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What's on That Surface?

How Disease Spreads Through Objects, Surfaces, Food, and Drinks

Infectious diseases present a huge burden on our public health systems. Bacteria and viruses have the incredible ability to re-emerge and evolve over time, continually posing new problems and challenges.

Previous scientific evidence has focused on direct contact between infected and healthy individuals, but there is now greater attention on the role of contaminated surfaces or objects (also called fomites) as vehicles for spreading pathogenic bacteria and viruses. The persistence of germs on fomites and high infectivity calls for a desperate need for interception strategies and interventions to reduce germ transmission and subsequent spreading of serious infectious diseases.

To date, there are numerous disinfection and good hygiene strategies to reduce germ spread, but they have shown to be only mildly effective. A new, simpler, and more feasible approach that targets easy ways for germs to spread may be through reducing the sharing of food and drinks, especially in group and social settings. A simple way of labelling cups and containers may be the best alternative to prevent exposure. This may significantly help reduce spreading of germs that can cause significant harmful, infectious illnesses.

What Is the Problem?

Ever wonder how many germs a person comes into contact with every day? Billions. There are said to be more microbes on a human body than the number of humans on earth (Thomas, 2004). With the ongoing global COVID-19 pandemic, personal hygiene has never been so important, with the public more aware of how quickly infections can spread.

Globally, infectious illnesses, such as lower respiratory infections, human immunodeficiency virus (HIV/AIDS), diarrheal diseases, malaria, and tuberculosis, are the leading causes of death, killing millions every year (Michaud, 2009) (Table 1). There is an immense burden of infectious diseases worldwide, and the continual evolution, emergence, and re-emergence of infectious microbes and viruses pose a huge challenge on global public health systems and human welfare (Fauci, 2001).

While pathogens can be transmitted directly through contact between an infected individual and a healthy one, there has been less focus in the past on how the environment can play a significant role in mediating infection transmission (Kraay et al., 2018).

Objects, surfaces, water, and food can all be important sources or "reservoirs" for pathogens, enhancing their ability to spread from one host to another (Kraay et al., 2018). Nowadays, there seems to be growing evidence to support the involvement of contaminated objects and surfaces as vehicles for viral transmission (Boone & Gerba, 2007). This white paper will address the severity of this problem by looking at germs, the scientific evidence on how much germs can spread, and the possible solutions that should be considered to tackle this challenge.

Disease	Proportion of total disease burden (%)	Proportion of total disease burden (%)
World	Total: 1.54 billion DALYs	Total: 56.2 millions deaths
Lower respiratory Infections	5.6	6.7
HIV/AIDS	4.7	4.6
Diarrheal diseases	3.9	3.2
Malaria	2.6	2.1
Tuberculosis	2.4	2.9
Low- and middle-income countries	Total: 1.39 billion DALYs	Total: 48.3 millions deaths
Lower respiratory Infections	6.0	7.0
HIV/AIDS	5.1	5.3
Diarrheal diseases	4.2	3.7
Malaria	2.9	2.5
Tuberculosis	2.6	3.3

[a]PAF: POPULATION ATTRIBUTE FRACTION,
DATA FROM THE GLOBAL BURDEN OF DISEASE AND RISK FACTORS.

Table 1. *The proportion of total disease burden (%) quantified in DALYs (one disability-adjusted life year (DALY) is one lost year of healthy life) and proportion of global deaths (%) caused by infectious diseases (Michaud, 2009).*

What are Germs?

