

Justified disinfection

Historically, housekeeping practices have constantly evolved. Multiple variables force us to modify certain procedures and working methods, and to develop new cleaning tools. Time constraints, financial and human resources also force us to adapt our ways of doing things. Despite these changes, the overall concept of «cleanliness» remains the focus of our hygiene and sanitation activities.

Despite this fact, people from both inside and outside the industry will give different answers when asked what their definition of the term «cleanliness» is. Some will tell you about the elimination of stains, others of microorganisms, while others will refer to a general and pleasant visual state. These divergent understandings of cleanliness inevitably lead people to use different types of products to achieve their goals; some will use cleaning products, others disinfectants or sanitizers and others disinfectant cleaners.

According to the Merriam-Webster dictionary, «cleanliness» is the quality or state of being “clean”, with “clean” being defined as “free from dirt” (Merriam-Webster, 2020). Therefore, cleaning products are able to make a surface «clean» by removing dirt and microorganisms. For their part, disinfectants are not intended to achieve this state of cleanliness; they are used to kill microorganisms. Cleaning products and disinfectants have completely different functions, but they may also have a certain complementarity.

As their use is aimed at killing microorganisms, disinfectants are classified as biocides or pesticides. It is well-known that their use can produce harmful effects on health, the environment and microbial ecosystems (discussed below) and that is why they must be used with great care.

This is the message at the heart of our position on and promotion of **JUSTIFIED DISINFECTION**.

**Justified disinfection is the art of disinfecting only where and when it is useful and relevant to do so.
It is the opposite of systematic or abusive disinfection.**

The benefits of disinfection

The process of disinfection aims to minimize the number of microorganisms on a surface. If correctly applied, disinfection can bring benefits in terms of individual and community protection by reducing the risk of transmission of microbial diseases.

For more than 20 years, Steve Teasdale has been conducting an awareness campaign with hygiene and sanitation stakeholders to inform them of the risks associated with the overuse of disinfectants. By promoting justified disinfection in America and Europe, he wants to help reduce the social and environmental impact of indiscriminate use of disinfectants.



In collaboration with scientists and medical health officers, he continues to reiterate that disinfectants should be used with care and with great caution and that their use should never be trivialized or routine.

The conditions of “Justified disinfection”?

For a surface to present a risk of transmission of microbial disease, it must be able to serve as a vehicle between a microorganism and humans. For example, floors, urinals, ceilings and most walls cannot typically be used as a vehicle because we typically do not touch them. The presence of a pathogenic microorganism on these surfaces therefore does not represent a real biological risk to our health.

In contrast, a door handle, bathroom faucets/taps, toilet flush handles, and light switches can present a genuine risk as we touch them frequently and then put our hands to our face and possibly our food. They can be sources of indirect transmission of microorganisms (individual - surface - individual) (CDC, 2016).

What to disinfect: Only surfaces frequently touched with the hands (high touch) should be disinfected, as only these surfaces can serve as a vehicle for the transmission of microbial diseases.

When to disinfect: Disinfecting a surface provides immediate but short-lived protection. It will be contaminated again and will have lost its disinfected and safe status as soon as it is touched again - which can sometimes happen a few seconds after disinfection. It has been shown that a disinfected surface can return to its original level of contamination (in terms of microbial load) within 2.5 hours (Attaway et al., 2012) or six hours (Schmidt, Fairey & Attaway, 2019) after its disinfection, depending on the microbes present. Indeed, in a hospital setting, disinfection was not found to make a significant difference in the colony numbers of certain bacteria, with microbial surface loads being indistinguishable 30 minutes before and 30 minutes after the disinfection procedure (Frickmann et al., 2017).

Since it would be impractical and excessive to disinfect a surface each time it is touched, maintenance programs generally provide one disinfection per day when disinfection is required. This frequency can be increased if necessary, depending on the situation and the traffic in a given location.

How to disinfect?

