HAND HYGIENE BIBLIOGRAPHY

Berndt U., Wigger-Alberti W., Gabard B., and Elsner P. Efficacy of a barrier cream and its vehicle as protective measures against occupational irritant contact dermatitis. Contact Dermatitis 2000;42:77-80.

A randomized, double-blinded trial demonstrating the benefit of regular and frequent application of skin cream on the condition of nurses' hands.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10703628&dopt=Abstract

Bischoff W. E., Reynolds T. M., Sessler C. N., Edmond M. B., and Wenzel R. P. Handwashing compliance by health care workers. The impact of introducing an accessible, alcohol-based hand antiseptic. Arch Intern Med 2000;160:1017-1021.

A 6-month prospective observational study of hand hygiene compliance before and after introduction of an alcohol hand rub in two intensive care units. Hand hygiene compliance increased significantly after the alcohol hand rub was made available.

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Bonten M. J. M., Hayden M. K., Nathan C., VanVoorhis J., Matushek M., Slaughter S., Rice T., and Weinstein R. A. Epidemiology of colonisation of patients and environment with vancomycin-resistant enterococci. Lancet 1996;348:1615-1619.

Culture survey revealing that patients with VRE frequently carry the organism on healthy, intact skin above the waist and on their upper extremities – a potential source of contamination of healthcare worker hands.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8961991&dopt=Abstract

Boyce J. M., Potter-Bynoe G., Chenevert C., and King T. Environmental contamination due to methicillin-resistant Staphylococcus aureus: possible infection control implications. Infect Control Hosp Epidemiol 1997;18:622-627.

Culture survey demonstrating that environmental surfaces in the rooms of patients with MRSA are frequently contaminated with the organism, and may represent a source of contamination of healthcare worker hands.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9309433&dopt=Abstract

Boyce J. M., Kelliher S., and Vallande N. Skin irritation and dryness associated with two hand hygiene regimens: soap and water handwashing versus hand antisepsis with an alcoholic hand gel. Infect Control Hosp Epidemiol 2000;21:442-448.

Prospective, randomized clinical trial comparing the impact of soap and water handwashing versus hand antisepsis with an alcohol hand gel on condition of nurses' hands. Objective measurements and visual assessments of nurses' hands documented that nurses experienced significantly less skin dryness when using the alcohol hand gel.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10926393&dopt=Abstract

Boyce, J. M. Antiseptic techology:access, affordability and acceptance. Emerg Infect Diseases 2001;7:231-233.

Review of the importance of easy accessibility and skin compatibility of hand hygiene agents. Costs of hand hygiene agents are compared to those associated with nosocomial infections.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11294713&dopt=Abstract

Boyce, J. M. Scientific basis for handwashing with alcohol and other waterless antiseptic agents. In:Rutala, W. A., eds. *Disinfection, sterilization and antisepsis: principles and practices in healthcare facilities*. Washington, DC: Association for Professionals in Infection Control and Epidemiology, Inc, 2001:140-151.

Review of studies demonstrating the efficacy of alcohol-based hand rubs for hand antisepsis, and the advantages of such agents when compared to soap and water handwashing.

Boyce, J. M., Pittet, D., and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Hand hygiene guideline for healthcare settings. (MMWR in press)

New evidence-based hand hygiene guidelines for healthcare facilities, developed by a multi-organizational task force. Includes extensive literature review and

recommendations on new strategies for improving hand hygiene practices among healthcare workers, including greater use of alcohol-based hand rubs.

Bryant KA, Pearce J, and Stover B. Flash fire associated with the use of alcohol-based in antiseptic agent. Am J Infect Control 2002; 30:256-257.

This paper describes a very rare side effect of using alcohol-based hand rubs. A nurse applied an alcohol-based hand rub, and then removed an isolation gown, generating a large amount of static electricity. Before allowing the alcohol on her hands to dry, she touched a metal door, igniting the alcohol on her hands. ***Note: Previous reports of this nature have not been published despite use of alcohol handrubs in parts of Europe for several decades.***

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12032505&dopt=Abstract

Casewell M. and Phillips I. Hands as route of transmission for Klebsiella species. Br Med J 1977;2:1315-1317.