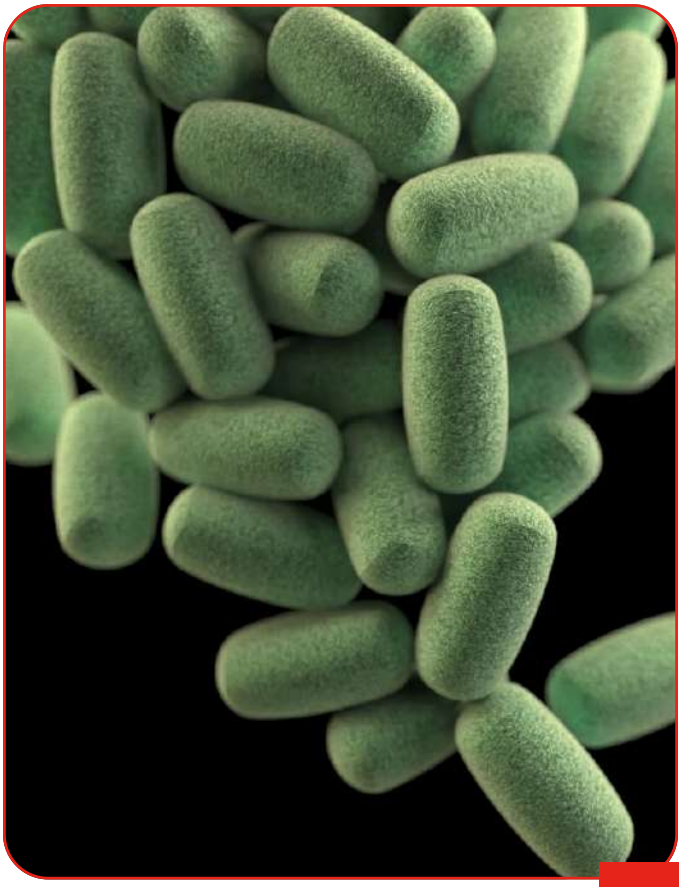
Germs are everywhere. On your mobile phone, floating in the air that you are breathing right now, and in the sandwich you ate for lunch. Personal hygiene has never been so important, especially due to the COVID-19 pandemic that has affected millions of lives globally. “Germs” is a generic, everyday term for microscopic, single-celled organisms that coexist with us in our ecosystem; they can be divided into different types, such as bacteria (microbes) and viruses (Thomas, 2004). These germs are not visible to the naked human eye; therefore, they can be hiding in areas where we least expect, such as under our fingernails and in our hair.

Bacteria and viruses that are responsible for some of the deadliest diseases in the world and are more commonly known as pathogens (Thomas, 2004). Interestingly, pathogens only make up a small fraction of the total number of microbial and viral species in our ecosystem, but they continue to emerge, re-emerge, and evolve over time, continually posing a huge threat to our health systems (Fauci, 2001).

There are several different types of bacteria and viruses. Viruses and bacteria can be categorized in several ways but can be grouped based on their shape or structure. For example, respiratory viruses that have caused past global outbreaks, such as influenza and HIV/AIDS, are enveloped viruses, as they are protected with a lipid envelope (Boone & Gerba, 2007). On the other hand, enteric viruses, like noroviruses, are non-enveloped viruses (Boone & Gerba, 2007). Streptococcus or “strep throat” is a common spherical bacterium (Lemos et al., 2013). Understanding the structure and the characteristics of viruses and bacteria are fundamental to understanding their mechanisms of action and therefore identifying potential targets of interest for treatment.

An example of a serious infectious disease is pneumonia, a potentially life-threatening lower respiratory tract infection predominantly caused by the bacteria Streptococcus pneumoniae (pneumococcus) (Torres et al., 2019). The disease can also be caused by viruses such as the respiratory syncytial virus (RSV) and coronaviruses that include SARS-CoV-2, the virus responsible for the current COVID-19 pandemic (Brar & Niederman, 2011; Gattinoni et al., 2020; Castaño et al., 2020). Pneumonia is potentially life-threatening, as the lungs become inflamed due to the air sacs in the lungs filling up with fluid, making it hard to breathe (Quinton, Walkey & Mizgerd, 2018). This is only just one of the numerous life-threatening infectious illnesses that exist today.

The main issue, though, is that we cannot see these germs lurking around us. So how easily can germs spread from one person to another?



How Easily Can Germs Spread?

Germs can spread very easily in shared environments, such as workplaces, schools, and public events. Pathogens can spread through aerosols from an infected person that are released when coughing or sneezing (Jones & Brosseau, 2015). One study demonstrated that a healthy employee was 5 times more likely to present similar symptoms within days following exposure to infected individuals with a respiratory tract infection a week before (Hovi et al., 2015).

One of the most prevalent viral respiratory infections worldwide is influenza, commonly known as the flu. The infectious period of an adult with influenza may be between a day before symptom onset and up to 5 days after, presenting a wide time frame for rapid viral spread in settings like the workplace (Harper et al., 2004). Previous studies show that employees with influenza episodes account for approximately 5–20% of illness-related absences at work (Keech & Beardsworth, 2008; Schanzer et al., 2011). Significant work to date has focused on direct modes of infection transmission, but there is now growing evidence of the importance of the environment, especially contaminated surfaces and objects, on the transfer of germs among people (Beamer et al., 2015; Zivich et al., 2018; Hewitt et al., 2012, Reynolds et al., 2005).