Like everything, if you want to disinfect a surface, you must do it correctly and observe the following application conditions:

1. Apply the disinfectant on a recently cleaned surface (the activity of the majority of disinfectants is reduced if used on unclean surfaces; the most effective regimen is precleaning, followed by disinfection [Tuladhar et al., 2012]);
2. Use the correct concentration of disinfectant, as prescribed by the manufacturer;
3. Adhere to the wet contact time prescribed by the manufacturer.

If these conditions are not met, you have not properly disinfected the surface and cannot expect to obtain the benefits sought by the disinfection process.

The disadvantages and risks associated with disinfection

- Resistance to disinfectants and antibiotics: Numerous studies show that widespread and inappropriate use of disinfectants can lead to resistance of pathogenic microorganisms to disinfectants and antibiotics; commonly termed ‘antimicrobial resistance,’ which is a significant threat to global health (Maillard et al., 2020; Osman, 2020; Ozkan, 2019; Shmerling, 2019; Günter, 2018; Sacha et al., 2018; Miniae et al., 2018; Kim et al., 2018; Carenco, 2017). The misuse of disinfectants would therefore make it increasingly difficult to eliminate pathogenic microorganisms, as the microorganisms can either acquire, or intrinsically generate, genetic elements that are resistant to the effects of antibiotics and disinfectants. These resistant genetic elements can accumulate, leading to multidrug resistant bacteria (Mc Carlie, Boucher & Bragg, 2020).

For example, a bacterial strain has become more than 200 times less sensitive to an antibiotic after being exposed to disinfectants repeatedly (Kim et al., 2018). The misuse of disinfectants can lead to their accumulation in natural environments. In these scenarios, microorganisms are exposed to less than lethal concentrations of disinfectants. This creates a selection pressure, whereby the microorganisms are able to adapt and develop resistance mechanisms that enable them to bypass the biocidal activity of the disinfectants (McBain, Rickard & Gilbert, 2002).

- False sense of security: Even if properly used, disinfectants cannot kill all types of pathogenic microorganisms, including certain bacterial spores, certain fungi, viruses and parasites (Andersen, 2019). Moreover, disinfectants only provide short-term efficacy (Schmidt, Fairey & Attaway, 2019; Frickmann et al., 2017, Attaway et al., 2012). In people's minds, the disinfected surface becomes safe and free from microorganisms. This perception leads to a false sense of security and leads to the adoption of behaviors that can increase biological risk to our health.
- Massive pollutant load: The thousands of tonnes of disinfectants sold worldwide each year (in 2018, 821,000 tonnes of disinfectants were exported worldwide, with 890,000 tonnes imported [Global Trade, 2020]) eventually end up in the environment (McBain, Rickard & Gilbert, 2002). Many of these disinfectants accumulate in the environment, for example in soil (Bollmann et al., 2017; Chen et al., 2013), as natural microorganisms are unable to effectively biodegrade these biocidal components. These relatively persistent biocidal residues can react with organic matter in soil, water and air, to create highly toxic, carcinogenic and mutagenic compounds that accumulate in the food chain and water cycle, ultimately impacting humans (Surfrider Foundation Europe, 2020).
- Allergies: Evidence suggests significant links between the excessive use of disinfectants and the increasing number of allergies among Western populations (Koch & Wollina, 2014; Krauss-Etschmann, Niedermaier & Beyer, 2009; Petroglou et al., 2007). As such, quaternary amines are among the 8 main allergens among employees in the health sector (Shutty & Scheinman, 2017; Purohit et al., 2000; Bernstein et al., 1994).
- Health risks: The problems posed by the majority of disinfectants for the health of workers are well known, including lung irritation problems, skin corrosion and irritation, eye irritation, asthma, (Casey et al., 2017; Dumas et al., 2017; Fityan & Pees, 2013; Sato et al., 2004). Further to this, certain disinfectants, and the incorrect use of disinfectants, can produce gases that are severely toxic (for example mixing bleach with ammonia, which leads to the formation of chloramine compounds) (Kang, Lauf & Jordan, 2019).

The experts' point of view

Based on these risks, more and more epidemiologists, doctors, microbiologists and hygienists are recommending that the use of disinfectants in certain sectors be minimized or even eliminated.

