

# Hand washing

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**Hand washing** or **hand hygiene** is the act of cleaning one's hands with or without the use of water or another liquid, or with the use of soap for the purpose of removing soil, dirt, and/or microorganisms. The spelling "handwashing" in one word is also common.

Medical hand hygiene pertains to the hygiene practices related to the administration of medicine and medical care that prevents or minimizes disease and the spreading of disease. The main medical purpose of washing hands is to cleanse the hands of pathogens (including bacteria or viruses) and chemicals which can cause personal harm or disease. This is especially important for people who handle food or work in the medical field, but it is also an important practice for the general public.

People can become infected with respiratory illnesses such as influenza or the common cold, for example, if they do not wash their hands before touching their eyes, nose, or mouth. As a general rule, hand washing protects people poorly or not at all from droplet and airborne diseases, such as measles, chickenpox, influenza, and tuberculosis. It protects best against diseases transmitted through fecal-oral routes (such as many forms of gastroenteritis) and direct physical contact (such as impetigo).

Symbolic hand washing, using water only to wash hands, is a part of ritual hand washing featured in many religions, including Bahá'í Faith, Hinduism, and tevilah and netilat yadayim in Judaism. Similar to these are the practices of Lavabo in Christianity, Wudu in Islam and Misogi in Shintō.



Hand washing with soap

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## Public health

Hand washing has the following health benefits:

- helps minimize the spread of influenza<sup>[1]</sup>
- diarrhea prevention<sup>[2]</sup>
- avoiding respiratory infections<sup>[3]</sup>
- a preventive measure for infant deaths at their home birth deliveries
- improved hand washing practices have been shown to lead to small improvements in the length growth in children under five years of age<sup>[4]</sup>

In developing countries, childhood mortality rates related to respiratory and diarrheal diseases can be reduced by introducing simple behavioral changes, such as hand washing with soap. This simple action can reduce the rate of mortality from these diseases by almost 50 percent.<sup>[5]</sup>

Hand washing with soap is the single most effective and inexpensive way to prevent diarrhea and acute respiratory infections (ARI), as automatic behavior performed in homes, schools, and communities worldwide. Pneumonia, a major ARI, is the number one cause of mortality among children under five years old, taking the life of an estimated 1.8 million children per year. Diarrhea and pneumonia together account for almost 3.5 million child deaths annually.<sup>[6]</sup> According to UNICEF, turning hand washing with soap before eating and after using the toilet into an ingrained habit can save more lives than any single vaccine or medical intervention, cutting deaths from diarrhea by almost half and deaths from acute respiratory infections by one-quarter. Hand washing is usually integrated together with other sanitation interventions as part of water, sanitation and hygiene (WASH) programmes.

A possible small detrimental effect of hand washing is that frequent hand washing can lead to skin damage due to drying of the skin.<sup>[7]</sup> Excessive hand washing is commonly seen as a symptom of obsessive-compulsive disorder (OCD).

### Behavior change

Group handwashing for school children at set times of the day has been used as one option in developing countries to engrain handwashing in children's behaviors. The "Essential Health Care Program" implemented by the Philippine Department of Education in the Philippines is an example of at scale action to promote children's health and education.<sup>[8]</sup> Deworming twice a year, supplemented with washing hands daily with soap, brushing teeth daily with fluoride, is at the core of this national program. It has also been successfully implemented in Indonesia.<sup>[9]</sup>

## Substances used

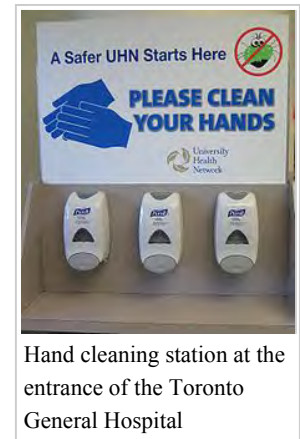
### Soap and detergents

Removal of microorganisms from skin is enhanced by the addition of soaps or detergents to water.<sup>[10]</sup> The main action of soaps and detergents is to reduce barriers to solution, and increase solubility. Water is an inefficient skin cleanser because fats and proteins, which are components of organic soil, are not readily dissolved in water. Cleansing is, however, aided by a reasonable flow of water.

