How will COVID-19 change consumer attitudes and behaviours in respect to hygiene and cleaning and can we expect to see a new generation of innovations in this market?

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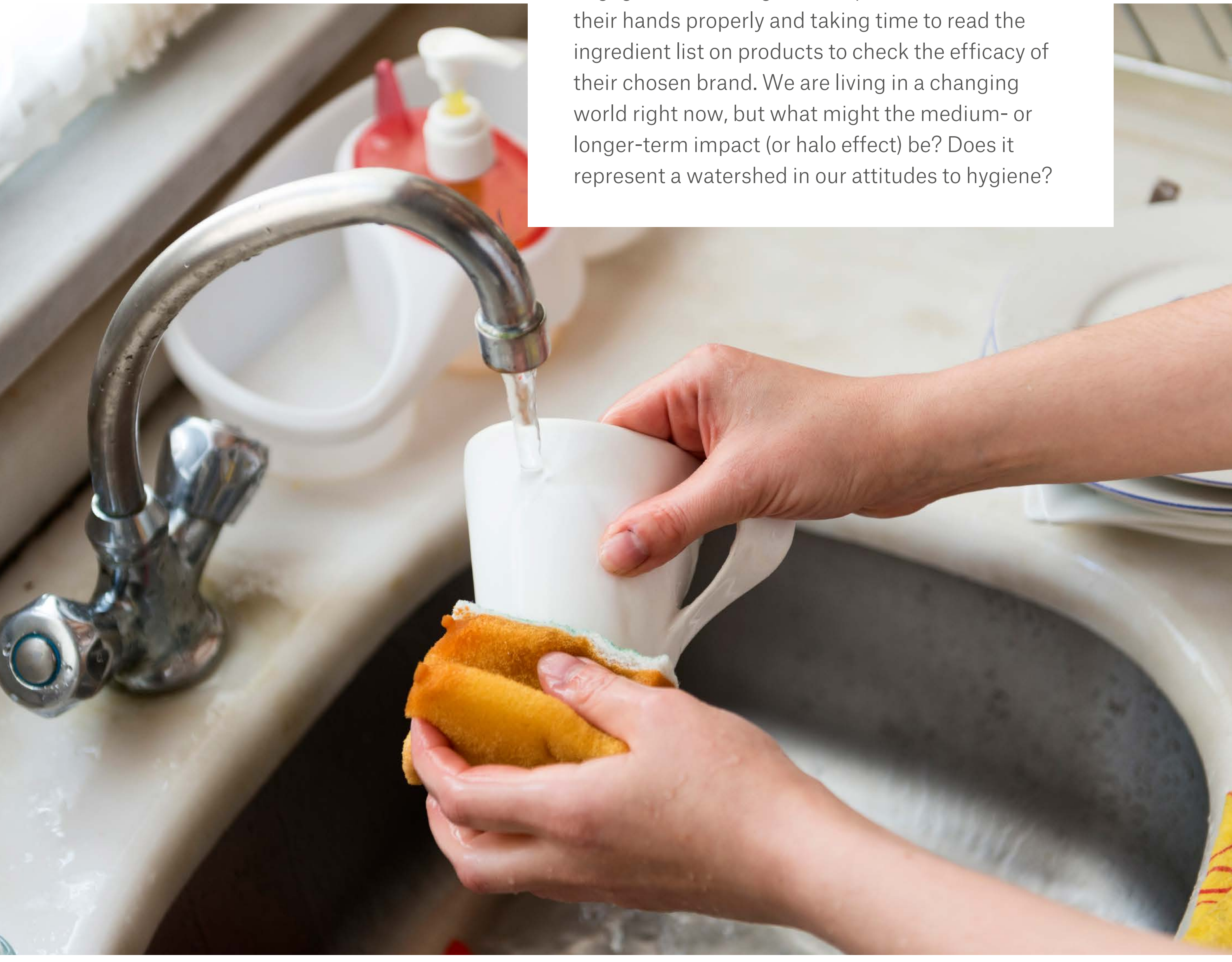
Until recently, a discussion on innovation to advance everyday personal hygiene or household cleaning products would have sparked a limited level of interest beyond the community directly engaged in these markets. COVID-19 has changed our world.

A change in attitudes to hygiene

At an alarming pace, this virus has spread across the globe bringing human tragedy and economic disruption. We now see consumers proactively engaged in watching video clips to learn how to wash their hands properly and taking time to read the ingredient list on products to check the efficacy of their chosen brand. We are living in a changing world right now, but what might the medium- or longer-term impact (or halo effect) be? Does it represent a watershed in our attitudes to hygiene?



As widely communicated in news and media, the virus that has caused the COVID-19 pandemic, now called SARS-CoV-2, is a novel and particularly infectious pathogen from the coronavirus family. Its name derives from Latin “corona”, meaning “crown” or “wreath”, referring to the characteristic appearance of these viruses under the microscope.

This RNA virus spreads via droplets dispersed by coughing and by means of contact mediated transfer. Products that sanitise the skin or aid surface cleaning and disinfection are critical tools for our defence. Many consumers are already aware of the importance of rigorous hygiene regimes, but adherence remains problematic. However, the COVID-19 pandemic may have created a more significant – and perhaps permanent paradigm shift in attitudes to hygiene whether in the home, at the office or on-the-go. We know that there are effective hygiene solutions available to consumers which, if used appropriately, should provide an appropriate level of protection against contracting and spreading the virus although adherence remains critical. However, the heighted focus on this issue is likely to drive demand for innovation in this space too.