Bacterial and Viral Persistence on Surfaces

Infected individuals with symptoms can shed up to millions of infectious viral particles, some of which may remain suspended in the air as aerosolized liquid droplets or settle on surfaces (Figure 1) (Bean et al., 1982; Castaño et al., 2020). There is growing attention on the significance of "fomite"-mediated pathways of germ transmission, with research showing that settled viral particles are able to remain viable on non-porous surfaces, such as a stainless steel door handle, for 24 to 48 hours (Bean et al.1982; Jones & Brosseau, 2015).

Fomites are inanimate objects or surfaces that can act as vehicles for germ spread via direct contact if they become contaminated with body secretions or fluids, soiled hands, or aerosolized liquid droplets (England, 1982). Notably, viruses can be very persistent even when they are outside a host. They can remain viable on surfaces and fomites long enough to infect a host, which means only a small amount of the virus may be required to cause infection (Rzeżutka & Cook, 2004). Their low infective dose indicates that they are able to persist for long periods in the environment with a high capability to source infections for up to several weeks or even months (Barker et al., 2004; Boone & Gerda, 2007; Rzeżutka & Cook, 2004).
But first, the ability for a bacteria or virus to spread through contact via a contaminated fomite requires them to maintain viability, and therefore infectivity, while on the fomite surface (Boone & Gerda, 2007).

Different types of bacteria and viruses have different intrinsic properties, characteristics, and behaviors; therefore, different germs may remain infectious on surfaces for different amounts of time (Kraay et al., 2018, Katzenberger, Rosel & Vonberg, 2021).

There is some extensive research analyzing pathogen-specific parameters to characterize the degree of bacterial and viral survival and infectivity. One meta-analysis analyzed data on three different viral pathogens — influenza, rhinovirus, and norovirus, all of which can spread through food and water but also through contact with surfaces (Lopman et al., 2009; Barker et al., 2004; Kraay et al., 2018). Based on the analyses, norovirus and rhinovirus seemed to be very environmentally persistent and therefore able to exploit fomite-mediated pathways to infect and spread to secondary parties (Kraay et al., 2018). Interestingly, the norovirus was shown to be infectious for longer (15 days) than the other two viruses examined (Table 2) (Milbrath et al., 2013).

Older research also demonstrated the high degree of survival and infectivity of different viruses on different surfaces. For example, enteric (gastrointestinal) viruses, such as astroviruses and rotaviruses, have been shown to remain viable and therefore infectious on a range of surfaces for 2 months or longer (Table 3) (Boone & Gerba, 2007). On the other hand, respiratory viruses, like coronaviruses, influenza, and respiratory syncytial viruses, could remain viable for several hours to several days (Table 3) (Boone & Gerba, 2007; Kramer & Assadian, 2014).

Similar to viruses, studies in bacteria have also looked at a range of different bacterial types and detected their ability to remain viable on inanimate surfaces for prolonged periods of time (Table 4) (Kramer & Assadian, 2014). Interestingly, different types of bacteria, such as S. aureus (Enterococcus spp.) (upper respiratory tract and skin bacteria) and E. coli (gastrointestinal bacteria), found commonly in food and water could survive for months on dry, inanimate surfaces (Table 3) (Wagenvoort et al., 2011; Erickson et al., 2010.

Table 2. *Meta-analysis of pathogen-specific parameters for three different viral pathogens. (Kraay et al., 2018)*