#### Solid soap

Solid soap, because of its reusable nature, may hold bacteria acquired from previous uses.<sup>[11]</sup> A small number of studies which have looked at the bacterial transfer from contaminated solid soap have concluded transfer is unlikely as the bacteria are rinsed off with the foam.<sup>[12]</sup> The CDC still states "liquid soap with hands-free controls for dispensing is preferable".<sup>[13]</sup>

#### Antibacterial soap



Hand cleaning station at the entrance of the Toronto General Hospital

Antibacterial soaps have been heavily promoted to a health-conscious public. To date, there is no evidence that using recommended antiseptics or disinfectants selects for antibiotic-resistant organisms in nature.<sup>[14]</sup> However, antibacterial soaps contain common antibacterial agents such as triclosan, which has an extensive list of resistant strains of organisms. So, even if antibiotic resistant strains aren't selected for by antibacterial soaps, they might not be as effective as they are marketed to be.

A comprehensive analysis from the University of Oregon School of Public Health indicated that plain soaps are as effective as consumer-grade anti-bacterial soaps containing triclosan in preventing illness and removing bacteria from the hands.<sup>[15]</sup>

## Water

Hot water that is comfortable for washing hands is not hot enough to kill bacteria. Bacteria grow much faster at body temperature (37 C). However, warm, soapy water is more effective than cold, soapy water at removing the natural oils on your hands which hold soils and bacteria. Contrary to popular belief however, scientific studies have shown that using warm water has no effect on reducing the microbial load on hands.<sup>[16][17]</sup>

## Hand antiseptics

A hand sanitizer or hand antiseptic is a non-water-based hand hygiene agent. In the late 1990s and early part of the 21st century, alcohol rub non-water-based hand hygiene agents (also known as alcohol-based hand rubs, antiseptic hand rubs, or hand sanitizers) began to gain popularity. Most are based on isopropyl alcohol or ethanol formulated together with a thickening agent such as Carbomer into a gel, or a humectant such as glycerin into a liquid, or foam for ease of use and to decrease the drying effect of the alcohol.

Hand sanitizers containing a minimum of 60 to 95% alcohol are efficient germ killers. Alcohol rub sanitizers kill bacteria, multi-drug resistant bacteria (MRSA and VRE), tuberculosis, and some viruses (including HIV, herpes, RSV, rhinovirus, vaccinia, influenza,<sup>[18]</sup> and hepatitis) and fungi. Alcohol rub sanitizers containing 70% alcohol kill 99.97% (3.5 Log reduction, similar to 35 Decibel reduction) of the bacteria on hands 30 seconds after application and 99.99% to 99.999% (4-5 log reduction) of the bacteria on hands 1 minute after application.<sup>[19]</sup>

Hand sanitizers are most effective against bacteria and less effective against some viruses. Alcohol-based hand sanitizers are almost entirely ineffective against norovirus or Norwalk type viruses, the most common cause of contagious gastroenteritis.

Enough hand antiseptic or alcohol rub must be used to thoroughly wet or cover both hands. The front and back of both hands and between and the ends of all fingers are rubbed for approximately 30 seconds until the liquid, foam or gel is dry. As well as finger tips must be washed well too rubbing them in both palms alternatively.

The Center for Disease Control and Prevention in the USA recommends hand washing over hand sanitizer rubs, particularly when hands are visibly dirty.<sup>[20]</sup> The increasing use of these agents is based on their ease of use and rapid killing activity against micro-organisms; however, they should not serve as a replacement for proper hand washing unless soap and water are unavailable.

Frequent use of alcohol-based hand sanitizers can cause dry skin unless emollients and/or skin moisturizers are added to the formula. The drying effect of alcohol can be reduced or eliminated by adding glycerin and/or other emollients to the formula. In clinical trials, alcohol-based hand sanitizers containing emollients caused substantially less skin irritation and dryness than soaps or antimicrobial detergents. Allergic contact dermatitis, contact urticaria syndrome or hypersensitivity to alcohol or additives present in alcohol hand rubs rarely occur.<sup>[21]</sup> The lower tendency to induce irritant contact dermatitis became an attraction as compared to soap and water hand washing.

