nosocomial infections in both long-term and acute care facilities. Compliance with effective handwashing and hand sanitization regimens can break this cycle. Methods: We investigated the antimicrobial efficacy and irritation potential of 5 handwash product regimens: a nonantimicrobial lotion soap, an antimicrobial lotion soap, an alcohol gel sanitizer, a nonantimicrobial lotion soap with an alcohol gel sanitizer, and an antimicrobial lotion soap with an alcohol gel sanitizer. The regimens were evaluated by using a Healthcare Personnel Handwash procedure, and irritation was assessed by using expert hand evaluation after 25 consecutive washes. Results: The Healthcare Personnel Handwash data showed that the mean log reductions from baseline were greatest for the lotion soaps with alcohol gel sanitizer, less for the alcohol and the antimicrobial soap alone, and least for the bland soap. All of the product regimens showed a low potential for skin irritation. Conclusion: In terms of both microorganism reduction and skin irritation, the most effective product regimens were the use of alcohol gel sanitizer in combination with either an antimicrobial or a plain lotion soap.
265. Paulson, D.S., et al., Efficacy evaluation of four hand cleansing regimens for food handlers. *Dairy, Food and Environmental-Sanitation*, 1999. 19(10): p. 680-684. Handwashing - Antimicrobial.
- Effective handwashing by foodhandlers is an important control measure for preventing transmission of food-borne diseases in food-service establishments. Effective handwashing requires both effective methods and effective handwash formulations. However, relative antimicrobial effectiveness of various hand-cleaning formulations and practices has not been established for foodhandlers. This study examined the ability of 4 handwashing regimens to reduce transient microorganisms on hands. Efficacy of these handwashing regimens was determined using a modified Health Care Personnel Handwash procedure and *Escherichia coli* as the transient marker organism. Regimens consisted of a non-antimicrobial hand cleanser, an alcohol gel hand sanitizer, an antibacterial soap and an antibacterial soap plus application of an alcohol gel hand sanitizer. All 4 regimens significantly reduced *E. coli* populations (log<sub>10</sub> reductions of 1.90-3.28) from baselines, after 1 wash. The most effective regimen for antimicrobial control was the combination of antibacterial soap handwash followed by alcohol gel application. This regimen demonstrated a high immediate reduction of the transient microorganism, with potential for further reductions with multiple applications of antimicrobial hand soap over a period of days. 2.

266. Pereira, L.J., Lee, G.M., and Wade, K.J., Effect of surgical handwashing routines on the microbial counts of operating room nurses. *Am J Infectious Control*, 1990. 18(6): p. 354-364. Handwashing - Antimicrobial.
- Many factors may affect the efficiency of handwashing techniques. This study examined two interdependent factors: the time taken to wash the hands and the type of antiseptic solution used. A 3-minute initial scrub and 30-second consecutive scrub regimen was compared with a current standard regimen of a 5-minute initial scrub and a 3-minute consecutive scrub. Chlorhexidine gluconate 4% and povidone-iodine 7.5% were the antiseptics used in the two regimens. The sample (n = 34) was drawn from nurses employed in the operating room suite of a 950-bed hospital. Chlorhexidine gluconate was found to be responsible for lower numbers of colony-forming units of bacteria than povidone-iodine. The duration of the scrub had no significant effect on the numbers of bacteria when povidone-iodine was used. The optimal regimen was found to be the 5-minute initial and 3-minute consecutive scrubs with chlorhexidine gluconate.
267. Perencevich, E.N., Wong, M.T., and Harris, A.D., National and regional assessment of the antibacterial soap market: A step toward determining the impact of prevalent antibacterial soaps. *Am J Infect Control*, 2001. 29: p. 281-283. Handwashing - Antimicrobial.
- Background: Consumer antibacterial soaps contain triclosan or triclocarban. No scientific data have been published to suggest that the use of antibacterial agents in household products prevents infection, and triclosan resistance mechanisms have recently been identified. Little data are available regarding the prevalence of antibacterial agents contained in consumer soaps. Methods: In a physician-performed survey of 23 stores in 10 states from December 1999 to April 2000, investigators determined the number of national brand liquid and bar soaps and percent of each containing antibacterial agents sold at national chain, regional grocery, and Internet stores. Results: Antibacterial agents were present in 76% of liquid soaps and 29% of bar soaps available nationally. There were no differences found between national, regional, and Internet stores. Conclusion: Overall, 45% of surveyed soaps contain antibacterial agents. With limited documented benefits and experimental laboratory evidence suggesting possible adverse effects on the emergence of antimicrobial resistance, consumer antibacterial use of this magnitude should be questioned. .
268. Peterson, A.F., Rosenberg, A., and Alatory, S.D., Comparative evaluation of surgical scrub preparation. *Surgery, Gyn. Obstet.*, 1978. 146: p. 63-65. Handwashing - Antimicrobial.
- The efficacy of 0.75% available povidone-iodine scrub solution, 4% chlorhexidine gluconate detergent solution and 3% hexachlorophene emulsion against resident and transient flora of the hand has been compared using two currently accepted study designs. Chlorhexidine gluconate produced the greatest initial reductions against resident flora, followed by povidone-iodine and hexachlorophene, respectively. In subsequent washings, all three treatments further reduced the flora, chlorhexidine giving the greatest reduction on any test day. On gloved hands, there was significant re-growth on gloved hands which had been washed with chlorhexidine gluconate or hexachlorophene. Against transient flora, chlorhexidine gluconate gave the lowest over-all counts, followed by povidone-iodine and hexachlorophene respectively. The reduction in bacteria counts increased following the repetitive use of chlorhexidine; no such trend was noted with either povidone-iodine or hexachlorophene.
269. Peterson, N.J., Collins, D.E., and Marshal, J.H., Microbiological assay technique for hands. *Health Lab Science*, 1973. 10(1): p. 18-22. Handwashing - Binder.
- An assay technique for hands capable of consistently detecting low levels of specific microorganisms and enumerating a variety of microorganisms simultaneously was developed. Hands were wiped with a commercially available, sterile, pre-moistened, rayon material. The material was placed in a sterile rinse solution and agitated to free the microorganisms from the material. The rinse solution was assayed using both direct plating and membrane filtration techniques. Laboratory and hospital test demonstrated that the technique permitted detection and enumeration of microbial contaminants acquired by hands during the examination of a patient. The technique was of particular value in determining the effect of handwashing on both the resident and transient microflora.
270. Pittet, D., Improving adherence to hand hygiene practice: A multidisciplinary approach. *Emerging Infectious Diseases*, 2001. 7(2). Handwashing.
- Hand hygiene prevents cross-infection in hospitals, but health-care workers' adherence to guidelines is poor. Easy, timely access to both hand hygiene and skin protection is necessary for satisfactory hand hygiene behavior. Alcohol-based hand rubs may be better than traditional handwashing as they require less time, act faster, are less irritating, and contribute to sustained improvement in compliance associated with decreased infection rates. This article reviews barriers to appropriate hand hygiene and risk factors for noncompliance and proposes strategies for promoting hand hygiene. 2.
271. Ponce de Leon Rosales, S., Hernandez, M.V., and Huertas, M., Infection control in ER: How hand-washing is avoided even in fiction. *Lancet*, 2005. 5. Handwashing.
- The results confirmed our hypothesis - preventive measures are extremely neglected in the television series [E.R.]. Appropriate hand-washing is never done, and this is also true for most other preventive recommendations. We should be able to take advantage of the power of the media to inform and not merely to entertain the population; they - and we - deserve much more than that.
272. Post, F.J. and Balzer, J.L., Effect of a hexachlorophene detergent on the microbial population of the hands of food handlers. *J. Milk Food Technol.*, 1963. 26: p. 142-147. Handwashing - Binder.
- A handwashing study was conducted to determine whether a 3% hexachlorophene hand detergent could materially reduce the normal bacterial population on the hands of food handlers. Total count, staphylococcus count, and total gram negative bacteria count showed significant reductions when the hexachlorophene detergent was used. No decline occurred when three other hand detergents were used. It was suggested that the gram negative bacteria count may be a better indicator of transient organisms on the hands than the total count which includes a greater proportion of resident bacteria.