Study showing how nurses may contaminate their hands when touching normal, intact areas of patients' skin. Nosocomial infection rates decreased with increasing handwashing.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=589166&dopt=Abstract

Codell Carter, K. *The etiology, concept, and prophylaxis of childbed fever.* Wisconsin: Semmelweis; 1983.

Abridged English translation of landmark studies by Ignaz Semmelweis, demonstrating that cleaning hands with a chemical disinfectant reduced maternal mortality due to nosocomial infections better than washing hands with plain soap and water.

Doebbeling B. N., Pfaller M. A., Houston A. K., and Wenzel R. P. Removal of nosocomial pathogens from the contaminated glove. Ann Intern Med 1988;109:394-398.

Study showing the ability of bacteria to penetrate gloves and contaminate hands of volunteers. Emphasizes the need to clean hands after glove removal.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3136685&dopt=Abstract

Doebbeling B. N., Stanley G. L., Sheetz C. T., Pfaller M. A., Houston A. K., Annis L., Li N., and Wenzel R. P. Comparative efficacy of alternative hand-washing agents in reducing nosocomial infections in intensive care units. N Engl J Med 1992;327:88-93.

Prospective trial comparing impact on nosocomial infections of handwashing with chlorhexidine soap versus handwashing with non-medicated soap or alcohol hand rinse. Because little alcohol was used, the trial compared primarily chlorhexidine soap versus non-medicated soap; infection rates were lower when chlorhexidine was used.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1285746&dopt=Abstract

Earl M. Improved rates of compliance with hand antisepsis guidelines. Am J Nursing 2001;101:26-33.

Prospective observational study which documented that hand antisepsis rates improved after an easily accessible alcohol hand gel was made available in two intensive care units.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11279993&dopt=Abstract

Ehrenkranz N. J. and Alfonso B. C. Failure of bland soap handwash to prevent hand transfer of patient bacteria to urethral catheters. Infect Control Hosp Epidemiol 1991;12:654-662.

Innovative clinical study which found that nurses who contaminated their hands by touching patients transferred the patient's flora to urinary catheter material despite washing their hands with plain soap and water. In contrast, alcohol hand disinfection prevented transfer of organisms in most experiments.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=17553080&dopt=Abstract

FDA. Tentative final monograph for healthcare antiseptic drug products; proposed rule. Federal Register 1994.

FDA document outlining hand hygiene agents felt to be safe and effective. Includes description of criteria required to demonstrate efficacy of such agents

Foca M., Jakob K., Whittier S., Della Latta P., Factor S., Rubenstein D., and Saiman L. Endemic Pseudomonas aeruginosa infection in a neonatal intensive care unit. N Engl J Med 2000;343:695-700.

An outbreak investigation which implicated healthcare workers who wore artificial fingernails or had onychomycosis as a source of P. aeruginosa acquired by infants in a NICU.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10974133&dopt=Abstract

Fox M. K., Langner S. B., and Wells R. W. How good are hand washing practices? Am J Nursing 1974;74:1676-1678.

An observational study of handwashing technique among 90 nursing personnel found that breaks in technique were common, and duration of handwashing was too short.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=4496520&dopt=Abstract

Garner J. S. Guideline for isolation in hospitals. The Hospital Infection Control Practices Advisory Committee. Infect Control Hosp Epidemiol 1996;17:53-80.

Isolation guidelines, which include a recommendation to either wash hands with an antiseptic soap or use a waterless antiseptic agent (e.g., an alcohol-based hand rub) for cleaning hands after caring for patients with multi-drug resistant pathogens.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8789689&dopt=Abstract

Girou E, Loyeau S, Legrand P, et al. Efficacy of handrubbing with alcohol based solution versus standard handwashing with antiseptic soap: randomised clinical trial. B Med J 2002;325:362-366.