- Health Canada: "The industry produces and markets disinfectants for hands and surfaces, resulting in the *frequent and unnecessary use* of products that contain antimicrobials.» «...overuse of antibacterial cleaning products in the home, the community and in health care facilities may lead to increased development of resistance in common microorganisms.» (Health Canada 2003)
- CDC – Center for Disease Control and Prevention: "Most, if not all, housekeeping surfaces need to be cleaned only with soap and water or a detergent/disinfectant, depending on the nature of the surface and the type and degree of contamination" "...but the actual physical removal of microorganisms and soil by wiping or scrubbing is probably as important, if not more so, than any antimicrobial effect of the cleaning agent used." "Studies have demonstrated that disinfection of floors offers no advantage over regular detergent/water cleaning and has minimal or no impact on the occurrence of health-care associated infections." (Carenco, 2017; CDC, 2019)

- U.S. Food and Drug Administration: “According to the U.S. Food and Drug Administration (FDA), there isn’t enough science to show that over-the-counter (OTC) antibacterial soaps are better at preventing illness than washing with plain soap and water. To date, the benefits of using antibacterial hand soap haven’t been proven. In addition, the wide use of these products over a long time has raised the question of potential negative effects on your health.” “Wash your hands with plain soap and water. That’s still one of the most important steps you can take to avoid getting sick and to prevent spreading germs.” (FDA, 2019)
 - European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR): “The frequency of antimicrobial resistance in bacteria has increased in concert with increasing usage of antimicrobial compounds.” “...selective stress exerted by biocides may favour bacteria expressing resistance mechanisms...that could create a potential risk of development of cross-resistance between antibiotics and biocides.” “In order to preserve the role of biocides in infection control and hygiene, it is paramount to prevent the emergence of bacterial resistance and cross-resistance through their appropriate and prudent use.” (European Commission, 2009)
- Justified Disinfection and COVID-19:**
The principles of justified disinfection, as outlined in this document, remain applicable during pandemic situations, such as the current COVID-19 outbreak. Disinfection is an important part of the management of the virus outbreak, with disinfectant use increasing from ‘normal’ use due to the increased risk of disease. However, the use of disinfectants during this pandemic must remain justified.
- European Centre for Disease Prevention and Control: “Use of antimicrobials...exerts an ecological pressure on microorganisms and contributes to emergence and selection of antimicrobial-resistant microorganisms in populations...” “...management, control and prevention of antimicrobial resistance [includes] prudent use of antimicrobials.” (ECDC, 2008)
 - David Suzuki Foundation: «...there is no evidence that antibacterial products do a better job than conventional soap in a home. The overuse of antibacterial ingredients like triclosan contributes to the creation of superbugs. Our obsession with germs could therefore make us sick.» (Coulter & Therrien, 2020)

In summary, there are only 2 situations where it is justified to disinfect:

- a. If you are ready to comply with the 3 application conditions required to ensure effective disinfection (listed above).
- b. When there is a real risk of disease transmission or infection via a critical area or surface (e.g. a door handle, faucet, pay phone, etc. – not walls and floors).

Besides these 2 situations, there is no beneficial reason to try to disinfect surfaces.

Conclusion

Considering the human and environmental risks and consequences associated with the overuse of disinfectants, there is no valid reason and no advantage to justify systematic disinfection of all surfaces. In most cases, a good surface cleaning procedure will provide an appropriate level of security.

Remember, the best possible protection against microbial infections starts with the individual’s personal hygiene behaviors - starting with healthy hand hygiene.

If you feel it is justified to disinfect certain surfaces, you must do so correctly and reasonably:

- Identify and target only frequently affected “high touch” surfaces that could potentially serve as a vector for the transmission of a disease.
- Comply with the dilutions, procedures and wet contact time required and only disinfect recently cleaned surfaces.

If you do not respect these two points, you are practicing an unnecessary, potentially harmful activity and your approach is not justified.