Despite their effectiveness, non-water agents do not cleanse the hands of organic material, but simply disinfect them. It is for this reason that hand sanitizers are not as effective as soap and water at preventing the spread of many pathogens, since the pathogens still remain on the hands.

Alcohol-free hand sanitizer efficacy is heavily dependent on the ingredients and formulation, and historically has significantly under-performed alcohol and alcohol rubs. More recently, formulations that use benzalkonium chloride have been shown to have persistent and cumulative antimicrobial activity after application,<sup>[22]</sup> unlike alcohol, which has been shown to decrease in efficacy after repeated use, probably due to progressive adverse skin reactions.<sup>[23]</sup>

## Ash or mud

Many people in low-income communities cannot afford soap and use ash or soil instead. Ash or soil may be more effective than water alone, but may be less effective than soap. Evidence quality is poor. One concern is that if the soil or ash is contaminated with microorganisms it may increase the spread of disease rather than decrease it.<sup>[24]</sup> Like soap, ash is also a disinfecting agent (alkaline).<sup>[25]</sup> WHO recommended ash or sand as alternative to soap when soap is not available.<sup>[26]</sup>

## Techniques

### Soap and water

One must use soap and warm running water if possible, and wash all skin and nails thoroughly. However, ash can substitute soap (see substances above) and cold water can also be used.

First one should rinse hands with warm water, keeping hands below wrists and forearms, to prevent contaminated water from moving from the hands to the wrists and arms. The warm water helps to open pores, which helps with the removal of microorganisms, without removing skin oils.<sup>[27]</sup> One should use five milliliters of liquid soap, to completely cover the hands,<sup>[27]</sup> and rub wet, soapy hands together, outside the running water, for at least 20 seconds.<sup>[28]</sup> The most commonly missed areas are the thumb, the wrist, the areas between the fingers, and under fingernails. Artificial nails and chipped nail polish harbor microorganisms.<sup>[27]</sup>

Then one should rinse thoroughly, from the wrist to the fingertips to ensure that any microorganisms fall off the skin rather than onto skin.<sup>[27]</sup>

One should use a paper towel to turn off the water. Dry hands and arms with a clean towel, disposable or not, and use a paper towel to open the door.

Moisturizing lotion is often recommended to keep the hands from drying out; Dry skin can lead to skin damage which can increase the risk for the transmission of infection.<sup>[27]</sup>

### Low-cost options when water is scarce

Various low-cost options can be made to facilitate hand washing where tap-water and/or soap is not available e.g. pouring water from a hanging jerrycan or gourd with suitable holes and/or using ash if needed in developing countries (see Substance section too).<sup>[29]</sup>

In situations with limited water supply (such as schools or rural areas in developing countries), there are water-conserving solutions, such as "tippy-taps" and other low-cost options.<sup>[30]</sup> A tippy-tap is a simple technology using a jug suspended by a rope, and a foot-operated lever to pour a small amount of water over the hands and a bar of soap.<sup>[31]</sup>

### Drying with towels or hand driers

Effective drying of the hands is an essential part of the hand hygiene process, but there is some debate over the most effective form of drying in public washrooms. A growing volume of research suggests paper towels are much more hygienic than the electric hand dryers found in many washrooms.

In 2008, a study was conducted by the University of Westminster, London, and sponsored by the paper-towel industry the European Tissue Symposium, to compare the levels of hygiene offered by paper towels, warm-air hand dryers and the more modern jet-air hand dryers.<sup>[32]</sup> The key findings were:

- after washing and drying hands with the warm-air dryer, the total number of bacteria was found to increase on average on the finger pads by 194% and on the palms by 254%



Schoolchildren washing their hands before eating lunch.



Drawing of a tippy tap with soap for hand washing at a school (Tanzania)

- drying with the jet-air dryer resulted in an increase on average of the total number of bacteria on the finger pads by 42% and on the palms by 15%
- after washing and drying hands with a paper towel, the total number of bacteria was reduced on average on the finger pads by up to 76% and on the palms by up to 77%.