Unlike many laboratory-based studies, this ward-based study involved healthcare workers who were caring for ICU patients. Their hands were cultured before and after cleaning their' hands with either antimicrobial soap or an alcohol-based hand rinse. The authors found that the alcohol hand rinse reduced bacterial counts on the hands of personnel significantly better than handwashing.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12183307&dopt=Abstract

Gottardi, W. Iodine and iodine compounds. In:Block, S. S., eds. *Disinfection, Sterilization and Preservation*. Philadelphia: Lea & Febiger, 1991:152-166.

This book chapter reviews the mechanism of action and efficacy of iodine and iodophor antiseptics.

Johnson S., Gerding D. N., Olson M. M., Weiler M. D., Hughes R. A., Clabots C. R., and Peterson L. R. Prospective, controlled study of vinyl glove use to interrupt Clostridium difficile nosocomial transmission. Am J Med 1990;88:137-140.

Prospective controlled trial demonstrating that frequent glove use by health personnel was associated with reduced transmission of C. difficile.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2301439&dopt=Abstract

Jones R. D., Jampani H. B., Newman J. L., and Lee A. S. Triclosan: a review of effectiveness and safety in health care settings. Am J Infect Control 2000;28:184-196.

Review article dealing with triclosan as hand antiseptic agent.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10760227&dopt=Abstract

Korniewicz D. M., Laughon B. E., and Butz A. Integrity of vinyl and latex procedures gloves. Nurs Res 1989;38:144-146.

Study showing that Serratia marcescens was able to penetrate vinyl gloves more frequently than latex gloves under conditions simulating clinical use. Emphasizes the need to clean hands after removing gloves.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2654892&dopt=Abstract

Kretzer E. K. and Larson E. L. Behavioral interventions to improve infection control practices. Am J Infect Control 1998;26:245-253.

Excellent review article of behavioral theories that should be considered when developing new programs to modify handwashing habits of healthcare personnel.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9638287&dopt=Abstract

Larson E. and Killien M. Factors influencing handwashing behavior of patient care personnel. Am J Infect Control 1982;10:93-99.

One of the early questionnaire studies of healthcare worker attitudes affecting handwashing practices. Issues raised by the paper are still very pertinent today.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6922685&dopt=Abstract

Larson E. Compliance with isolation technique. Am J Infect Control 1983;11:221-225.

Observational study documenting levels of compliance of personnel with recommended barrier precautions and handwashing.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6559546&dopt=Abstract

Larson E., Silberger M., Jakob K., Whittier S., Lai L., Della Latta P., and Saiman L. Assessment of alternative hand hygiene regimens to improve skin health among neonatal intensive care unit nurses. Heart Lung 2000;29:136-142.

A prospective, randomized trial which found that using a mild soap for cleaning and an alcohol rinse for degerming hands produced less skin damage than washing hands with chlorhexidine-containing soap.

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Larson E. and Kretzer E. K. Compliance with handwashing and barrier precautions. J Hosp Infect 1995;30 (suppl):88-106.

In-depth review of literature dealing with compliance of healthcare workers with universal precautions, other indications for glove use, and handwashing.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7561001&dopt=Abstract

Larson E., Aiello A. E., and Heilman J. M. Comparison of different regimens for surgical hand preparation. AORN J 2001;73:412-432.

A small clinical trial comparing a traditional surgical scrub with 4% chlorhexidine gluconate (CHG) detergent versus application of a waterless hand rinse containing 61% ethyl alcohol plus 1% CHG and emollients. The alcohol preparation was more effective than CHG detergent in reducing viable bacterial counts on the hands of staff, produced less skin damage, and was less expensive.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11218929&dopt=Abstract

Larson E. L., Eke P. I., and Laughon B. E. Efficacy of alcohol-based hand rinses under frequent-use conditions. Antimicrob Agents Chemother 1986;30:542-544.

Laboratory-based study involving volunteers who cleaned their hands 15 times a day for 5 days with either a non-antimicrobial soap, a 4% CHG-based detergent, or one of 3 alcohol-based hand rinses. The alcohol-based products were highly efficacious.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3789690&dopt=Abstract

Larson E. L., Eke P. I., Wilder M. P., and Laughon B. E. Quantity of soap as a variable in handwashing. Infect Control 1987;8:371-375.