	Influenza		Rhinovirus		Norovirus	
Pathogen-specific parameters						
1/y: Infectious period (days)	6	[38-40]	104	[41]	15	[42]
a: Shedding rate (pathogen hours^{-1} people^{-1})	1 x 10^4	[43-45]	1 x 10^3	[46, 47]	2.88 x 10^3	[48, 49]
μ_F: Inactivation rate in fomites (hours^{-1})	0.121 (0.058, 0.121)	[50-52]	1.44 (0.990, 1.44)	[53, 54]	0.288 (0.0006, 0.288)	[8]
μ_H: Inactivation rate in hands(hours^{-1})	88.2 (55.2, 88.2)	[13, 50, 52]	0.767	[55]	1.07 (0, 1.07)	[9, 56, 57]
T_{FH}: Transfer efficacy (*F* to *H*) (proportion)	0.1 (0.04, 0.16)	[13, 16, 50, 58]	0.2 (0.1, 0.40)	[55, 59-61]	0.07 (0.051, 0.089)	[62]
$T\mu^F$: Transfer efficacy (*H* to *F*) (proportion)	0.025 (0.01, 0.04)	[13, 16, 50, 58]	0.2 (0.1, 0.40)	[55, 59-61]	0.13 (0.094, 0166)	[62]
$ø_H$: Pathogen excreted to *H* (proportion)	0.15 (0.10, 0.2)		0.15 (0.10, 0.2)		0.90 (0.50, 1)	
$ø_F$: Pathogen excreted to *F* (proportion)	1 - $ø_H$		1 - $ø_H$		1 - $ø_H$	
π: Inefectivity parameter in contact with x pathogens (unitless)	6.93e-05		2.46e-3		4.78e-4	
o_H: Rate pathogens are added to hands (pathogen time^{-1} people^{-1})	a$ø_H$		a$ø_H$		a$ø_H$	

Table 3. *Pooled data on survival of different types of bacterial and viral pathogens on various inanimate surfaces (Kramer & Assadian, 2014; Kramer et al., 2006).*

	Duration of persistence (range)
(a) Type of bacterium	
Acinetobacter spp.	3 days to 5 months
Bordetella pertussis	3-5 days
Campylobacter jejuni	up to 6 days
Clostridium difficile (spores)	5 months
Chlamydia pneumoniae, C. trachomatis	≤30 h
Chlamydia psittaci	15 days
Corynebacterium diphtheriae	7 days to 6 months
Corynebacterium pseudotuberculosis	1-8 days
Escherichia coli	1.5 h to 16 months
Enterococcus spp. including VRE and VSE	5 days to 4 months
Haemophilus influenzae	12 days
Helicobacter pylori	≤90 min
Klebsiella spp.	2 h to >30 months
Listeria spp.	1 day to months
Mycobacterium bovis	>2 months
Mycobacterium tuberculosis	1 day to 4 months
Neisseria gonorrhoeae	1-3 days
Proteus vulgaris	1-2 days
Pseudomonas aeruginosa	6 h to 16 months; on dry floor: 5 weeks
Salmonella typhi	6 h to 4 weeks
Salmonella typhimurium	10 days to 4.2 years
Salmonella spp.	1 day
Serratia marcescens	3 days to 2 months; on dry floor: 5 weeks
Shigella spp.	2 days to 5 months
Staphylococcus aureus, including MRSA	7 days to 7 months
Streptococcus pneumoniae	1-20 days
Streptococcus pyogenes	3 days to 6.5 months
Vibrio cholerae	1-7 days
(b) Type of fungus	
Candida albicans	1-120 days
Candida parapsilosis	14 days
Torulopsis glabrata	102-150 days
(c) Type of virus	
Adenovirus	7 days to 3 months
Astrovirus	7-90 days
Coronavirus	3h
SARS-associated virus	72-96 h
Coxsackievirus	>2 weeks
Cytomegalovirus	8h
Echovirus	7 days
HAV	2h to 60 days
HBV	>1 week
HIV	>7 days
Herpes simplex virus, type 1 and 2	4.5 h to 8 weeks
Influenza virus	1-2 days
Norovirus and feline calicivirus (FCV)	8 h to7 days
Papillomavirus 16	>7 days
Papovavirus	8 days
Parvovirus	>1 year
Poliovirus type 1	4h to < 8 days
Poliovirus type 2	1 day to 8 weeks
Pseudorabies virus	≥ 7 days
Respiratory syncytial virus	up to 6 h
Rhinovirus	2 h to 7 days
Rotavirus	6-60 days
Vaccinia Virus	3 weeks to > 20 weeks