The scientists also carried out tests to establish whether there was the potential for cross contamination of other washroom users and the washroom environment as a result of each type of drying method. They found that:

- the jet-air dryer, which blows air out of the unit at claimed speeds of 400 mph, was capable of blowing micro-organisms from the hands and the unit and potentially contaminating other washroom users and the washroom environment up to 2 metres away.
- use of a warm-air hand dryer spread micro-organisms up to 0.25 metres from the dryer.
- paper towels showed no significant spread of micro-organisms.

In 2005, in a study conducted by TÜV Produkt und Umwelt, different hand drying methods were evaluated.<sup>[33]</sup> The following changes in the bacterial count after drying the hands were observed:

Drying method	Effect on bacterial count
Paper towels and roll	Decrease of 24%
Hot-air dryer	Increase of 12%

Many different hand dryer manufacturers exist, and hand driers have been compared against drying with paper towels.

## Hand washing with wipes

Hand washing using hand sanitizing wipes is an alternative during traveling in the absence of soap and water<sup>[34]</sup>

## Medical use

Medical hand-washing became mandatory long after Hungarian physician Ignaz Semmelweis discovered its effectiveness (in 1846) in preventing disease in a hospital environment.<sup>[35]</sup> There are nowadays electronic devices in some hospitals that provide feedback to remind hospital staff to wash their hands when they forget.<sup>[36]</sup> One study has found decreased infection rates with their use.<sup>[37]</sup>

## Method

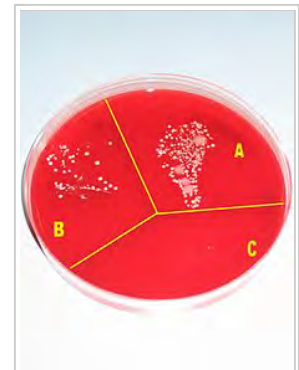
Medical hand-washing is for a minimum of 15 seconds, using generous amounts of soap and water or gel to lather and rub each part of the hands.<sup>[38]</sup> Hands should be rubbed together with digits interlocking. If there is debris under fingernails, a bristle brush may be used to remove it. Since germs may remain in the water on the hands, it is important to rinse well and wipe dry with a clean towel. After drying, the paper towel should be used to turn off the water (and open any exit door if necessary). This avoids re-contaminating the hands from those surfaces.

The purpose of hand-washing in the health-care setting is to remove pathogenic microorganisms ("germs") and avoid transmitting them. The *New England Journal of Medicine* reports that a lack of hand-washing remains at unacceptable levels in most medical environments, with large numbers of doctors and nurses routinely forgetting to wash their hands before touching patients.

<sup>[39]</sup> One study showed that proper hand-washing and other simple procedures can decrease the rate of catheter-related bloodstream infections by 66 percent.<sup>[40]</sup>



Students washing their hands with a simple handwasher at a school in Zimbabwe (Chisungu School in Epworth)



Microbial growth on a cultivation plate without procedures (A), after washing hands with soap (B) and after disinfection with alcohol (C).

The World Health Organization has published a sheet demonstrating standard hand-washing and hand-rubbing in health-care sectors.<sup>[41]</sup> The draft guidance of hand hygiene by the organization can also be found at its website for public comment.<sup>[42]</sup> A relevant review was conducted by Whitby *et al.*<sup>[43]</sup> Commercial devices can measure and validate hand hygiene, if demonstration of regulatory compliance is required.



Video demonstration on hand washing

The World Health Organization has "Five Moments" for washing hands

- before patient care
- after environmental contact
- after exposure to blood/body fluids
- before an aseptic task, and
- after patient care.

The addition of antiseptic chemicals to soap ("medicated" or "antimicrobial" soaps) confers killing action to a hand-washing agent. Such killing action may be desired prior to performing surgery or in settings in which antibiotic-resistant organisms are highly prevalent.<sup>[44]</sup>

To 'scrub' one's hands for a surgical operation, it is necessary to have a tap that can be turned on and off without touching it with the hands, some chlorhexidine or iodine wash, sterile towels for drying the hands after washing, and a sterile brush for scrubbing and another sterile instrument for cleaning under the fingernails. All jewelry should be removed. This procedure requires washing the hands and forearms up to the elbow, usually 2–6 minutes. Long scrub-times (10 minutes) are not necessary. When rinsing, water on the forearms must be prevented from running back to the hands. After hand-washing is completed, the hands are dried with a sterile cloth and a surgical gown is donned.