Laboratory-based trial comparing the microbiologic efficacy of 1 ml versus 3 ml of a non-antimicrobial soap, a CHG-based detergent and 2 alcohol-based hand rinses. The volume did not effect the efficacy of plain soap, but the larger volume was more effective when CHG detergent or alcohol rinses were used.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3654132&dopt=Abstract

Larson E. L., Butz A. M., Gullette D. L., and Laughon B. A. Alcohol for surgical scrubbing? Infect Control Hosp Epidemiol 1990;11:139-143.

Laboratory study comparing the efficacy of 70% ethyl alcohol plus 0.5% CHG to povidone-iodine, 4% CHG, triclosan and a non-medicated soap (control) as surgical scrubs. All antiseptic agents reduced viable bacteria on the hands of volunteers more effectively than the control soap. After 5 days, bacterial counts on the hands were lowest immediately after the scrub and 4 hrs after the scrub when alcohol was used.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2313083&dopt=Abstract

Larson E. L., Early E., Cloonan P., Sugrue S., and Parides M. An organizational climate intervention associated with increased handwashing and decreased nosocomial infections. Behavioral Medicine 2000;26:14-22.

An intervention trial demonstrating that implementation of a multidisciplinary program (including administrative support, recruitment of role models, and involvement by nursing managers) can improved handwashing frequency and lower nosocomial infections. Comparable improvements did not occur in the control hospital.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10971880&dopt=Abstract

Larson, E. L. Trends in hand degerming for surgical personnel: the decade of the1990s. In:*Disinfection, Sterilization and Antisepsis: Principles and Practices in Health Care Facilities*. 2001:152-156.

Timely review of studies dealing with methods for surgical hand antisepsis. Provides arguments in favor of reducing prolonged scrub routines with brushes, which damage skin, and of using alcohol-based preparations for preoperative hand antisepsis.

Larson E. L., Aiello A. E., Bastyr J., Lyle C., Stahl J., Cronquist A., Lai L., and Della-Latta P. Assessmant of two hand hygiene regimens for intensive care unit personnel. Crit Care Med 2001;29;944-951.

Prospective, randomized clinical trial comparing a 2% CHG detergent to an alcohol hand rub (with plain soap used only when hands were soiled). The two regimens had similar microbiologic efficacy. The alcohol rub regimen required less time to use, was less expensive, and left healthcare workers' skin in better condition.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11378602&dopt=Abstract

Lucet JC, Rigaud MP, Mentre F, et al. Hand contamination before and after different hand hygiene techniques: a randomized clinical trial. J Hosp Infection 2002;50:276-280.

This study involved healthcare workers whose hands became contaminated while performing a variety of common patient care activities. The authors demonstrated that both handwashing with an antimicrobial soap and hand disinfection with an alcohol-based hand rinse reduced bacterial counts on the hands of personnel significantly better than washing hands with plain soap. The greatest log reductions in bacterial counts occurred with the alcohol-based hand rinse.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12014900&dopt=Abstract

Maki D. G. The use of antiseptics for handwashing by medical personnel. J Chemother 1989;1 (Suppl):3-11.

A sequential comparative trial of non-medicated soap, 10% povidone-iodine solution, and 4% CHG for handwashing in a surgical intensive care unit. The incidence of

nosocomial infections was 50% lower when antiseptic agents were used for handwashing than when non-medicated soap was used.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2754463&dopt=Abstract

Maury E., Alzieu M., Baudel J. L., and Haram N. Availability of an alcohol solution can improve hand disinfection compliance in an intensive care unit. Am J Respir Crit Care Med 2000;162:324-327.

A prospective intervention trial of conventional handwashing (period 1) versus alcohol hand rub or conventional handwashing (period 2). Compliance of healthcare workers with recommended hand hygiene practices improved when the alcohol hand rub was available (period 2).

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10903262&dopt=Abstract

McCormick R. D., Buchman T. L., and Maki D. 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;28:302-310.