273. Price, P.B., Bacteriology of normal skin: A new quantitative test applied to a study of the bacterial flora and the disinfection action of mechanical cleansing. *J. Infect. Dis.*, 1938. 63: p. 301-306. Handwashing - Binder.  
 Skin bacteria are of two sorts, "transients" and "residents". Transients, acquired mainly by contact, vary greatly in both number and kind. They may be abundant on exposed skin, under nails, etc., but are relatively scarce on clean, unexposed skin. Resident bacteria form a comparatively stable flora. Forces increasing (Chiefly multiplication in situ) and decreasing their number tend to reach an equilibrium. Protected skin has as a rule a somewhat larger resident flora than exposed skin. After reduction (e.g., disinfection) reestablishment of the resident flora appears to proceed at a rate represented in general by a sigmoid curve, as is true of bacterial growths in cultures. Hands and arms thoroughly degermed may require a week or more for complete reestablishment of the usual flora.
274. Prince, H.N., Disinfectant activity against bacteria and viruses: A hospital guide. Report, 1983. Handwashing - Binder.  
 Discussion of disinfectants used in hospitals from view of EPA. Discusses test procedures and effectiveness of disinfectants.
275. Redway, K., et al., Hand drying: A study of bacterial types associated with different hand drying methods and with hot air dryers. Report, 1994. Handwashing - Michaels.  
 Published by Applied Ecology Research Group, University of Westminster. Summary: In a previous study under natural conditions, towels were found to be more efficient in drying the hands than hot air dryers where many people completed drying on clothes etc. Microbiological studies revealed that using towels after washing reduced bacterial counts on the hands by an average of 42% (paper) and 10% (cotton). With hot air dryers, however, counts increased by more than 500%. Bacteria were blown out of dryers whenever they were running. In the present study, standard techniques were used to identify and count the bacteria associated with hand washing and drying under natural conditions. Average bacterial counts were again reduced using towels - the most significant decrease being with paper towel. Hot air dryers produced significant increases in all bacteria - 436% rise with some skin and gut bacteria. The presence of gut bacteria is indicative of fecal contamination of the hands. In a further study, bacteria were isolated from swabs taken from the air flow nozzle and air inlet of 35 hot air dryers in nine types of locations (including hospitals, eating places, railway stations, public houses, colleges, shops and sports clubs.) Bacteria were relatively numerous in the airflows and on the inlets of 100% of dryers sampled and in 97% of the nozzles. Staphylococci and micrococci (probably from skin and hair) were blown out of all of the dryers sampled for these type of bacteria and 95% showed evidence of the potential pathogen *Staphylococcus aureus*. At least 6 species of gut bacteria (enterobacteria) were isolated from the air flows of 63% of the dryers, indicating fecal contamination. It is concluded that hot air dryers have the potential for depositing pathogenic bacteria onto the hands and body. Bacteria could also be inhaled and are distributed into the general environment whenever dryers are running. It is suggested that the use of hot air dryers should be carefully considered on health grounds, especially in sensitive locations.
276. Rego, A. and Roley, L., In-use barrier integrity of gloves: Latex and nitrile superior to vinyl. *Am J Infect Control*, 1999. 27(5): p. 405-410. Handwashing - Gloves.  
 Conclusions: This study indicates that the latex and nitrile gloves evaluated were comparable in terms of barrier performance characteristics both unused and during manipulations mimicking patient care procedures. Whereas stretch vinyl exhibited lower failure rates than standard vinyl, the higher in-use leakage rates associated with all vinyl gloves tested indicate decreased durability and, potentially, compromised barrier protection when this synthetic is used. Careful consideration to the degree of barrier effectiveness should be given before glove selection when the potential exposure to bloodborne pathogens or biohazard risks is a concern.
277. Reingold, A.L., Kane, M.A., and Hightower, A.W., Failure of gloves and other protective devices to prevent transmission of hepatitis b virus to oral surgeons. *JAMA*, 1988. 259(17): p. 2558-2560. Handwashing - Gloves.  
 A survey of 434 oral surgeons was conducted to examine risk factors for hepatitis B virus (HBV) infection. Overall, 112 (26%) of the participants demonstrated serologic evidence of past or current infection with HBV. Seropositivity was significantly associated with age, number of years in practice, and year of graduation from dental school but not with other variables examined, such as the number of patients seen annually or the number of patients seen who were at high risk of HBV infection. The strong correlation between years in practice and seropositivity was unaffected by reported use of gloves, face masks, or eye shields. The use of gloves and other protective devices does not appear to offer substantial protection against HBV exposure in oral surgeons, and all oral surgeons should receive HBV vaccine.
278. Restaino, L. and Wind, C.E., Antimicrobial effectiveness of hand washing for food establishments. *Dairy, Food and Environmental Sanitation*, 1990. 10(3): p. 136-141. Handwashing - Antimicrobial.  
 A complex etiological relationship exists among the factors: food; environment; and food handlers. Controlling all three factors so they or their interactions do not become a health hazard is of utmost importance. The primary goal is to define an adequate plane which will control the resident and transient bacterial types. The overall aim of an hand sanitation program must implement hygienic measures to control and prevent contamination of the food products. Health Departments, Sanitary Regulations, and Good Manufacturing Practices stress the importance of frequent and thorough handwashing to prevent microbial contamination. Washing the hand with ordinary soap and water removes the transient bacteria and the use of an antiseptic or sanitizer in the hand soap would control the resident bacterial. The pH of these hand soaps should be acidic to prevent hand irritation and pH altering of the skin. Hospitals have shown that an alcohol rinse containing a humectant can be beneficial in controlling and removing both transient and resident bacteria without hand irritation. Handwashing and hand treatment scheme for a food service establishment must: 1) kill a broad spectrum of microorganisms (both transient and resident) especially pathogenic bacteria. 2) maintain a residual effect where the bacterial load on the skin is controlled between applications by antimicrobial agents remaining on the skin. 3) be non irritating to the skin. (2) Contents of Paper: Factors Affecting Microbial Growth - climate, occupation, cosmetic lotions, personal hygiene, location on body, age, hair, nutrients;

- Microflora of the Skin; Efficacy of Hand Washing - transmission of microorganisms, handwashing, hand soaps containing antimicrobial agents, alcohol applications.
279. Rose, J.B. and Haas, C.N., Risk assessment framework for the evaluation of skin infections and the potential impact of antibacterial soap washing. *Am J Infect Control*, 1999. 27(6): p. S26-S33. Handwashing - Antimicrobial.
- Antibacterial soaps may have an important role in the control of skin infection. However, quantitative estimation of their benefit is difficult because of the problems associated with conducting epidemiologic studies. An alternative benefit estimation approach, quantitative microbial risk assessment, has application to this problem. This article sets forth the quantitative microbial risk assessment method and applies it specifically to the estimation of the reduction in risk of dermal infection from *Staphylococcus aureus* resulting from use of antibacterial soaps. A dose-response model was formulated by using available information on growth kinetics of the organism on the skin and dose data based on the inoculation of the forearm skin in volunteers. A predictive relationship for microbial growth on the skin was developed. These data were limited, and clearly more studies are needed on inoculation at more than one site and growth leading to infection on the skin with and without the use of germicidal soaps. However, by using relationships based on extant data sets, it was estimated that the use of germicidal soap could result in a substantial reduction in the risk of infection by *S aureus*. The estimated risk reduction was in general concordance with published results from epidemiologic studies conducted on military cadets. The methodology of quantitative microbial risk assessment has thus been shown to be applicable to this problem and may have broader applicability in other personal hygiene contexts.
280. Rosenthal, V.D., et al., Effect of education on performance feedback on handwashing: The benefit of administrative support in Argentinean hospitals. *Am J Infect Control*, 2003. 31: p. 85-92. Handwashing.
- Background: Patients admitted to hospitals are at risk of acquiring nosocomial infections. Many peer-reviewed studies show that handwashing (HW) significantly reduces hospital infections and mortality. Our objective was to evaluate the effects of HW by health care workers (HCW) before contact with patients in 3 Argentinean hospitals. We performed an observational study of HCW to measure the effect of 2 interventions: education alone and education plus performance feedback. Methods: A total of 3 hospitals were studied for adherence to a HW protocol. The observed HCW included physicians, nursing personnel, and ancillary staff. After initial observations to establish baseline rates of HW (phase 1), we evaluated the effect of education alone (phase 2), followed by education plus performance feedback (phase 3). We also evaluated the relationship between the administrative support and HW adherence. Results: We observed 15,531 patient contacts in 3 hospitals. The baseline rate of HW before contact with patients was 17%. With education, HW before contact with the patients increased to 44% (relative risk 2.65; 95% confidence interval 2.33-3.02;  $P < .001$ ). Using education and performance feedback HW further increased to 58% (relative risk 1.86; 95% confidence interval 1.38-2.51;  $P < .001$ ). In the private hospitals where administrative support for the HW program was significantly greater, HW compliance was significantly higher (logistic regression analysis: odds ratio 5.57; 95% confidence interval 5.25-6.31;  $P < .001$ ). Conclusions: In this study, HW policies and education of HCW significantly improved HCW adherence to the HW protocol, however, when performance feedback was incorporated, the HW compliance increased to a greater degree. We identified that administrative support provides a positive influence in efforts to improve HW adherence.
281. Ross, T., Wash your hands. Book, 2000. Handwashing.
- A children's book about a princess who doesn't want to wash her hands. .
282. Rossoff, L.J., Borenstein, M., and Isenberg, H.D., Is hand washing really needed in an intensive care unit? *Critical Care Medicine*, 1995. 23(7): p. 1211-1216. Handwashing - Antimicrobial.
- OBJECTIVES: To determine whether a rigorous antiseptic hand washing of bare hands with 4% chlorhexidine and alcohol reduced fingertip microbial colonization as compared with the use of boxed, clean, nonsterile latex gloves. In addition, to investigate if aseptic donning technique and/or a prior hand washing would reduce the level of glove contamination. DESIGN: Prospective, randomized, crossover design, with each subject serving as his/her own control. SETTING: University intensive care unit. SUBJECTS: Forty-three intensive care nurses. INTERVENTIONS: The fingertips of 20 nurses were cultured before and after a strict antiseptic hand washing and before and after the routine and aseptic donning of sterile gloves. Subsequently, the fingertips of 43 nurses were cultured before and after the casual donning of nonsterile gloves over unwashed hands and before and after a strict antiseptic hand washing. Fingertip cultures were plated directly on agar, incubated for 24 hrs, and counted and recorded as the number of colony-forming units (cfu) for each hand. Different colony types were then subcultured. MEASUREMENTS AND MAIN RESULTS: Hand washing with antiseptic reduced colonization from 84 to 2 cfu ( $p < .001$ ). The proportion of cases with  $> 200$  cfu/hand was reduced from 30% to 9%. Aseptic or casual donning of sterile gloves, with or without prior antiseptic hand washing, resulted in consistently low glove counts between 0 and 1.25 cfu. Nonsterile gloves casually donned over washed or unwashed bare hands diminished the bioburden to 2.17 and 1.34 cfu, respectively. No qualitative difference was found in the microorganisms recovered from gloved or bare hands. CONCLUSIONS: Antiseptic hand washing and the use of nonsterile gloves over unwashed hands confer similar reductions in the number of microorganisms. There is no additional benefit with the use of aseptic donning technique, prior antiseptic hand washing, or the use of individually packaged sterile gloves.
283. Rotter, M.L., Hand washing and hand disinfection. Book Chapter 87, 1999. Handwashing - Antimicrobial.
- Microbial Flora of Hands, Strategies of Hand Hygiene, Methods of Eliminating Microorganisms from the Hands, Acceptability of Hand Washing and Hand Disinfection Procedures, Agents Used for Disinfection of Hands.
284. Rotter, M.L., Alcoholic hand disinfectants and European handwashing guidelines. Telefax Response to Email, 2000. Handwashing - Antimicrobial.