References

- Andersen BM (2019) 'Disinfection of Instruments and Equipment.' *Prevention and Control of Infections in Hospitals*, 815-834
- Attaway HH, Fairey S, Steed LL et al. (2012) 'Intrinsic bacterial burden associated with intensive care unit hospital beds: effects of disinfection on population recovery and mitigation of potential infection risk.' *American Journal of Infection Control*, 40, 907-12
- Bernstein JA, Stauder T, Bernstein DI et al. (1994) 'A combined respiratory and cutaneous hypersensitivity syndrome induced by work exposure to quaternary amines.' *J Allergy Clin Immunol*; 94(2 Pt 1):257-9
- Bollmann UE, Fernández-Calviño D, Brandt KK et al. (2017) 'Biocide Runoff from Building Facades: Degradation Kinetics in Soil.' *Environmental Science & Technology*, 51, 7, 3694-3702
- Carenco P (2017) 'Antibiorésistance et biocides.' *Médecin hygiéniste*, CH Hyères (83), Bulletin CCLin-Arlin n° 7
- Casey ML, Hawley B, Edwards N et al. (2017) 'Health problems and disinfectant product exposure among staff at a large multispecialty hospital.' *Am J Infect Control*, 45(10): 1133-1138
- Centers for Disease Control and Prevention (CDC) (2016). How Infections Spread|Infection Control|CDC [Online]. Available at: <https://www.cdc.gov/infectioncontrol/spread/index.html> (Accessed 13 May 2020)
- Centers for Disease Control and Prevention (CDC) (2019) 'Guidelines for Environmental Infection Control in Health-Care Facilities – Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC).'
- Chen ZF, Ying GG, Ma YB et al. (2013) 'Typical Azole Biocides in Biosolid-Amended Soils and Plants Following Biosolid Applications.' *Journal of Agricultural and Food Chemistry*, 61, 26, 6198-6206
- "clean." Merriam-Webster.com. 2020. <https://www.merriam-webster.com> (12 May 2020)
- "cleanliness." Merriam-Webster.com. 2020. <https://www.merriam-webster.com> (12 May 2020)
- Coulter L, Therrien AL (2020) 'Remèdes maisons pour dire adieu aux microbes', Fondation David Suzuki, [Online]. Available at : <https://fr.davidsuzuki.org/mode-de-vie/remedes-maisons-pour-dire-adieu-aux-microbes/> [Accessed 17 May 2020]
- Dumas O, Wiley AS, Quinot C et al. (2017) 'Occupational exposure to disinfectants and asthma control in U.S. nurses.' *Eur Respir J*, 50(4)
- European Centre for Disease Prevention and Control (ECDC) (2008) 'Factsheet for experts – Antimicrobial resistance.' [Online]. Available at: <https://www.ecdc.europa.eu/en/antimicrobial-resistance/facts/factsheets/experts> [Accessed 23 May 2020]
- European Commission Scientific Committee on Emerging and Newly Identified Health Risks (2009) 'Assessment of the Antibiotic Resistance Effects of Biocides.'
- Fityan A & Pees B (2013) 'Skin reaction to a commonly used hospital disinfectant.' *BMJ*, 346:f202
- Frickmann H, Bachert S, Warnke P et al. (2017) 'Validated measurements of microbial loads on environmental surfaces in intensive care units before and after disinfecting cleaning.' *Journal of Applied Microbiology*, 124, 874-880
- Global Trade (2020) 'Global Trade of Disinfectants Has Doubled Over The Past Decade.' *Global Trade Magazine* [Online]. Available at: <https://www.globaltrademag.com/global-trade-of-disinfectants-has-doubled-over-the-past-decade/> [Accessed 16 May 2020]
- Health Canada (2003) 'For Your Information: Antimicrobial Resistance.' Government of Canada [Online]. Available at: <https://www.canada.ca/en/health-canada/services/drugs-health-products/veterinary-drugs/factsheets-faq/your-information-antimicrobial-resistance.html> [Accessed 16 May 2020]
- Kampf G (2018) 'Biocidal Agents Used for Disinfection Can Enhance Antibiotic Resistance in Gram-Negative Species.' *Antibiotics*, 7, 110.
- Kang V, Lauf R & Jordan K (2019) 'Household Bleach Inhalation and ARDS.' *Am J Respir Crit Care Med*; 199: A1799
- Kim M, Weigand MR, Seungdae O et al. (2018) 'Widely Used Benzalkonium Chloride Disinfectants Can Promote Antibiotic Resistance.' *Applied and Environmental Microbiology*, Vol 84, Issue 17
- Koch A & Wollina U (2014) 'Chlorhexidine allergy.' *Allergo J Int*; 23: 84-6
- Krauss-Etschmann S, Niedermaier S & Beyer J (2009) 'Current use of room disinfectants and allergic symptoms at the age of 4 years.' *Journal of Allergy and Clinical Immunology*, Vol 123, Issue 5, P1176-1178