Prospective, randomized, double-blind trial to compare the effects of an oil-based lotion versus a barrier skin cream on the condition of healthcare workers. Regular use of either product improved the condition of participants' hands, and handwashing frequency increased when the lotion was being used.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10926708&dopt=Abstract

McFarland L. V., Mulligan M. E., Kwok R. Y. Y., and Stamm W. E. Nosocomial acquisition of Clostridium difficile infection. N Engl J Med 1989;320:204-210.

Elegant epidemiological study of C. difficile transmission, demonstrating the frequency of environmental contamination, contamination of care giver hands during minor patient care activities, the protective effect of gloves, and the value of washing hands with an antiseptic agent.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2911306&dopt=Abstract

McGuckin M., Waterman R., Storr J., Bowler I. C. J. W., Ashby M., Topley K., and Porten L. Evaluation of a patient-empowering hand hygiene programme in the U.K. J Hosp Infect 2001;48:222-227.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11439010&dopt=Abstract

McNeil S. A., Foster C. L., and Hedderwick S. A. Effect of hand cleansing with antimicrobial soap or alcohol-based gel on microbial colonization of artificial fingernails worn by health care workers. Clin Infect Dis 2001;32:367-372.

A demonstrating that pathogens were recovered more frequently from the nails and subungual skin of care givers wearing artificial nails than from those with natural nails,

both before and after cleaning hands with soap or alcohol. Alcohol reduced skin flora more effectively than a soap containing PCMX.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10968715&dopt=Abstract

Meers P. D. and Yeo G. A. Shedding of bacteria and skin squames after handwashing. J Hyg (Camb) 1978;81:99-105.

Laboratory study of shedding of skin squames and viable bacteria from hands before and after washing with bar soap, surgical scrubs containing either CHG, hexachlorophene or povidone-iodine, and an alcohol hand rinse. Shedding of skin squames was greatest after washing with bar soap, and least after rubbing hands with the alcohol rinse. Bacterial shedding was greatest with bar soap, and least with CHG detergent and alcohol rinse.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=690427&dopt=Abstract

Moolenaar R. L., Crutcher M., San Joaquin V. H., Sewell L. V., Hutwagner L. C., Carson L. A., Robison D. A., Smithee L. M., and Jarvis W. R. A prolonged outbreak of *Pseudomonas aeruginosa* in a neonatal intensive care unit: did staff fingernails play a role in disease transmission? Infect Control Hosp Epidemiol 2000;21:80-85.

Outbreak investigation found that neonates who acquired Pseudomonas were significantly more likely to have been exposed to two nurses with Pseudomonas hand colonization. One nurse had long natural nails and the other had long artificial nails,

suggesting a possible role of long or artificial fingernails in colonization of hands with Pseudomonas.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10697282&dopt=Abstract

Mortimer E. A., Lipsitz P.J., Wolinsky E. et al. Transmission of staphylococci between newborns. Am J Dis Child 1962;104:289-295.

Prospective, controlled clinical trial comparing the influence of no handwashing versus washing with hexachlorophene soap on acquisition of S. aureus by infants in a nursery. Infants cared for by nurses who did not wash their hands between patients acquired S. aureus significantly more often and more rapidly than infants cared for by nurses who washed with an antiseptic soap between patient contacts. Compelling evidence that handwashing with an antiseptic soap reduces transmission of pathogenic microorganisms.

Muto C. A., Sistrom M. G., and Farr B. M. Hand hygiene rates unaffected by installation of dispensers of a rapidly acting hand antiseptic. Am J Infect Control 2000;28:273-276.

Intervention trial showing that a brief educational program and making an alcohol hand gel available on wards does not necessarily lead to sustained improvement in hand hygiene compliance of healthcare workers. Compliance of physicians was greatly affected by the level of compliance by attending physicians on the ward. More long-term, multidisciplinary programs to promote hand hygiene are necessary.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10840351&dopt=Abstract

Ojajarvi J., Makela P., and Rantasalo I. Failure of hand disinfection with frequent hand washing: a need for prolonged field studies. J Hyg 1977;79:107-119.