Bacterial and Viral Infectivity on Surfaces

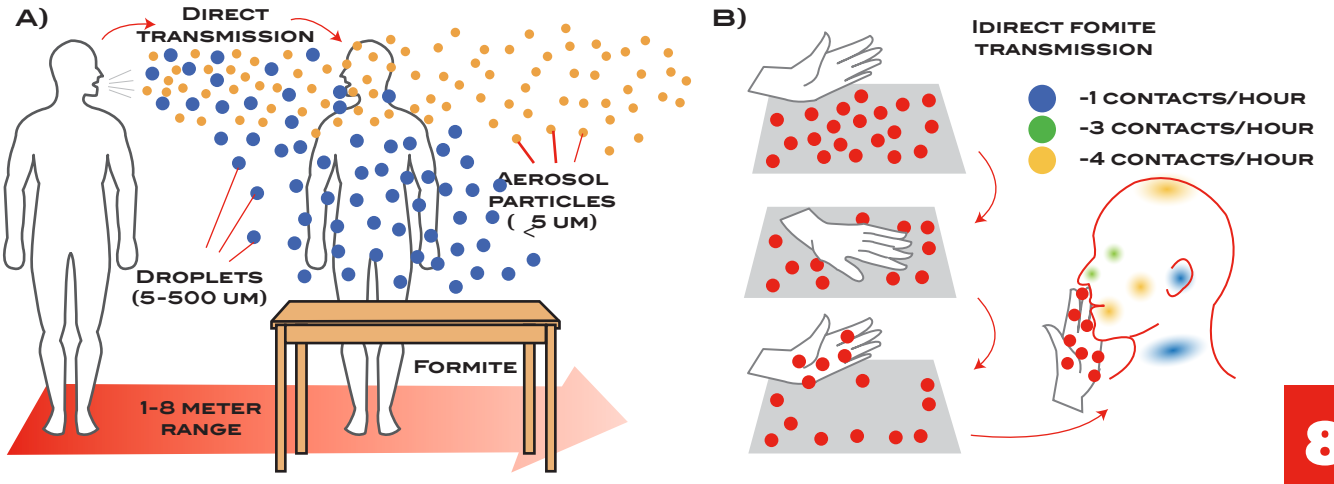
It is evident that bacteria and viruses are able to survive on surfaces for substantial periods of time, but the question often asked is what are the chances of someone picking up the germs and subsequently getting sick? The degree of pathogen transfer from a single hand contact with a contaminated surface is variable, as it depends on the pathogen itself as well as the surface it has contaminated. However, previous research has demonstrated that very efficient transfer of common bacteria is possible. For example, a few studies demonstrated E. coli, Salmonella spp., and S. aureus achieving 100% transfer from contaminated surfaces to uncontaminated hands (Kramer et al., 2006; Kramer, Schwebke & Kampf, 2006b). Nevertheless, other viruses, such as rhinovirus and hepatitis A virus, were capable of transfer too, but were less efficient, achieving 61% and 22 –33% transfer, respectively (Kramer, Schwebke & Kampf, 2006b).

Figure 1. *Different routes of viral transmission. A) Release of respiratory droplets and aerosol particles following coughing, sneezing, talking, or exhaling by an infected individual. This can directly infect another individual, remain suspended in the air or immediately settle and adsorb onto surfaces or objects (fomites) to be picked up by another individual. B) Indirect fomite-mediated transmission pathway to a new human host by means of self-inoculation (touching open nasal and oral passages following contact with fomite) (Kwok, Gralton & McLaws, 2015; Castaño et al., 2020).*

In addition, another interesting, but often unnoticed, player in microbial and viral transmission is airborne transfer from an infected person to food. This is more common than we expect and presents a big challenge, especially in large group, workplace, and social settings. Earlier studies have shown the significant amount of bacteria a person (let alone an infected individual) can release in one breath.

So from just breathing, coughing, or sneezing, a sick and infected person can potentially release a huge number of airborne bacteria or viral particles. Some of these can remain suspended in the air for substantial periods of time and travel via air currents, or settle on nearby objects and surfaces, creating potential for a healthy individual in close proximity to be susceptible to infection (Figure 1) (Kwok, Gralton & McLaws, 2015; Castaño et al., 2020).

Surprisingly, bioaerosols resulting from an infected person sneezing and coughing can also contaminate surfaces up to several meters away from the source (Castaño et al., 2020). Furthermore, it has been previously estimated that humans are able to release 37 million bacterial gene copies (based on a size-resolved concentration approach to quantify bacterial amounts) per hour, making us a large contributor to bioairbornes, especially in indoor workplace or group environments (Qian et al., 2012).