- Answers the questions about alcoholic hand disinfectants vs soap and water, and European Guidelines on food hygiene. (And Austrian Guidelines). These are attached - but are in German and brief translations are written by M.L. Rotter. - The initial questions asked are not included.
285. Rotter, M.L. and Koller, W., Test models for hygienic handrub and hygienic handwash: The effects of two different contamination and sampling techniques. *J. Hosp. Infect.*, 1992. 20: p. 163-171. Handwashing.
- Two methods for artificial contamination of hands and two sampling techniques to recover the test organisms were compared for their effects on the results of two post-contamination hand treatments: a handrub with two portions of 3 ml of 2-propanol 60% v/v for 1 min, and a handwash with liquid soap 20% w/v for 1 min followed by a 15 s rinse. The two contamination methods involved a short immersion of the hands (up to the middle of the mid-hand) in a suspension of the test organism followed by either air-drying (3 min) or drying by rubbing the hands' vigorously against each other (3 min) in a standardized way. The two sampling techniques consisted of rubbing the fingertips in either 10 ml trypticase soy broth (TSB) against the bottom of a Petri dish; or 100 ml TSB against glass beads contained in a bowl. Sixteen volunteers were randomly allotted to four blocks of four. They carried out the four possible combinations of two treatments and two contamination methods in a series of four tests arranged in a Latin-square design. In addition, the two sampling techniques were compared with each other concurrently by sampling of the right and left hand each with a different one of the two techniques. The alcoholic handrub reduced the release of test organisms significantly (2P less than 0.005) more effectively, by 1.1-1.3 x log<sub>10</sub>, than did the handwash with liquid soap, regardless of the contamination or sampling method. Whereas the two recovery techniques yielded virtually identical results in corresponding situations, the method of artificial contamination affected the mean reduction factors, strongly.(ABSTRACT TRUNCATED AT 250 WORDS).
286. Rusin, P., Maxwell, S., and Gerba, C., Comparative surface-to-hand and fingertip-to-mouth transfer efficiency of gram-positive bacteria, gram-negative bacteria, and phage. *J Applied Microbio*, 2002. 93(4): p. 585-592. Handwashing.
- Aims: To determine the transfer efficiency of micro-organisms from fomites to hands and the subsequent transfer from the fingertip to the lip. Methods and Results: Volunteers hands were sampled after the normal usage of fomites seeded with a pooled culture of a Gram-positive bacterium (*Micrococcus luteus*), a Gram-negative bacterium (*Serratia rubidea*) and phage PRD-1 (Period A). Activities included wringing out a dishcloth/sponge, turning on/off a kitchen faucet, cutting up a carrot, making hamburger patties, holding a phone receiver, and removing laundry from the washing machine. Transfer efficiencies were 38-47% to 65-80% and 27-59% to 40-03% for the phone receiver and faucet, respectively. Transfer efficiencies from porous fomites were <0.01%. In most cases, *M.luteus* was transferred most efficiently, followed by phage PRD-1 and *S. rubidea*. When the volunteers' fingertips were inoculated with the pooled organisms and held to the lip area (Period B), transfer rates of 40-99%, 33-97%, and 33-90% occurred with *M. luteus*, *S. rubidea*, and PRD-1, respectively. Conclusions: The highest bacterial transfer rates from fomites to the hands were seen with the hard, non-porous surfaces. Even with low transfer rates, the numbers of bacteria transferred to the hands were still high (up to 10<sup>6</sup> cells). Transfer of bacteria from the fingertip to the lip is similar to that observed from hard surfaces to hands. Significance and Impact of the Study: Infectious doses of pathogens may be transferred to the mouth after handling an everyday contaminated household object.
287. Russo, A., et al., Antimicrobial activity of a new intact skin antiseptis formulation. *Am J Infect Control*, 2003. 31(2): p. 117-123. Handwashing - Antimicrobial.
- Different antiseptic formulations have shown limitations when applied to disinfecting intact skin, notably short-term tolerability and/or efficacy. The purpose of this study was optimizing a new antiseptic formulation specifically targeted at intact skin disinfection and evaluating its in vitro microbicidal activity and in vivo efficacy. Methods: The biocidal properties of the antiseptic solution containing 0.5% chloramine-T diluted in 50% isopropyl alcohol (Cloral; Eurospital SpA Trieste, Italy) were measured in vitro versus gram-positive-, gram-negative-, and acid-alcohol-resistant germs and fungi with standard suspension tests in the presence of fetal bovine serum. Virus-inhibiting activity was evaluated in vitro against human cytomegalovirus, herpes simplex virus, poliovirus, hepatitis B virus, and hepatitis C virus. Tests used different methods for the different biologic and in vitro replication capacity of these human viruses. Lastly, Cloral tolerability and skin colonization retardation efficacy after disinfection were studied in vivo. Results: The antiseptic under review showed fast and sustained antimicrobial activity. The efficacy of Cloral against clinically important bacterial and viral pathogens and fungi was highlighted under the experimental conditions described in this article. Finally, microbial regrowth lag and no side effects were documented in vivo after disinfection of 11 volunteers. Conclusions: A stable chloramine-T solution in isopropyl alcohol may be suggested for intact skin antiseptis.
288. Safefood, Bare hands or gloves? *Safefood News*, 2003. VII(4). Handwashing - Gloves.
- The debate continues as to whether food is more safely prepared by workers using bare hands or those wearing gloves. Published data on the effectiveness of handwashing and glove use in a foodservice setting are limited. Most data on glove effectiveness have originated from the healthcare literature, which have evaluated surgical gloves using a method which doesn't simulate gloves in use, especially foodservice. Taking extra precautions to prevent foodborne illness makes sense. The combination of handwashing and glove use appears to be more effective than either alone. Both sides agree that proper training is the key. A hand sanitation program that combines proper handwashing and disposable glove use along with other barriers can provide one more layer of protection to keeping our food safer. <http://www.ext.colostate.edu/safefood/newsltr/menunews.html> / <http://www.ext.colostate.edu/safefood/newsltr/v7n4s04.html> - article.
289. Salyers, A.A. and Whitt, D.D., Hand washing past and present. Book Chapter 1, 1994. Handwashing. Bacterial Pathogenesis: A Molecular Approach. .
290. Salyers, A.A. and Whitt, D.D., Host defenses against bacterial pathogens: Defenses of body surfaces. Book Chapter 1, 1994. Handwashing.