This 4-week study conducted in a neonatal unit with high handwashing frequencies found that frequent handwashing with a 4% CHG detergent resulted in increased counts of bacteria on nurses' hands and irritant contact dermatitis in a majority of nurses. Changing to a regimen of a mild detergent followed by an alcohol hand rinse containing glycerol and 0.5% CHG yielded lower bacterial counts on the hands of nurses. The study emphasizes the need to consider the impact of hand hygiene products on the skin of healthcare workers.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=267663&dopt=Abstract

Olsen R. J., Lynch P., Coyle M. B., Cummings J., Bokete T., and Stamm W. E. Examination gloves as barriers to hand contamination in clinical practice. JAMA 1993;270:350-353.

Observational study demonstrating that healthcare workers contaminated their hands with patient skin flora despite wearing gloves during patient contact, presumably via tiny holes in gloves or by contaminating their hands when removing gloves. Emphasizes the need to clean hands after glove removal.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8315779&dopt=Abstract

Passaro D. J., Waring L., Armstrong R., Bolding F., Bouvier B., Rosenberg J., Reingold A. W., McQuitty M., Philpott S. M., Jarvis W. R., Werner S. B., Tompkins L. S., and Vugia D. J. Postoperative *Serratia marcescens* wound infections traced to an out-of-hospital source. J Infect Dis 1997;175:992-995.

An epidemiologic investigation implicated a nurse who wore artificial fingernails as the probable source of an outbreak of surgical site infections. Although cultures of the nurse's hands were negative, the outbreak strain was recovered from a jar of exfoliant cream in the nurse's home. Removal of the cream ended the outbreak.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9086167&dopt=Abstract

Parienti JJ, Thibon P, Heller R, et al. Hand-rubbing with an aqueous alcoholic solution vs traditional surgical hand-scrubbing and 30-day surgical site infection rates. JAMA 2002;288:722-727.

This important randomized clinical trial determined surgical site infection rates among patients who were operated on by personnel who (a) scrubbed their hands preoperatively with traditional antimicrobial scrub solution or (b) washed their hands for one min. with a nonantimicrobial soap and then disinfected their hands with an alcohol-based hand rinse preoperatively. Postoperative surgical site infection rates among the

two groups of patients were identical, demonstrating that the alcohol-based hand rinse can safely be used as an alternative to traditional surgical hand scrubbing.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=12169076&dopt=Abstract

Pittet D., Dharan S., Touveneau S., Sauvan V., and Perneger T. V. Bacterial contamination of the hands of hospital staff during routine patient care. Arch Intern Med 1999;159:821-826.

A clinical study showing that bacterial contamination of healthcare worker hands increased with the time spent caring for patients with ungloved hands, especially during direct patient contact, respiratory care, handling body secretions, and interruptions in the sequence of patient care. Wearing gloves reduced hand contamination. Washing hands with non-medicated soap before patient care resulted in significantly higher bacterial counts on the hands than using an alcohol hand rinse.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10219927&dopt=Abstract

Pittet D., Mourouga P., Perneger T. V., and members of the Infection Control Program. Compliance with handwashing in a teaching hospital. Ann Intern Med 1999;130:126-130.

Largest and most sophisticated observational study of handwashing compliance of healthcare workers, involving more than 2800 observations and multivariate analysis. Factors associated with poor compliance included being a physician, working weekdays

or in an intensive care unit, performing procedures with a high risk of contamination, and whenworkloads were high (high intensity of care). These factors need to be considered when designing programs to promote improved hand hygiene.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10068358&dopt=Abstract

Pittet D., Hugonnet S., Harbarth S., Mourouga P., Sauvan V., and Touveneau S. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. Lancet 2000;356:1307-1312.

A 4-year study of the impact of implementing a multidisciplinary hand hygiene promotional campaign on hand hygiene compliance. The campaign included administrative support, use of "talking walls" (posting color cartoons), promoting use of an alcohol hand rinse, surveys of compliance, and feedback of compliance rates to healthcare workers. Compliance steadily increased (due primarily to increased use of alcohol hand antisepsis), and the prevalence of nosocomial infections decreased, as did the incidence of MRSA colonization/infection.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11073019&dopt=Abstract

Pittet, D. and Boyce, J.M. Hand hygiene and patient care: pursuing the Semmelweis legacy. Lancet Infectious Diseases 2001; April :9-20.