Another easy and common, yet unrecognized, transmission route is the sharing of food or drinks. One study quantified the transfer of bacteria from the rim of a cup, as well as residual bacteria in the water inside the cup following consumption. An average of 100,000 to 1,000,000 bacterial colonies were transferred to the rim of a cup after drinking compared to a control cup, while approximately 1,000 to 15,000 bacteria were transferred to the water inside the cup following drinking (Figure 2) (Dawson et al., 2018). Meanwhile, another study looked at double-dipping a cracker when sharing food and measured a higher population of bacteria found in solutions that were dipped into after biting the cracker. There were an estimated 150 to 1,000 bacterial colonies per milliliter transferred to the dip (Figure 3) (Dawson et al., 2009). Therefore, an infected person can transfer a large number of harmful pathogens to foods and drinks, which can then be passed on directly to another individual if they make contact with it.

Another route of transmission is direct contact between hands/utensils and food. Transmission of disease via human hands is a big public health challenge, as previous experiences with influenza A has shown that the virus remains infectious on hands, shedding from fingers for 30 minutes after inoculation (Thomas et al., 2014). Other research further supports the theory that there is a large transfer of microbes to food indirectly through the use of hands or sharing utensils (Purohit, 2009; Dawson, 2020).

Interestingly, one study analyzed the efficiency of viral transfer from fomites to hands (F to H) and hands to fomites (H to F), and observed a higher rate of influenza virus transfer from fomites to hands, especially from non-porous surfaces (Table 2) (Bean et al.,1982). Notably, the reverse was observed for norovirus, where there was a higher rate of viral transfer from soiled hands to uncontaminated objects and/or

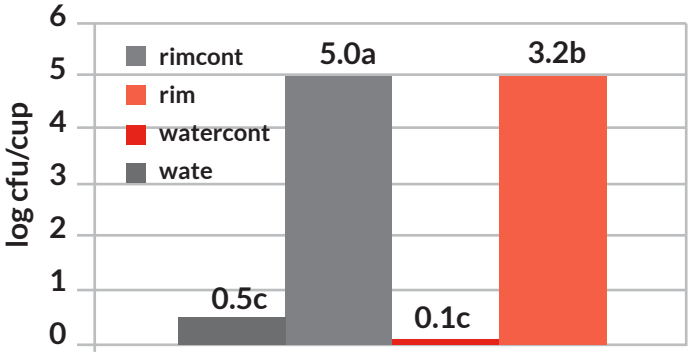


Figure 2. *Higher total bacteria recovered from the rim of a cup after drinking (rim) compared to the rim of the control cup (no drinking, rimcont). Higher residual bacteria in the water of the cup after drinking (water) and in the water of the control cup (no drinking, watercont) (Dawson et al., 2018).*

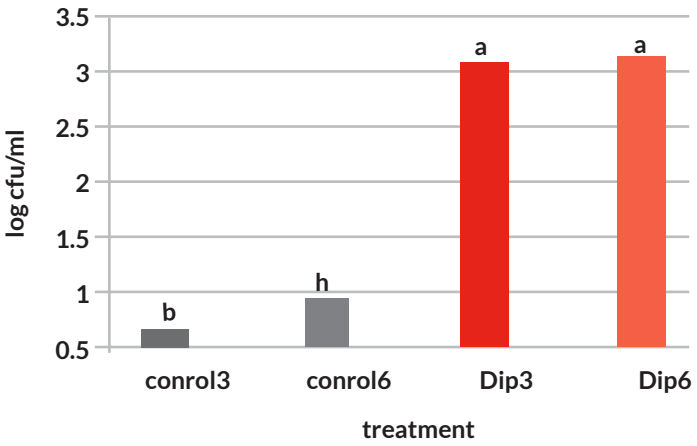


Figure 3. *Greater total bacteria in dips recovered following cracker biting before dipping (Dawson et al., 2009)*

surfaces (Rusin, Maxwell & Gerba, 2002). This particular analysis emphasizes how efficiently viruses can spread, showing their immense potential for cross-contaminating secondary objects or surfaces such as food. Furthermore, 50% of once healthy individuals that handled a coffee cup contaminated with rhinovirus subsequently developed infections, most likely through self-inoculation (i.e., touching the face and oral/nasal passages with soiled hands) (Gwaltney & Hendley, 1982).
Studies also support the idea that bacteria and

viruses can cause high levels of cross-contamination (Table 4), leading to a cascade of contamination events enhancing germ spread. For example, the norovirus could transfer from a contaminated surface or fomite to unsoiled, clean hands, and then to a secondary surface or object (Barker et al., 2004).