- Clinical Importance of Understanding Host Defenses, Preventing Contact between Host and Pathogen, Skin and Mucosal Surfaces, Summary: Handwashing Past and Present, Special Defenses of Specific Mucosal Surfaces. Very good on skin and handwashing.
291. Schaffner, D. and Montville, R., Handwashing and glove use: A summary of recent research. Powerpoint Presentation, n.d. Handwashing - Gloves.  
The issues of handwashing and gloving, research issues, hand drying, alcohol disinfectants, research results, cross-contamination, failure of gloves. Conclusions: Many factors effect handwashing, but the most important seem to be soap type and drying method. Gloves are far from fail proof; if gloves are being used, handwashing is imperative. It's not gloves vs. handwashing.
292. Schuler, G.A., Christian, J.A., and Hurst, W.C., Food, hands and bacteria. Bulletin 693, 1989. Handwashing - Antimicrobial.
293. Schwartz, H.J., Latex: A potential hidden "Food" Allergen in fast food restaurants. J Allergy Clin Immunol, 1995. 95(1): p. 139-140. Handwashing - Gloves.  
Two case studies where patients were treated for severe allergic reactions because of food handled with latex gloves. .
294. Schwartz, M., Haccp and hand washing. Trade Talk, 1998(October). Handwashing.  
An overview of hand washing sinks available on the market today and how to use them. Hand sinks must be visible and accessible to the facility manager with written procedures and an adequate employee training program which is reinforced frequently. .
295. SDA, Prevention of occupational skin diseases. Booklet, 1981. Handwashing.  
SDA = Soap and Detergent Association. Dermatitis, Skin and the causes of dermatoses, Prevention of Occupational Dermatoses, Industrial skin cleaners.
296. Seal, L.A., Rizer, R.L., and Maas-Irslinger, R., Unique water optional health care personnel handwash provides antimicrobial persistence and residual effects while decreasing the need for additional products. Am J Infect Control, 2005. 33: p. 207-216. Handwashing - Antimicrobial.  
Background: The Centers for Disease Control and Prevention (CDC) has published guidelines for hand hygiene practices, recommending a handwash regimen that alternates between waterless alcohol products and antimicrobial or nonantimicrobial soap and water. The advent of an alcohol-based product that can be used with or without water (ie, water optional) to decontaminate the hands while providing immediacy of kill and antimicrobial persistence could reduce the confusion associated with handwash guidelines. Such a product has been developed, is alcohol-based (61%), and zinc pyrithione (ZPT) preserved (61% alcohol-ZPT) and has proven to be fully compliant with the Food and Drug Administration (FDA) and CDC guidelines. Methods: FDA-required testing of the 61% alcohol-ZPT product for the health care personnel handwash indication was performed as outlined in the Tentative Final Monograph (TFM) for Health-Care Antiseptic Drug Products, employing waterless and water-aided product applications. It was next assessed for antimicrobial persistence and residual effects by comparing it, in separate waterless and water-aided applications, with commonly available handwashes containing various antimicrobials in a 5-day study employing 49 subjects, in which samples were collected immediately and at 4 hours and 8 hours postapplication. The skin conditioning properties of this formulation were investigated via appropriate methods. Results: The 61% alcohol-ZPT product easily produced >3.0 log<sub>10</sub> reduction in the indicator strain (*Serratia marcescens*) following the first wash, exceeding the 2.0 log<sub>10</sub> FDA requirement. This level of performance was maintained through the tenth wash, surpassing the 3.0 log<sub>10</sub> FDA requirement for the handwash indication. For the assessment of persistence and residual effect in the waterless mode, the water-optional, 61% alcohol-ZPT product consistently produced log<sub>10</sub> reductions of nearly 3.5 or greater at every point over the entire study period. In the water-aided configuration, similar results were obtained as log<sub>10</sub> reductions of 2.5 were observed. The formulation is nonirritating, actually contributing to hand skin condition. Conclusions: The 61% alcohol-ZPT product exceeds all FDA criteria for the health care personnel handwash indication and is a significant advancement in the concept of skin antiseptics. It represents a single product suitable for use in all hand hygiene settings, demonstrating improved antimicrobial persistence and residual effects. The 61% alcohol-ZPT formulation contributes positively to overall hand conditioning, and a previously reported study has documented it to be virucidal for several DNA and RNA viruses. .
297. Seligmann, R. and Rosenbluth, S., Comparison of bacterial flora on hands of personnel engaged in non-food and in food industries: A study of transient and resident bacteria. J Milk and Food Technology, 1975. 38(11): p. 673-677. Handwashing - Binder.  
Two hundred non-food workers were examined for five test bacteria; 44% tested positive for one or more test bacteria on the hands. Food-service workers showed a significant difference when compared to non-food contact workers. 97% tested positive to one or more bacteria. .
298. Selwyn, S. and Ellis, H., Skin bacteria and skin disinfection reconsidered. British Medical Journal, 1972. 1: p. 136-140. Handwashing.  
Summary: Large discrepancies in the available data on skin microbiology simulated investigations of the number, interactions, and location of commensals and the true efficiency of disinfection by using skin biopsy, culture of frozen sections, and other methods. Most current procedures were less than 0.5% as sensitive as the biopsy method described. This gave mean bacterial counts ranging from 4,000/cm<sup>2</sup> on the breast to 400,000/cm<sup>2</sup> in the axillae. An iodine preparation removed 95% of accessible organisms, but about 20% of bacteria were protected by follicles, crevices, and lipids. Commensals in over 20% of people produced antibiotics against a wide range of pathogens. Conversely, "satellitism" was demonstrable in 12% of people. 2.
299. Sheena, A.Z. and Stiles, M.E., Efficacy of germicidal hand wash agents in hygienic hand disinfection. J. Food Protect., 1982. 45(8). Handwashing - Antimicrobial.  
The efficacy of hygienic hand wash procedures for food handlers using germicidal soaps and hand dips was studied by measuring the changes in numbers of microorganisms released from hands before and after each of two successive 15 second treatments. Both hand rinse and fingertip imprint sampling techniques were used. Of the hand dip agents, including sodium hypochlorite

(50 ppm available chlorine), iodophor (25 ppm available iodine) and a quaternary ammonium compound (QAC) (930 ppm benzalkonium chloride), only the QAC gave a statistically significant decrease in the number of bacteria released when tested by the finger imprint technique. This experiment included a bar soap containing 1.0% trichlorocarbanilide which gave results equivalent to a non-germicidal soap control. Of the hand wash agents, 4% chlorhexidine gluconate and iodophor (0.75% available iodine) resulted in significant decreases in numbers of bacteria released when tested by either sampling technique. Products containing Irgasan DP 300 (0.25% active ingredient at use concentration), tribromosalicyllanilide (0.5%) and para-chloro-meta-xyleneol (0.325%) were no better than the non-germicidal soap control under conditions of this experiment. Identification of 3,591 aerobic isolates from finger imprint plates indicated that *Staphylococcus epidermidis* and *Micrococcus* spp. were the predominating organisms (85.3%) released from the hands.

300. Sheena, A.Z. and Stiles, M.E., Comparison of barrier creams and germicides for hand hygiene. *J. Food Protect.*, 1983. 46(11): p. 943-946. Handwashing - Binder.

Germicidal handwash agents and two barrier creams for use on hands were compared to determine their ability to reduce the number of microorganisms released from fingertips. Use of the barrier creams resulted in a significant decrease in the number of microorganisms released equivalent to the reduction achieved when effective germicidal agents were used, such as 4% chlorhexidine gluconate or iodophor containing 0.75% available iodine. The persistence of the effect of barrier creams on the skin was also studied and it was found that the initial increase in number of microorganisms released occurred after rinsing with water or washing with non-germicidal soap. Sequential rinsing of hands with tap water, after treatment with the barrier creams or with the effective germicidal agents gave similar results. Barrier creams can perform a useful adjunct role in hygienic hand disinfection. In this study, they were equivalent to effective hand germicides.

301. Sheena, A.Z. and Stiles, M.E., Efficacy of germicidal hand wash agents against transient bacteria inoculated onto hands. *J. Food Protect.*, 1983. 48(8): p. 722-727. Handwashing - Antimicrobial.

The efficacy of germicidal hand wash agents against transient bacteria (*Escherichia coli* and *Pseudomonas fluorescens*) in ground beef rubbed onto hands was determined using a hand rinse sampling technique. The reduction in *E. coli* and *P. fluorescens* counts on the selective growth media and the change in count of Baird-Parker medium were used to indicate action against transient and resident bacteria, respectively. Most of the agents tested, including 0.4% chlorhexidine gluconate, iodophor (0.75% available iodine), Irgasan DP 300, para-chloro-meta-xyleneol (PCMX) as well as the non-germicidal soap gave marked reductions in *E. coli* and *P. fluorescens* (>90% reduction), even after one 15 sec. wash. The hand dip treatments with iodophor (25 ppm available iodine), hypochlorite (50 ppm available chlorine) or QAC (930 ppm benzalkonium chloride) were generally less effective than hand wash treatments, especially against *P. fluorescens*. Iodophor (25 ppm available iodine) and 4% chlorhexidine gluconate significantly reduced more *E. coli* on hands than other agents.