Review article, with discussion of important historical points, factors influencing hand hygiene compliance, strategies for improving compliance, and evidence supporting the impact of hand hygiene promotion on transmission of nosocomial pathogens.

Pottinger J., Burns S., and Manske C. Bacterial carriage by artificial versus natural nails. Am J Infect Control 1989;17:340-344.

Culture survey of flora on fingertips of 56 nurses with artificial nails and 56 with natural nails, before and after handwashing. Both before and after handwashing, a greater number of gram-negative rods were recovered from the fingertips of nurses with artificial nails.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2596731&dopt=Abstract

Price P. B. The bacteriology of normal skin; a new quantitative test applied to a study of the bacterial flora and the disinfectant action of mechanical cleansing. J Infect Dis 1938;63:301-318.

Landmark study using quantitative methods demonstrated that normal skin is colonized with both transient and resident bacterial flora, and that bacterial counts can increase dramatically when rubber gloves are worn for several hours. The authors showed that scrubbing hands removes subungual bacteria more effectively when fingernails are short.

Rotter, M. Hand washing and hand disinfection. In:Mayhall, C. G., eds. Hospital epidemiology and infection control. *Philadelphia: Lippincott Williams & Wilkins, 1999:1339-1355.*

Excellent review of handwashing, hand antisepsis, and surgical scrub practices and the efficacy of various agents used for hand hygiene, by one of Europe's leading experts on handwashing and hand antisepsis.

Rotter M. L., Simpson R. A., and Koller W. Surgical hand disinfection with alcohols at various concentrations: parallel experiments using the new proposed European standards method. Infect Control Hosp Epidemiol 1998;19:778-781.

Laboratory-based study comparing the microbiology efficacy of various concentrations of isopropanol and of 60% n-propanol as surgical hand antisepsis showed that 80% to 90% isopropanol produced immediate log reductions in bacterial counts comparable to 60% n-propanol, with somewhat more variable results when hands were cultured after wearing gloves for 3 hours. A 3-min application of an alcohol, without using a brush, is an effective method of surgical hand antisepsis.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9801287&dopt=Abstract

Rotter M. L., Koller W., and Neumann R. The influence of cosmetic additives on the acceptability of alcohol-based hand disinfectants. J Hosp Infect 1991;18 (suppl B):57-63.

Prospective, randomized, double-blind study of acceptability of alcohol hand rinse with and without emollients revealed that skin condition of hands was significantly better when volunteers used the alcohol rinse containing emollients.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1679449&dopt=Abstract

Sattar S. A., Abebe M., and Bueti A. J. Activity of an alcohol-based hand hel against human adeno-, rhino-, and rotaviruses using the fingerpad method. Infect Control Hosp Epidemiol 2000;21:516-519.

Laboratory-based study of the ability of a 60% ethanol hand gel to reduce the amount of viable non-enveloped viruses on artificially contaminated fingertips. The alcohol gel good antiviral activity, reducing the infectivity titers of the three viruses tested by 3 to > 4 logs.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10968717&dopt=Abstract

Scott D., Barnes A., Lister M., and Arkell P. An evaluation of the user acceptability of chlorhexidine handwash formulations. J Hosp Infect 1991;18:51-55.

Healthcare workers evaluated four chlorhexidine-based detergents with respect to smell, feel, lather, rinsing and tendency to cause itching of the skin. Healthcare workers felt they would not be willing to routinely use one product that received the lowest scores with respect to smell, feel, and lathering characteristics. The study emphasizes the need to assess user acceptability of hand hygiene products.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1679448&dopt=Abstract

Stingeni L., Lapomarda V., and Lisi P. Occupational hand dermatitis in hospital environments. Contact Dermatitis 1995;33:172-176.