Disturbingly, in norovirus cross-contamination, a series of seven different clean surfaces could be contaminated without having to re-contaminate hands (Barker et al., 2004). Lastly, it is important to note that self-inoculation via the hands is quite significant. Following contact with contaminated fomites or surfaces, self-inoculation via touching the face or oral/nasal passages emphasizes that these microbes and viruses are persistent in the environment and ready to cause infection. Therefore, scientific evidence supports the idea that bacterial and viral (Table 4) transmission via fomites (either directly or indirectly) is a very important mode of germ transmission (Figure 1). Consequently, it should definitely be taken into consideration when assessing and investigating potential interventions to reduce spread of harmful germs.

Table 4. *General but potential role of fomites in viral transmission (Boone & Gerba, 2007).*

Virus	Optimal Enviromental condition for survival (reference[s])	Viral transfer via fomite (reference[s])	Minimally infectious dose of virus (reference[s])	Evidence of transmission by fomite (reference[s])
Respiratory Syncytial virus	Composition of surface more important than Mumidity and temp (3, 24)	From porous (tissues, gloves) and nonporous (countertops) fomites (33)	Intranasal inoculation, humans, 100-640. $TCID_{50}$ (54, 55)	Proven (3, 22)
Rhinovirus	Survived well in high humidity but poorly under dry conditions (64)	Clean hands pick up virus when handling contaminated fomites (S, 52); 70% of virus útransferred to recipients fingers (30)	Intranasal inoculation, humans, 0.032-0.4 $TCID_{50}$ (55) reported elsewhere as 1-10 $TCID_{50}$ (7,28,39)	Proven, considered minor (3,22)
Influenza Virus	Survival at lab temp of 28°C and 40% humidity for 48 h on dry surface(73); 72 h for influenza A virus on dy surface (73); 72h forinfluenza A virus on wet surface (9)	Virus transfered from contaminated surface to hands for up to 24 h after noculation (9)	Intranasal inoculation, humans, 2-790. $TCID_{50}$ (54, 55)	Proven, considered secondary or minor (38)
Parainfluenza Virus	Survival decreases above 37°C; stable at 4°C, pH 7.4 to 8.0, and low humidity recovered after freezing for 26 yrs (37)	Stainless steel surfaces to clean fingers (5)	Intranasal inoculation, humans, 15-80 $TCID_{50}$ (parainfluenza virus 1) (7, 38,54)	Not proven, indirect evidence supports)3,22)
Coronavirus	Humidity 55-77% and temp 21°C remained infective up to 6 days in PBS (5O); remains infective 1-2 days. in feces (68)	Theoretically possible but not studied (68)	Not found	Not proven but suspected (3, 38, 58)
Feline Calicivirus	Survived at 4°C when dried on coverslip for 56 days: survival decreased with temp (21); sensitive to humidity ín 30-70% range. (19,61)	From gloved hands to kitchen utensils and doorknob and vice versa (53); from contaminated surface to clean hands to phone, door handle, or water tap handle (8)	Estimated to be as few as 10-100 particles (1.8, 17, 39)	Not proven, indirect evidence supports CDC lists surface contamination (17, 41)
Rotavirus	Remained infective for 32 mos at 1O°C and 2½ mos at 30°C when stored in feces (25)	16% viral transfer from contaminated fingertips to steel disc añier 20 min (4)	Not found; estimated at 10-100 $TCID_{50}$, (7, 55)	Proven (7, 22)
Hepatitis A Virus	Survival inversely proportional to relative humidity and temp 5°C is Optimal temp (1, 48)	25% viral transfer from fingers to disc; moisture facilitated transfer (47); 9.2% of virus transferred to lettuce (11)	Estimated at 10-100 $TCID_{50}$, (55, 59)	Accepted (food and fecally contaminated. surfaces) (1, 41)
Adenovirus	Survived shorter periods in presence of feces and atlower humidity (1, 42, 46, 61)	Not found	Intranasal, 150 $TCID_{50}$; oral, 1,000 $TCID_{50}$ (capsule form of serotypes 4 and 7) (54)	Widelly accepted contaminated. surfaces (1)
Astrovirus	Survived 4°C on china for 60 days and paper for 90 days; faster decay at higher temp (2,61)	Not found	Not found	May play an important role in secondary transmission (2,61)

What Can Be Done to Manage This Problem?