302. Sheena, A.Z. and Stiles, M.E., Immediate and residual (substantive) efficacy of germicidal hand wash agents. *J. Food Protect.*, 1983. 46(7): p. 629-632. Handwashing - Binder.

A range of commercial hand wash agents was compared against 4% chlorhexidine gluconate (Hibitane) for immediate and residual (substantive) germicidal effect in hygienic hand disinfection. Chlorhexidine gluconate (4%) liquid detergent gave an immediate and residual reduction in number of microorganisms released from finger tips after a short exposure (15 sec.) hand wash. An iodophor product containing 0.75% available iodine gave comparable results for the immediate reduction in number of microorganisms released, but it did not give a residual effect. Other products, including those containing Irgasan DP 300, para-chloro-meta-xyleneol (PCMX) or low concentration iodophor (0.005% available iodine) as the active ingredient, did not give an immediate or residual reduction in microorganisms released from finger tips.

303. Sheldon, J.E., 25 tips on hand washing: See if you know them all. *Nursing*, 1994. 24(1): p. 20. Handwashing.

What to Use, How to Wash, When to Wash, Hands and Nails.

304. Sickbert-Bennett, E.E., et al., Comparative efficacy of hand hygiene agents in the reduction of bacteria and viruses. *American Journal of Infection Control*, 2005. 33(2): p. 67-77. Handwashing - Antimicrobial.

**BACKGROUND:** Health care-associated infections most commonly result from person-to-person transmission via the hands of health care workers. **METHODS:** We studied the efficacy of hand hygiene agents (n = 14) following 10-second applications to reduce the level of challenge organisms (*Serratia marcescens* and MS2 bacteriophage) from the hands of healthy volunteers using the ASTM-E-1174-94 test method. **RESULTS:** The highest log<sub>10</sub> reductions of *S. marcescens* were achieved with agents containing chlorhexidine gluconate (CHG), triclosan, benzethonium chloride, and the controls, tap water alone and nonantimicrobial soap and water (episode 1 of hand hygiene, 1.60-2.01; episode 10, 1.60-3.63). Handwipes but not alcohol-based handrubs were significantly inferior from these agents after a single episode of hand hygiene, but both groups were significantly inferior after 10 episodes. After a single episode of hand hygiene, alcohol/silver iodide, CHG, triclosan, and benzethonium chloride were similar to the controls in reduction of MS2, but, in general, handwipes and alcohol-based handrubs showed significantly lower efficacy. After 10 episodes, only benzethonium chloride (1.33) performed as well as the controls (1.59-1.89) in the reduction of MS2. **CONCLUSIONS:** Antimicrobial handwashing agents were the most efficacious in bacterial removal, whereas waterless agents showed variable efficacy. Alcohol-based handrubs compared with other products demonstrated better efficacy after a single episode of hand hygiene than after 10 episodes. Effective hand hygiene for high levels of viral contamination with a nonenveloped virus was best achieved by physical removal with a nonantimicrobial soap or tap water alone.

305. Snyder, O.P., Cross-contamination of gloves when being put on. HI-TM article, 1994. Handwashing - Gloves.

This studied whether single-use gloves have any public health value if one does not double wash hands. Conclusion: If fingertips have not been washed correctly, there is a possibility of significant transfer to gloves when putting them on.

306. Snyder, O.P., Pete's HACCP restaurant: Our policy on gloves. HI-TM Report, 1994. Handwashing - Gloves.

You will notice that we do not wear gloves when working with food. I would like to explain why we believe our employees' hands are safer without wearing gloves than when wearing gloves. .

307. Snyder, O.P., E2 and hard surface sanitizers. eMail correspondence, 1997. Handwashing - Antimicrobial.

We have been having a discussion about the effectiveness of hand sanitizers meeting the E2 USDA criterion and surface sanitizers as accepted by EPA. The following are required government Tests for approval. (Hand Sanitizing, Surface Sanitizing, My comments).

308. Snyder, O.P., San jamar kleen-brush nail brush study to measure removal of e. Coli from fingertips and residual e. Coli left on the nail brush. HI-TM Report, 2006. Handwashing.

The purpose of this study is to measure the effectiveness of the Kleen-Brushtm product to remove non-pathogen surrogate E. coli pathogen organisms from fingertips; to measure the residual E. coli on the nail brush; and to identify the benefits of design of the Kleen-Brushtm product to current available brushes.

309. Snyder, O.P., Removal of bacteria from fingertips and the residual amount remaining on the hand washing nail brush. HI-TM Report, 2007. Handwashing.

The purpose of this small study, that utilized 3 volunteer participants, was to measure the effectiveness of the double hand washing procedure for removing non-pathogenic, surrogate Escherichia coli organisms from fingertips and to measure the residual amount of E. coli remaining on the nailbrush. Data from the experiment show that use of the nailbrush during hand and fingertip washing (Wash #1) reduced an inoculum of E. coli on fingertips by 2.98 log<sub>10</sub> CFU/ml, or an almost 1,000-to-1 reduction. When Wash #1 was followed by a 10-second wash without the nailbrush (Wash #2) there was an additional reduction of 1.72 log<sub>10</sub> CFU/ml, or approximately 50-to-1 reduction. Added together, there was a combined average reduction of 4.70 log<sub>10</sub> CFU/ml. Thus, the double hand wash method was shown to reduce bacteria on fingers and offer a validated solution for the foodservice operation that would like to use the FDA Food Code provision of §3-301.11(D)(6) as an alternative to gloving. The average population of E. coli on the remaining on the nailbrush after being used during Wash #1 was measured and was found to be less than a 1-in-10,000,000 retention of the initial bacterial inoculum.

310. Sprunt, K., Redman, W., and Leidy, G., Antibacterial effectiveness of routine hand washing. Pediatrics, 1973. 52(2): p. 264-271. Handwashing - Antimicrobial.

A broth rinse method was used to determine the indigenous bacteria of the hands of nursery personnel and to demonstrate its stability under test conditions. The efficacy of five wash agents in removing infant-acquired organisms from the hands was then explored. All agents were equally effective including water when followed by drying on a paper towel. The data show that the routine-type quick hand wash usually employed by busy aides and nurses is effective in removing patient-acquired organisms and provide additional emphasis on the importance of the hand wash procedures in prevention of spread of bacteria from patient to patient.

311. State, W., Program for the evaluation and approval of marketed sanitizers. General Procedures, 1997. Handwashing - Antimicrobial.

Wisconsin State Division of Health. General procedures set for by the Department on Evaluation of Sanitizers for all who intend to participate in this program. Laboratory Testing, Method of Product Submission, Test Requirements, Publication, and Labeling.

312. Steere, A.C. and Mallison, G.F., Handwashing practices for the prevention of nosocomial infections. Annals Int. Med., 1975. 83(683-690). Handwashing - Binder.

Handwashing is generally considered the most important procedure in preventing nosocomial infections, because many types of these infections may be caused by organisms transmitted on the hands of personnel. Personnel should wash their hands before and after significant contact with any patient. The risk of personnel acquiring transient hand carriage of organisms is usually greatest after significant contact with any patient. The risk of personnel acquiring transient hand carriage of organisms is usually greatest after contact with excretions, secretions, or blood; patients at greatest risk are those undergoing surgery, those with catheters and newborn infants. Although hand washing with an antiseptic agent between patient contact is theoretically desirable, handwashing with soap, water, and mechanical friction are sufficient to remove most transiently acquired organisms. Antiseptic agents may produce excessively dry skin if used frequently, and any regimen of handwashing that leads to dermatitis negated the purpose of handwashing. We favor antiseptic for handwashing before surgery and other high-risk invasive procedures and in the care of newborn infants, but prefer soap and water for other hand washing.

313. Stevens, S., Is there a place for alcohol based hand rubs in food premises. Environmental Health Review, 2007(Summer): p. 48-54. Handwashing - Antimicrobial.

This paper will attempt to show that there may indeed be a place for the use of alcohol based hand rubs within the food handling industry, even with the perceived limitations in efficacy presented by hands that may be soiled by organic matter. Its usefulness will be compared only to what is known as a "social" handwash (with plain soap and water) as this is the only other method of hand hygiene commonly found in a food handling environment. Comparison to products with higher-level disinfectants that are commonly found in healthcare settings, such as Chlorhexidine or Triclosan, will not be considered here as they are not widely available in food premises.

314. Stiles, M.E. and Sheena, A.Z., Efficacy of low-concentration iodophore for germicidal hand washing. J. Hyg. (Camb.), 1985. 94: p. 269-277. Handwashing - Antimicrobial.