## Effectiveness

Interventions that promote hand washing can reduce diarrhoea episodes by about a third, and this is comparable to providing clean water in low income areas.<sup>[45]</sup> Furthermore, 48% reductions in diarrhoea episodes can be associated with hand washing with soap.<sup>[46]</sup>

There are five critical times in washing hands with soap and/or using of a hand antiseptic related to fecal-oral transmission: after using a bathroom (private or public), after changing a diaper, before feeding a child, before eating and before preparing food or handling raw meat, fish, or poultry, or any other situation leading to potential contamination and see below.<sup>[47]</sup> To reduce the spread of germs, it is also better to wash the hands and/or use a hand antiseptic before and after tending to a sick person.

For control of staphylococcal infections in hospitals, it has been found that the greatest benefit from hand-cleansing came from the first 20% of washing, and that very little additional benefit was gained when hand cleansing frequency was increased beyond 35%.<sup>[48]</sup> Washing with plain soap results in more than triple the rate of bacterial infectious disease transmitted to food as compared to washing with antibacterial soap.<sup>[49]</sup> Comparing hand-rubbing with alcohol-based solution with hand washing with antibacterial soap for a median time of 30 seconds each showed that the alcohol hand-rubbing reduced bacterial contamination 26% more than the antibacterial soap.<sup>[50]</sup> But soap and water is more effective than alcohol-based hand rubs for reducing H1N1 influenza A virus<sup>[51]</sup> and *Clostridium difficile* spores from hands.<sup>[52]</sup>

## Developing countries

In developing countries, hand washing with soap is recognized as a cost-effective, essential tool for achieving good health, and even good nutrition.<sup>[8]</sup> However, a lack of reliable water supply, soap or hand washing facilities in people's homes, at schools and at the workplace make it a challenge to achieve universal hand washing behaviors. For example, in most of rural Africa handwashing taps close to every private or public toilet are scarce, even though cheap options exist to build handwashing stations.<sup>[30]</sup> However, low handwashing rates rather can also be the result of engrained habits rather than due to a lack of soap or water.<sup>[53]</sup>



## Promotion campaigns

The promotion and advocacy of handwashing with soap can influence policy decisions, raise awareness about the benefits of handwashing and lead to long-term behavior change of the population.<sup>[54]</sup> For this to work effectively, monitoring and evaluation are necessary. One example for handwashing promotion in schools is the “Three Star Approach” by UNICEF that encourages schools to take simple, inexpensive steps to ensure that students wash their hands with soap, among other hygienic requirements. When minimum standards are achieved, schools can move from one to ultimately three stars.<sup>[55]</sup> Building hand washing stations can be a part of handwashing promotion campaigns that are carried out in order to reduce diseases and child mortality.

The Global Handwashing Day is another example for an awareness raising campaign which is trying to achieve behavior change.<sup>[56]</sup>

## Cost effectiveness

Few studies have considered the overall cost effectiveness of handwashing in developing countries in relationship to DALYs averted. However, one review suggests that promoting handwashing with soap is significantly more cost-effective than other water and sanitation interventions.<sup>[57]</sup>

### Cost-Effectiveness of Water Supply, Sanitation and Hygiene Promotion<sup>[57]</sup>

Intervention	Costs (US\$/DALY)
Hand-pump or standpost	94
House water connection	223
Water sector regulation	47
Basic sanitation - construction and promotion	≤270
Sanitation promotion only	11.2
Hygiene promotion	3.4



Poster used in Africa for raising awareness about handwashing after using the toilet with simple low-cost handwashing device



Poster to indicate critical times when hands should be washed to reduce spread of disease

## History

The importance of hand washing for human health - particularly for people in vulnerable circumstances like mothers who had just given birth or wounded soldiers in hospitals - was first recognized in the mid 19th century by two remarkable pioneers of hand hygiene: the Hungarian physician Ignaz Semmelweis who worked in Vienna, Austria and Florence Nightingale, the English "founder of modern nursing".<sup>[58]</sup> At that time most people still believed that infections were caused by foul odors called miasmas.