Currently, treatment options for infectious diseases are limited, especially in an outbreak situation. There are numerous antibiotic drugs for a range of bacterial infections, but due to a rise in antibiotic resistant bacteria, it is becoming harder to treat patients. Furthermore, there are only a handful of antiviral medications and vaccines for viral illnesses. The prevention and management of these infectious diseases relies heavily on medications and presents a huge burden on the global health system. This raises the question of whether there are any effective yet simple and feasible ways to prevent and/or reduce spreading of germs.

Common interventions that scientists have studied extensively in the past are cleaning or disinfection strategies. Most of these studies have shown that chemical disinfectants have only a mild effect in reducing microbial and viral contamination. However, it is also worth noting that in spite of these strategies, there was a high potential for cross-contamination events on secondary surfaces and objects (Barker et al., 2004). For example, a detergent-based cleaning regimen indicated a potential to reduce risk of cross-contamination, but significant norovirus contamination was still detected in 28% of the surfaces that were tested (Barker et al., 2004). One of the limitations of utilizing chemical disinfectants for reducing contamination is that their effectiveness is dependent on various factors, such as the contact time between the disinfectant and the fomite or surface, the physical properties of the fomite/surface, how the chemical disinfectant is applied, as well as other environmental factors (Castaño et al., 2020).

One simple strategy is to educate people on good hygiene practices and habits, such as handwashing. It is something that we have control over and is feasible for

everyone to adopt. Washing hands frequently can lower the incidence of germ transfer from fomites to open facial passages like the nose, eyes, and mouth (Sattar et al., 2002). But good and effective handwashing is only as effective as the antiseptic used (Castaño et al., 2020).

Moreover, handwashing methods were traditionally catered to decreasing bacterial infection and spread and did not effectively target viruses. The uniqueness of viruses, including their strong ability to persist on skin, may lend to their ability to evade inactivation through common hygiene practices (Sattar et al., 2002).

An alternative to handwashing is the use of hand sanitizers, most of which are ethanol- or isopropanol-based and have shown effectiveness in inactivating germs present on hands (WHO, 2009). But all these methods seem to be sub-par and mildly effective. As such, there is a significant need for a solution to successfully control cross-contamination via fomite-mediated infection.

To tackle this problem, an approach that targets large groups to maximize bacterial and viral disinfection should be considered.

The sharing of food and drinks is a common practice among people in group and social settings and is by far one of the easiest ways to share germs. Therefore, a promising approach may involve identifying an interception strategy by means of labelling food and drinks to prevent sharing in the first place. This would allow individuals to identify their own foods and drinks and prevent others from touching them.

Plus Brand (https://plusbrand.com/) has developed an all-scratch technology that can label your property, like your drinks and food containers, to prevent others from mistaking them as their own and avoid any confusion. These labels have been created with very helpful properties, such as water and condensation resistance to help with label adherence. This non-scientific, but easy and feasible, approach may be an effective way to control environmental and fomite contamination, which are crucial in lessening the burden of serious infectious illnesses.

Figure 4. *All-scratch label for foods and drinks by Plus Brand.*

Conclusion

In summary, infectious illnesses present a huge burden on our global health systems, as these pathogens continue to emerge, re-emerge, and evolve over time. More often than not, fomite-mediated transmission pathways are under-recognized, but growing scientific evidence shows that bacterial and viral pathogens are quite persistent on surfaces and objects, and through contact, are readily able to infect a host.

It is evident that it is easy to become infected with a pathogenic bacteria or virus through basic, normal activities, such as sharing foods and drinks. The transfer of infectious pathogens in these events is mediated by contamination of surfaces and objects, which can lead to potentially serious and life-threatening consequences from the illnesses they can cause. Despite assessment of extensive sanitization and cleaning intervention strategies in past studies, their lack of effectiveness calls for a need to find simple and feasible ways to prevent or manage the risk of spreading germs.

One recommendation would be to try a simple method of labelling objects like foods and drinks to prevent others from coming into contact with them and leading to potential cross-contamination events.

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