Questionnaire study of the prevalence of hand dermatitis among 1300 healthcare workers in one hospital found that 21% gave a history of dermatitis, which was most frequently related to 4% chlorhexidine, disinfectants such as glutaraldehyde, latex proteins or starch glove powder.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8565458&dopt=Abstract

Tenorio A. R., Badri S. M., Sahgal N. B., Hota B., Matushek M., Hayden M. K., Trenholme G. M., and Weinstein R. A. Effectiveness of gloves in preventing personnel handcarriage of vancomycin-resistant enterococcus (VRE) after patient care. Clin Infect Dis 2001;32:826-829.

Prospective study of the ability of gloves to prevent healthcare workers from contaminating their hands with VRE during routine patient care. About 40% of personnel contaminated their gloves with VRE when caring for affected patients, and 29% of those with contaminated gloves had the same strain on their hands after glove removal. The study illustrates the need to cleanse hands after glove removal.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11229854&dopt=Abstract

Voss A. and Widmer A. F. No time for handwashing!? Handwashing versus alcoholic rub: can we afford 100% compliance? Infect Control Hosp Epidemiol 1997;18:205-208.

Investigators documented that it took intensive care nurses an average of 62 seconds to walk to a sink, wash hands, and return to patient care. A model based on varying levels of hand hygiene compliance of nurses revealed that handwashing required four times more nursing time than using an alcohol hand rub available at patient bedsides. The authors suggested that replacing handwashing with alcohol hand disinfection might lead to improved hand hygiene compliance.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9090551&dopt=Abstract

Wade J. J., Desai N., and Casewell M. W. Hygienic hand disinfection for the removal of epidemic vancomycin-resistant Enterococcus faecium and gentamicin-resistant Enterobacter cloacae. J Hosp Infect 1991;18:211-218.

Laboratory-based evaluation of efficacy of various hand hygiene agents against multi-drug resistant pathogens demonstrated that alcoholic chlorhexidine, 60% isopropanol, and detergents containing chlorhexidine or povidone-iodine were more effective than plain soap and water handwashing in removing VRE and resistant gram-negative rods from artificially contaminated fingertips.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16880903&dopt=Abstract

Webster J., Faoagali J. L., and Cartwright D. Elimination of methicillin-resistant Staphylococcus aureus from a neonatal intensive care unit after hand washing with triclosan. J Paediatr Child Health 1994;30:59-64.

Intervention trial in which introduction of a 1% triclosan handwashing preparation was associated with elimination of MRSA from a neonatal intensive care unit.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8148192&dopt=Abstract

Widmer A. F. Replace hand washing with use of a waterless alcohol hand rub? Clin Infect Dis 2000;31:136-143.

Excellent review article outlining the arguments in favor of using alcohol hand rubs for routine hand hygiene in healthcare facilities.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10913411&dopt=Abstract

Winnefeld M., Richard M. A., Drancourt M., and Grobb J. J. Skin tolerance and effectiveness of two hand decontamination procedures in everyday hospital use. Br J Dermatol 2000;143:546-550.

A short, prospective, randomized clinical trial comparing the use of a non-medicated soap or an alcohol rinse for hand hygiene in a hospital setting found that the alcohol product produced less skin damage and was microbiologically more effective than washing hands with soap and water.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10971327&dopt=Abstract

Zafar A. B., Butler R. C., Reese D. J., and Gaydos L. A. Use of 0.3% triclosan (Bacti-Stat*) to eradicate an outbreak of methicillin-resistant Staphylococcus aureus in a neonatal nursery. Am J Infect Control 1995;23:200-208.

Intervention trial in which introduction of a handwashing preparation containing 0.3% triclosan was associated with elimination of MRSA from a newborn nursery.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7677266&dopt=Abstract

Zimakoff J., Kjelsberg A. B., Larsen S. O., and Holstein B. A multicenter questionnaire investigation of attitudes toward hand hygiene, assessed by the staff in fifteen hospitals in Denmark and Norway. Am J Infect Control 1992;20:58-64.

A questionnaire study involving more than 2500 healthcare workers in Scandinavia lists factors that personnel felt promoted hand hygiene and those which interfered with hand hygiene. Highlights behavioral issues that need to be considered when designing campaigns to improve hand hygiene compliance.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1590600&dopt=Abstract