In the 1980s, foodborne outbreaks and healthcare-associated infections led the United States Centers for Disease Control and Prevention to more actively promote hand hygiene as an important way to prevent the spread of infection. The outbreak of swine flu in 2009 led to increased awareness in many countries of the importance of washing hands with soap to protect oneself from such infectious diseases. For example, posters with "correct handwashing techniques" were hung up next to hand washing sinks in public toilets and in the toilets of office buildings and airports in Germany.

## Society and culture

### Moral aspects

The phrase "washing one's hands of" something, means declaring one's unwillingness to take responsibility for the thing or share complicity in it. It originates from the bible passage in Matthew where Pontius Pilate washed his hands of the decision to crucify Jesus Christ, but has become a phrase with a much wider usage in some English communities.

In Shakespeare's *Macbeth*, Lady Macbeth begins to compulsively wash her hands in an attempt to cleanse an imagined stain, representing her guilty conscience regarding crimes she had committed and induced her husband to commit.

It has also been found that people, after having recalled or contemplated unethical acts, tend to wash hands more often than others, and tend to value hand washing equipment more. Furthermore, those who are allowed to wash their hands after such a contemplation are less likely to engage in other "cleansing" compensatory actions, such as volunteering.<sup>[59][60]</sup>

## Religion

Washing hands with water only (i.e. without soap) is a part of ritual handwashing as a feature of many religions, including Bahá'í Faith, Hinduism, Islam (Muslim hygienical jurisprudence), Christianity (Lavabo), Shintō (Misogi) and Judaism (Ablution in Judaism).

## See also

- Antibacterial soap
- Antibiotic resistance
- Global Handwashing Day
- Hand sanitizer
- Nosocomial infection
- Occupational biosafety
- Public health
- Patient safety
- Rubbing alcohol
- Stainless steel soap
- Didier Pittet

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Tsukubai, provided at a Japanese temple for symbolic hand washing and mouth rinsing

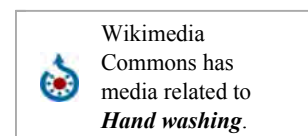


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## External links

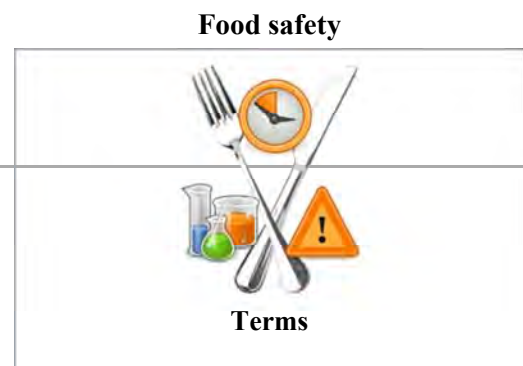
- Centers for Disease Control on hand hygiene in healthcare settings (<http://www.cdc.gov/handhygiene/>)
- Hy2U appropriate technology waterdispenser and handwashing campaign (<http://www.hy2u.org>)
- Hand Hygiene Resource Page ([http://www.picnetbc.ca/hand\\_hygiene.htm](http://www.picnetbc.ca/hand_hygiene.htm)) from the Provincial Infection Control Network of BC (<http://www.picnetbc.ca>) (PICNet)
- Global Public-Private Partnership for Handwashing (<http://globalhandwashing.org>)
- Photos of low-cost handwashing installations in developing countries (<https://www.flickr.com/photos/gtzecosan/sets/72157625967026368/>) (collected by Sustainable Sanitation Alliance)



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Foodborne illness

Hazard analysis and critical control points (HACCP) • Hazard analysis and risk-based preventive controls (HARPC)

Critical control point

### **Critical factors**

FAT TOM

pH

Water activity ( $a_w$ )

### **Bacterial pathogens**

*Clostridium botulinum*

*Escherichia coli*

*Listeria*

*Salmonella*

*Vibrio cholerae*

### **Viral pathogens**

Enterovirus

Hepatitis A

Norovirus

Rotavirus

### **Parasitic pathogens**

*Cryptosporidium*

*Entamoeba histolytica*

*Giardia*

*Trichinella*