The efficacy of iodophor germicides containing different concentrations of available iodine against transient (inoculated) bacteria and the natural hand microflora was compared with chlorhexidine gluconate (2 and 4%) liquid detergent (Hibitane), non-germicidal soap and a tap water rinse. The tap water rinse was ineffective compared with all other treatments. Only 4% chlorhexidine gluconate liquid detergent and iodophor containing 0.75% available iodine were significantly better than the non-germicidal soap for reduction of transient bacteria, Escherichia coli and Pseudomonas fluorescens, that had been inoculated

- onto hands. These agents also cause a significant reduction in the number of natural microorganisms released from hands after a standard 15 second hand wash. The low-concentration iodophor products and the product containing 2% chlorhexidine gluconate failed to give results significantly better than the non-germicidal control soap. Baird-Parker medium and standard aerobic plate counts were highly correlated ( $r=0.82$ ), so that for studies of Gram-negative bacteria inoculated onto hands as a transient microflora, counts on Baird-Parker medium give a reasonable indication of natural (residual hand microflora).
315. Stiles, M.E. and Sheena, A.Z., Efficacy of germicidal hand wash agents in use in a meat processing plant. *J. Food Protect.*, 1987. 50(4): p. 289-295. Handwashing - Antimicrobial.
- The in-use efficacy of a selected range of germicidal hand wash agents was tested in a meat processing plant. The hand washes included non-germicidal soaps and germicidal agents containing chlorhexidine, iodophor and Irgasan DP 300 as active ingredients. A laboratory study was done under controlled conditions with standardized procedures for hand washing; in the meat plant, "normal" (unstandardized) hand wash procedures were followed. Levels of contamination of hands varied markedly between work units. Only in the meat cutting area could a significant difference be attributed to hand wash agents against transient bacteria on workers' hands. The hand wash agent with 4% chlorhexidine gluconate, the iodophor with 0.75% available iodine and the gel containing 0.3% Irgasan DP 300 were the only products that gave a significantly better reduction of transient bacteria than non-germicidal soap. Transient bacteria were detected on hands after washing, indicating that under the in-use conditions in the meat processing plant, hand wash techniques did not remove all of these bacteria from hands. The plant workers generally indicated a dislike for the iodophor products as germicides.
316. Stuller, J., Cleanliness has only recently become a virtue. *Smithsonian*, 1991. 21(11): p. 126-134. Handwashing. History of bathing.
317. Susman, E., Too clean for comfort. *Environ Health Perspect*, 2001. 109(1). Handwashing - Antimicrobial.
- A research survey of liquid and solid soaps from across the country reveals that 45% contained antibacterial agents—chemicals that scientists say may not benefit human health but might instead create stronger bugs. In a presentation at the annual meeting of the Infectious Diseases Society of America in September 2000, Eli N. Perencevich, a research fellow in infectious diseases at Beth Israel Deaconess Medical Center in Boston, and colleagues described how they went through the lists of liquid and solid soaps sold in 23 national and local stores to see how many of them contained antibacterial agents. Nevertheless, says Perencevich, "The magnitude of the availability of antibacterial soap products that we documented in our survey is cause for concern. This study suggests that further surveillance and study of triclosan resistance is warranted."
318. Sussman, G.L. and Beezhold, D.H., Allergy to latex rubber. *Ann Intern Med*, 1995. 122: p. 43-46. Handwashing - Gloves.
- Objective: To summarize the clinical symptoms of latex rubber allergy and provide guidelines for the management of this allergy.
319. Sweeney, A.E., Food safety resource list - hand washing. List of Resources, 2005. Handwashing. (USDA-FDA). General/Food industry citations. Medical Literature citations. 2.
320. Talaro, K. and Talaro, A., Quest for sterile skin. Book chapter, 1996. Handwashing. Microbiology Chapter 11. Heavy Metal Compounds, Hydrogen Peroxide and Related Germicides - Applications, Chemicals with Surface Action: Detergents - Applications.
321. Taylor, J.S. and Praditsuwan, P., Latex allergy - review of 44 cases including outcome and frequent association. *Arch Dermatol*, 1996. 132: p. 265-271. Handwashing - Gloves.
- BACKGROUND AND DESIGN:** Latex allergy is a type I reaction to natural rubber latex (NRL) proteins with clinical manifestations ranging from contact urticaria to fatal anaphylaxis. Previous US studies on NRL allergy have largely been reported by allergists with little detailed information on concomitant hand eczema, contact allergy, or on outcome. The charts of all patients with latex allergy seen between 1980 and 1994 in a dermatology department are reported with results of history; prick, scratch, wear, and patch tests; latex radioallergosorbent test; and follow-up questionnaire. **RESULTS:** There were 44 patients (37 female) with NRL allergy; 34 of whom had atopy. In 38 it was occupationally related, with all but two in health-related professions. Of the six nonoccupational cases, three had spina bifida. Twenty-nine had local skin reactions of urticaria and/or pruritus; seven, anaphylaxis; and eight, contact urticaria with other systemic symptoms. The diagnosis was based on a positive prick or scratch test to NRL in 37 cases, a class 2 or greater latex radioallergosorbent test in five cases, and strongly positive wear test results to an NRL glove in two cases. Thirty-six patients had hand eczema, with 26 having relevant positive patch test results that included glutaraldehyde, latex and vinyl gloves, and rubber chemicals. Follow-up revealed one patient quit work and eight changed jobs or tasks because of NRL allergy, 33 of 39 continued to have symptoms at work, and 12 had lost work time because of latex allergy symptoms. **CONCLUSIONS:** Latex allergy was frequently seen in health care or dental workers, which was frequently associated with systemic symptoms, hand eczema, and allergic contact dermatitis. Most continue to work, but remained symptomatic. Patients with NRL allergy should be provided information on nonlatex devices and latex avoidance in medical, dental, and occupational settings. Low-NRL allergen gloves should be worn by coworkers of health care workers with NRL allergy.
322. Taylor, L.J., Evaluation of handwashing techniques. *Nursing Times*, 1978(Jan. 12): p. 54-55. Handwashing - Antimicrobial.
- Review article. Hand disinfection by ward staff with 70% alcohol is generally effective (Ayliffe, et al., 1975). In some instances a large number of organism survived this treatment, suggesting that the method of application was inadequate. This was confirmed in laboratory studies. A preliminary test was carried out using the same technique but the addition of a dye to 70% alcohol. This revealed that one of the nurse volunteers failed to cover the tip of her thumb with the solution (Babb et al., 1977). The use of a dye for investigating the efficiency of applying disinfectants to the hands has been described previously (Reber, 1976), but this technique has not been used in this country to any extent. Indications are that the dye method is a good way of studying the effectiveness of handwashing by all grades of a nursing staff.