Maillard JY, Blomfield SF, Courvalin P et al. (2020) 'Reducing antibiotic prescribing and addressing the global problem of antibiotic resistance by targeted hygiene in the home and everyday life settings: A Position Paper.' *America Journal of Infection Control – Journal Pre-proof*

Mc Carlie S, Boucher CE & Bragg RR (2020) 'Molecular basis of bacterial disinfectant resistance.' *Drug Resistance Updates*, 48

McBain AJ, Rickard AH & Gilbert P (2002) 'Possible implications of biocide accumulation in the environment on the prevalence of bacterial antibiotic resistance.' *Journal of Industrial Microbiology & Biotechnology*, 29, 326-330

Osman L (2020) 'Prochaine pandémie, les superbactéries?' *La Presse* [Online]. Available at: <https://www.lapresse.ca/covid-19/202005/14/01-5273509-prochaine-pandemie-les-superbacteries.php> (Accessed 14 May 2020)

Ozkan A (2019) 'Disinfectants as a double-edged sword: Are disinfectants promoting antimicrobial resistance?' *Catalyst*, Vol 3, Issue 1

Petroglou N, Komitopoulos N, Dadoumi S et al. (2007) 'Occupational Allergic Reactions in the Hospital Nursing Staff.' *Health Science Journal*, Issue 4

Pidot SJ, Gao W, Buultjens AH et al. (2018) 'Increasing tolerance of hospital *Enterococcus faecium* to handwash alcohols.' *Science Translational Medicine*, 10

Purohit A, Kopferschmitt-Kubler MC, Moreau C et al. (2000) 'Quaternary ammonium compounds and occupational asthma.' *Int Arch Occup Environ Health*, 73: 423-427

Sato K, Kusaka Y, Suganuma N et al. (2004) 'Occupational Allergy in Medical Doctors.' *Journal of Occupational Health*, 46: 165-170

Schmerling RH (2019) 'Are antibacterial products with triclosan fueling bacterial resistance?' *Harvard Health Publishing* [Online]

Schmidt MG, Fairey SE, Attaway HH. (2019) 'In situ evaluation of persistent disinfectant provides continuous decontamination within the clinical environment.' *American Journal of Infection Control*, 47, 732-734

Shutty BG & Scheinman PL (2017) 'Occupationally Induced Allergic Contact Dermatitis to Aerosolized Quaternary Ammonium Compounds.' *Dermatitis*, Vol 28, No. 6

Surfrider Foundation Europe (2020) 'Street Disinfection Causes Environmental Concerns.' *Surfrider Foundation Europe Blog* [Online]. Available at: <https://surfrider.eu/en/learn/blog/street-disinfection-causes-environmental-concerns-121409207592.html> [Accessed 16 May 2020]

Tuladhar E, Hazeleger WC, Koopmans M et al. (2012) 'Residual Viral and Bacterial Contamination of Surfaces after Cleaning and Disinfection.' *Applied and Environmental Microbiology*, 78(21), 7769-7775

U.S. Food and Drug Administration (FDA) (2019) 'Antibacterial Soap? You Can Skip It, Use Plain Soap and Water.' [Online]. Available at: <https://www.fda.gov/consumers/consumer-updates/antibacterial-soap-you-can-skip-it-use-plain-soap-and-water> [Accessed 17 May 2020]