323. Teare, L., Cookson, B., and Stone, S., Hand hygiene - use alcohol hand rubs between patients: They reduce the transmission of infection. *BMJ*, 2001. 323: p. 411-412. Handwashing - Antimicrobial.  
[\[http://bmj.bmjournals.com/cgi/content/full/323/7310/411\]](http://bmj.bmjournals.com/cgi/content/full/323/7310/411) BMJ Editorial. Formal handwashing with soap and water is required when there is soiling. When there is none the hand hygiene liaison group now advocates that staff should use an alcohol-glycerol hand rub between patients. Alcohol hand rubs are quick to use (10-20 instead of 90-120 seconds) and can be used while walking and talking. Thus they overcome objections to hand washing, including lack of time, lack of sinks, and skin damage. Indeed, a recent study has shown that such hand rubs cause less irritation than soaps.<sup>6</sup> The Epic systematic review would appear to support this strategy because it shows that, though liquid soap and water decontaminate hands, 70% alcohol or an alcohol based antiseptic rub decontaminates hands more effectively for a wide variety of organisms, including *S aureus*, *Pseudomonas aeruginosa*, *Klebsiella* spp, and rotavirus.
324. Tebbut, G.M., Evaluation of various working practices in shops selling raw and cooked meats. *J Hyg Camb*, 1986. 97: p. 81-90. Handwashing.  
 Three groups of premises (butchers' shops, supermarkets and general dealers) which sell raw and cooked meats were compared. *Salmonellas* were not detected, but *Escherichia coli*, and to a lesser degree *Staphylococcus aureus* and *Streptococcus faecalis*, were widely distributed in all three groups of premises. Contamination of hands, towels and nail brushes was related to poor working practices. The presence of *E. coli* or *Str. faecalis* on slicing machines was associated with contamination of meat samples. A number of wiping cloths were heavily contaminated with *E. coli*, and many also contained *Clostridium perfringens*. Fewer premises provided written cleaning plans, and in many cases staff did not receive an adequate training in food hygiene. The use of disinfectants as part of the cleaning process did not necessarily reduce the level of bacterial contamination. In general there was poor correlation between microbiological results and a visual inspection made by an environmental health officer. The possible reasons for this finding are discussed.
325. Thomas, M., et al., Focus group data as a tool in assessing effectiveness of a hand hygiene campaign. *Am J Infect Control*, 2005. 33: p. 368-373. Handwashing.  
 Background: Routine handwashing has been proven to decrease incidence of health care-associated infections, including methicillin-resistant *Staphylococcus aureus* (MRSA), spawning numerous attempts to "advertise" its importance. However, most control measures fail to evaluate systematically the efficacy of handwashing initiatives. The purpose of this study was to implement a hand hygiene program in an academic medical center, utilizing visual cues developed with periodic input from hospital personnel. Methods: After estimation of baseline compliance (20%), visual cues in the form of 11" x 17" posters were developed in a sequential fashion, based on suggestions from participants. The stepwise approach was supported by data collected via focus groups. These data were used to design target-specific messages and to understand better the benefits of utilizing participant input. Results: Postexposure compliance rates indicated a modest improvement over baseline, increasing to 37% during the 12-month study. In addition, the stepwise design proved to be highly useful in guiding the intervention process. Analysis of qualitative data also elucidated numerous routes through which effective hand hygiene campaigns could be implemented. Conclusions: Through diligent observation and participant feedback, the research team was able to develop and market educational cues to meet service demands of health care professionals in a unified effort to control health care-associated infections. Future interventions should employ incremental evaluation designs supported by participant input to develop effective hand hygiene initiatives. .
326. Todd, E., et al., Hazard identification in the fresh produce industry. *J Food Protect*, 2003. 66(Sup A): p. 183. Handwashing - Michaels.  
 This symposium will focus on soil amendment safety, survival of human pathogens on fresh produce, and hazards identified in FDA farm investigation. We will also review the likelihood of occurrence of pathogens in fresh-cut produce, and risk assessment in transportation and distribution of produce. Abstract only.
327. Troller, J.A., Personal hygiene (chapter 8). Book Chapter, 1983. Handwashing - Binder.  
 Chapter 8 from Sanitation in Food Processing by John A. Troller. Excellent chapter on personal hygiene. Very good section on hand washing, supplies and location of handwashing facilities. Extensive precautions such as those used to attempt to sterilize skin are not necessary for the food industry, however careful and frequent hand washing will do much to reduce hand contamination. ----Sufficient time and vigorous scrubbing are the two principle prerequisites. At least 30 sec. should be devoted to active scrubbing. Many food plants also make cleaning under fingernails a requirement. Unless there are specific reasons for dipping hands in a solution of chlorine, iodine, or quats, it is not advised because of possible allergic conditions and chapping of hands. Supports use of bar soaps, particularly those with bactericidal formulations instead of liquid soaps. Does not recommend use of skin lubricants or barrier creams because they can be carried into food product area. Recommends use of electric dryers or paper towels for drying hands (no use of the communal cloth towel). Gloves Advantage of wearing gloves: A sterile contact surface (initially) is assured, and potentially pathogenic bacteria on the skin are not permitted to enter foods as long as the glove is not torn or breached in some way. Alternatively, skin under gloves is occluded and heavily contaminated perspiration builds up rapidly between the internal surface of the glove and the skin. Accidental rips or tears in the glove then allows massive contamination of food. Gloves seem to promote a kind of complacency that is not conducive to good hygienic habits. Gloves are expensive and occasionally they find their way into food products due to carelessness. Does not recommend glove use in food processing or in the serving environment, and that effective hand washing be strictly adhered to. At the same time there are specific circumstances and conditions that justify the use of gloves.
328. Truscott, W.M. and Roley, L., Glove-associated reactions and barrier preservation in the cleanroom. *Cleanrooms*, 1995(June). Handwashing - Gloves.  
 Lists the symptoms of various sensitivities to gloves and how to work around them.

329. Turjanmaa, K., et al., Rubber contact urticaria: Allergenic properties of 19 brands of latex gloves. *Contact Dermatitis*, 1988. 19: p. 362-367. Handwashing - Gloves.
- To compare the immediate skin test reactivity of various latex (natural rubber) surgical and cleaning gloves. prick tests were performed on 40 latex-allergic persons, 26 of whom were sensitized by surgical and 14 by cleaning latex gloves. 6/17 surgical gloves tested and 1/2 cleaning gloves caused positive reactions in almost all (over 87%) of the allergic subjects. In contrast. the frequencies of positive reactions to 4 other surgical latex gloves were as low as 8–21%, suggesting that not all surgical gloves are equally allergenic. Control prick tests with 1 synthetic rubber and 1 polyvinyl chloride (PVC) glove were negative in all subjects. 2 surgical latex gloves causing either a high or low number of positive prick tests in allergic subjects were analyzed with high-pressure liquid chromatography (HPLC). Similar allergenic protein fractions were detected, which showed protein peaks at MW 2000 5000 and 3000 daltons. Corresponding proteins were detected in 1 latex cleaning glove analyzed and in natural rubber. This result confirms that allergenic proteins persist in various surgical and cleaning latex gloves after manufacture from natural rubber and may cause contact, urticaria symptoms in sensitized people.
330. Unglow, R., Food handling gloves. Email Correspondence, 2000. Handwashing - Gloves.
- Food Handling Gloves and Inverted Bags/Utensils. Some suggestions for retailers to keep bare-hand contact with food at a minimum.
331. Updegraff, D.M., Cultural method of quantitatively studying the microorganisms in the skin. *J. Invest. Dermatol.*, 1964. 43: p. 129-137. Handwashing - Binder.
- The purpose of this study was to develop a method for enumerating the number of bacteria in human skin with regard to depth in the stratum corneum as well as area. None of the many methods employed to date can accomplish this purpose. Such a method should find use in the study of the flora of both normal and pathological skin, and in the comparative evaluation of skin. A plastic-tape stripping method was developed for the quantitative enumeration and cultivation of the microorganisms present in human skin. It was found that many tapes are highly bacteriostatic. A suitable transparent tape was found which has little or no bacteriostatic activity, and a culture medium was developed which has little or no bacteriostatic activity, and a culture medium was developed which neutralizes any residual bacteriostatic action. Using this tape, Scotch brand 850 (3-M, St. Paul, MN.) 14 successive layers of the stratum corneum, one cell thick were removed and examined culturally for microorganisms. The total number of colonies obtained was compared with counts obtained by other methods. The counts were much lower, indicating that the tape stripping method enumerates colonies of bacteria, while the other published methods enumerate the total number of individual cells.
332. USDA-FDA, Food safety links - hand washing. List of Links, 2005. Handwashing.
- Curricula, videos, and other teaching materials. Web sites. Guides, fact sheets, manuals. Signs and posters. Forms. Online slides and videos. Real-time database search.
333. van der Hoeven, E. and Hinton, N.A., Assessment of the prolonged effect of antiseptic scrubs on the bacterial flora of the hands. *Can. Med. Assoc. J.*, 1968. 99: p. 402-407. Handwashing - Binder.
- The degree to which the bacterial flora of the hands is altered by serial basin scrub technique to estimate skin flora, the effects of povidone-iodine, hexachlorophene, hexachlorophene-chloroxylenol were compared. A 10 minute daily scrub with any other agents tested substantially reduced the bacterial flora of the hands for prolonged periods of time. Hexachlorophene-chloroxylenol produced the most prolonged reduction. It is recommended that all hospital personnel having contact with patients should be required to perform a surgical-type hand scrub with a hexachlorophene preparation once a day and to wash the hands with hexachlorophene soap between patient contacts.
334. van Warner, R., Taking off the gloves: Sanitation starts with clean hands. Magazine Article, n.d. Handwashing - Gloves.
- Article identification materials are absent. Includes quotations from Peter Snyder on the effectiveness of handwashing and glove use and New York's new barrier law against direct food contact.
335. Vesley, D., Lillquist, D.R., and Le, C.T., Evaluation of nongermicidal handwashing protocols for removal of transient microbial flora. *Appl Environ. Microbiol.*, 1985. 49(5): p. 1067-1071. Handwashing.
- A method is described which compared the efficacy of different non-germicidal hand washing protocols for removal of transient microbial flora without the necessity of establishing or relying on a previously determined baseline for an individual subject. The wash effluent was collected, and colony counts for the effluent reflect the number removed by the wash protocol. A second standard wash in a hand washing machine was performed and the test is the percent removed in the test wash based on the sum of total CFU recovered from the two washes. The method was used to compare an 8 second cycle for a newly developed handwashing machine with a conventional 15 second Ivory soap wash. When machine pressure was adequate (42 lb/in<sup>2</sup>), there was no statistically significant difference in the percent removal of transient flora by the two methods (48.8% from the machine versus 45.1% from the Ivory soap wash). At 32 lb/in<sup>2</sup>, the Ivory soap wash recovered 60.3%, where as the machine recovered 45.1%. 2.
336. Villages, H.E.T., Handwashing handbook. Handbook, 2005. Handwashing.
- A guide for developing a hygiene promotion program to increase handwashing with soap. Describes a new approach to handwashing promotion, building on the pioneering work of the Public-Private Partnership for Handwashing with Soap. It explains how the latest thinking in industrial marketing can be combined with the latest research in public health to provide powerful new insights to drive effective handwashing campaigns. It offers lessons from national programs in Ghana, Peru, Senegal, and other countries. Early indicators suggest that this may be the start of an exciting new field in public health in the 21st century. FORWARD ONLY - full PDF available from Health Education to Villages: [http://www.globalhandwashing.org/Publications/Handwashing\\_Handbook.pdf](http://www.globalhandwashing.org/Publications/Handwashing_Handbook.pdf) (linked from <http://hetv.org/programmes/soap-and-water.htm>).

337. Voss, J.G., Effects of an antibacterial soap on the ecology of aerobic bacterial flora of human skin. *Appl. Microbiol.*, 1975. 30(4): p. 551-556. Handwashing - Binder.  
The effects of ad lib used of an antibacterial soap containing 1.0% trichlorobarnilide and 0.5% trifluoromethyldichlorocarbanilide on the bacterial flora of six skin sites of 132 subjects were measured by comparison with the flora of 93 control subjects who avoided the use of topical anti bacterials. Each subject was examined once. The test soap produced significant reductions on the geometric mean counts of the total aerobic flora on the back, chest, forearm, calf, and foot; counts were also reduced in the axilla, but not to a significant extent. The overall reduction by the test soap on all sites was 62% ( $P < 0.001$ ). Neither age nor sex influenced the effect of the soap on the flora. The antibacterial soap also reduced the prevalence of *Staphylococcus aureus* on the skin, mostly by virtually eliminating it from areas other than the axilla; *Klesiella pneumoniae* and *Enterobacter aerogenes* were the species most commonly found.
338. Waler, P.E., Mechanical air drying of hands following preoperative scrubbing. *Public Health Reports*, 1953. 68(3): p. 317-319. Handwashing - Michaels.  
Conclusions: Bacteriological studies showed a probably significant reduction of gross contaminatin of the hands when a mechanical air dryer was used. The mechanical air-drying technique is less expensive than the towel-drying technique.
339. Weatheral, J.A.C. and Winner, H.I., Intermittent use of hexachlorophene soap: A controlled trial. *J. Hyg. (Camb.)*, 1963. 61: p. 443-449. Handwashing - Binder.  
In this investigation, nurses used hexachlorophene soap only while at work. Any washing with other soaps or detergents while not at work probably removed any hexachlorophene which had accumulated during work, so that no effective antibacterial concentration of hexachlorophene was ever reached. This work shows that hexachlorophene soap has no effect in reducing the number of superficial bacteria on the hands. The number of bacteria on the hands of nurses using 2% hexachlorophene soap intermittently was compared with the numbers of bacteria on the hands of nurses using ordinary soap. No significant differences were observed.
340. Wedderburn, D.L., Antiseptic cream for use on the hands in food establishments. *Brit. J. Indust. Med.*, 1960. 17: p. 125-129. Handwashing - Binder.  
An antiseptic cream containing benzalkonium chloride as germicide has been developed for use on the hands. It inhibits growth on agar of staphylococci, *E. Coli*, and *S. typhymurium*. It persists on the fingers, kills organisms applied to the skin and reduces the normal bacterial population of skin. It is convenient to apply and has been found acceptable by workers in several food factories.
341. White, C., et al., Effect of hand hygiene on illness rate among students in university residence halls. *Am J Infect Control*, 2003. 31(6): p. 364-370. Handwashing - Antimicrobial.  
Background: Several studies have indicated a connection between hand sanitization and infection control in numerous settings such as extended care facilities, schools, and hospitals. The purpose of this study was to assess the effectiveness of both a hand-hygiene message campaign and the use of an alcohol gel hand sanitizer in decreasing the incidence of upper-respiratory illness among students living in university residence halls. Method: This study involved a total of 430 students recruited from 4 residence halls during the fall semester at the University of Colorado at the Boulder campus. Dormitories were paired into control and product groups. In the product groups, alcohol gel hand-sanitizer dispensers were installed in every room, bathroom, and dining hall. The data were statistically analyzed for the differences between product and control groups in reported symptoms, illness rates, and absenteeism from classes. Results: The overall increase in hand-hygiene behavior and reduction in symptoms, illness rates, and absenteeism between the product group and control group was statistically significant. Reductions in upper respiratory-illness symptoms ranged from 14.8% to 39.9%. Total improvement in illness rate was 20%. The product group had 43% less missed school/work days. Conclusion: Hand-hygiene practices were improved with increased frequency of handwashing through increasing awareness of the importance of hand hygiene, and the use of alcohol gel hand sanitizer in university dormitories. This resulted in fewer upper respiratory-illness symptoms, lower illness rates, and lower absenteeism. .
342. Williams, G., Biology of ... Handwashing: Your mother was right - in an age when antibiotics don't kill germs very well, soap does. *Discover Magazine*, 1999. 20(12). Handwashing - Antimicrobial.  
No matter how long you wash, the ancient flora will soon reemerge from hiding—from subungual spaces, sweat glands, hair follicles, and skin folds—and bloom again. For surgeon Kim and the rest of us, there will be many more rounds in this fight. But you know what to do: Shake hands at your own risk, and keep washing until that nursery song drives you nuts. [<http://discovermagazine.com/1999/dec/feathand>].
343. Wrangsjo, K., Osterman, K., and van Hage-Hamstein, M., Glove-related skin symptoms among operating theatre and dental care unit personnel (i) interview investigation. *Contact Dermatitis*, 1994. 60: p. 102-107. Handwashing - Gloves.  
233 employees in hospital and dental care participated in an interview investigation on glove-related skin complaints. 37% (87/233) reported skin symptoms related to glove use. 2% (4/233) reported localized contact urticaria provoked by latex gloves, 10% (23/233) hand eczema and 24% (56/233) unclassifiable skin intolerance reactions from gloves. Another 2% (4/233) reported facial irritation from gloves. Glove-related skin symptoms were thus reported by more than 1/3 of the personnel and the reported glove-provoked contact urticaria constituted 5% (4/87) of the intolerance reactions.
344. Yangco, B.G. and Yangco, N.F., What is leaky can be risky: A study of the integrity of hospital gloves. *Infect Control Hosp Epidemiol*, 1989. 10(12): p. 553-556. Handwashing - Gloves.  
One thousand six-hundred and eighteen medical gloves were tested to determine whether, with current increased demands, these gloves are of high quality, i.e., free of leaks. The risk of exposure to potentially infected fluids when using leaky gloves was also estimated. Using a four-stage leak test, no significant difference was found between 64 of 790 (8.1%, range 0% to 44.4%)

unsterile latex gloves and 11 of 210 (5.2%, range 1.7% to 21.7%) unsterile vinyl gloves ( $p = .21$ ). Sterile surgical gloves (7 of 618, 1.13% [range 0% to 3%]) had fewer leaks compared to unsterile latex and vinyl gloves combined ( $p$  less than .0001). The safranin test was positive in 27 of 28 (96.4%) leaky gloves tested, indicating a high risk of exposure to potentially infected fluids when leaky gloves are used. Because of these findings, elements of "universal precautions" such as changing gloves after each patient contact and good handwashing after using gloves should be carefully observed. There is a need for the Food and Drug Administration to establish more stringent guidelines for manufacturing gloves and to verify compliance with these guidelines.

345. Zaragoza, M., et al., Handwashing with soap or alcoholic solutions? A randomized clinical trial of its effectiveness. *Am J Infect Control*, 1999. 27: p. 258-261. Handwashing - Antimicrobial.

Background: The effectiveness of an alcoholic solution compared with the standard hygienic handwashing procedure during regular work in clinical wards and intensive care units of a large public university hospital in Barcelona was assessed. Methods: A prospective, randomized clinical trial with crossover design, paired data, and blind evaluation was done. Eligible health care workers (HCWs) included permanent and temporary HCWs of wards and intensive care units. From each category, a random sample of persons was selected. HCWs were randomly assigned to regular handwashing (liquid soap and water) or handwashing with the alcoholic solution by using a crossover design. The number of colony-forming units on agar plates from hands printing in 3 different samples was counted. Results: A total of 47 HCWs were included. The average reduction in the number of colony-forming units from samples before handwashing to samples after handwashing was 49.6% for soap and water and 88.2% for the alcoholic solution. When both methods were compared, the average number of colony-forming units recovered after the procedure showed a statistically significant difference in favor of the alcoholic solution ( $P < .001$ ). The alcoholic solution was well tolerated by HCWs. Overall acceptance rate was classified as "good" by 72% of HCWs after 2 weeks use. Of all HCWs included, 9.3% stated that the use of the alcoholic solution worsened minor pre-existing skin conditions. Conclusions: Although the regular use of hygienic soap and water handwashing procedures is the gold standard, the use of alcoholic solutions is effective and safe and deserves more attention, especially in situations in which the handwashing compliance rate is hampered by architectural problems (lack of sinks) or nursing work overload. (*AJIC Am J Infect Control* 1999;27:258-61)