Many consumers are already aware of the importance of rigorous hygiene regimes, but adherence remains problematic.

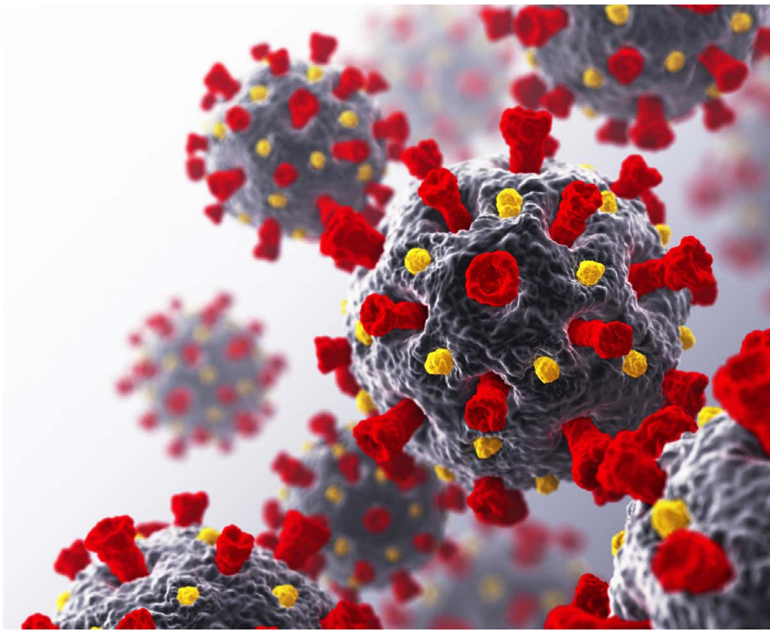
In order to develop effective solutions, we need to understand the virus' nature, survival and transferability

In order to control – and ultimately beat - the virus, we need to understand its nature. Much of what we know today is founded on our knowledge and experience with other viruses of the same family including SARS-CoV-1, MERS-CoV and some associated with the common cold[1,2]. The severity of this pandemic has brought into stark focus the need to better understand the virus and has caused effort to be directed at finding ways to treat and prevent its devasting consequences.

Teams from around the globe are already working to address this challenge: An initial scan of recently published literature reveals collaborative efforts in play across many parts of the globe. For example, in China[23] scientists look at the genomic structure of this RNA based virus, while in Egypt[24] biophysicists investigate the surface structure and associated binding sites. Elsewhere, other research institutions including Imperial and Kings Colleges in London and Oxford University are looking at vaccines and other forms of treatment.[25,26,27]

Encouragement may also be taken from voices such as virologist Seema Lakdawala of the University of Pittsburgh who suggests lipid-enveloped viruses such as SARS-CoV-2 may be easier to de-activate than, for example, those having tough protein shells called capsid[3] which are found in gastrointestinal viruses such as norovirus.

This newly generated knowledge, emerging from the science community and founded in first principles, will inform our efforts to develop future hygiene and cleaning solutions.



More data is required to understand viral survival on different types of surface

Generally, chemical disinfection of hard and smooth surfaces is relatively easy: the US Environment Protection Agency, recommends household disinfection of hard surfaces with 70% ethanol or bleach - diluted to the user's needs. In contrast however, disinfection of soft materials such as carpets or upholstery often requires special chemicals and may need other interventions such as laundering or steaming, often at very high temperatures. This is particularly relevant for SARS-CoV-2 as human coronavirus survival rates appear to be quite vulnerable to heat and even a modest increase in temperature has drastic effects on reducing viral load. According to a recent review, human coronaviruses can persist on plastic surfaces for 2-9 days at room temperature but at 30°C, this drops down to 8-24 hours.[4] Interestingly, SARS-CoV-2 only appears to persist on copper surfaces for up to 4 hours[6]. The table below shows how the coronaviruses can persist on different surfaces.

Surface type	Persistence of human coronaviruses (e.g. SARS -CoV-1 and MERS-CoV)	Persistence of SARS-CoV-2
Steel	5 days	2 days
Aluminium	2-8 hours	
Wood	4 days	
Paper/Cardboard	1-5 days	1 day
Glass	4-5 days	
Plastic	2-9 days	3 days
Copper	8 hours	4 hours

Table 1: Current best knowledge of duration of survival of human coronaviruses and SARS-CoV-2 in various types of surfaces. Data from Kampf et al, 2020[4] , van Doremalen et al, 2020[6]

Many organisations are looking at virus survival on surfaces: the Institute of Hygiene and Environmental Medicine at the Greifswald University Hospital[4], the National Institute of Allergy and Infectious Diseases Hamilton in the US[6], several SMEs working on infection prevention including Novaerus, Vital Vio and SwipeSense provide just a few examples of such work. However, it is important to note that finding viral material on surfaces does not always indicate the level of infectibility the viral particles may have.

A better understanding of the infection capability of viral particles present on surfaces is needed. Testing virus survival on different surfaces typically involves placing known amounts of viral particles onto a surface under controlled conditions and measuring viral load periodically over hours/days to determine the amount of viral genetic material that is found on the surface, usually by using polymerase chain reaction (PCR).[17]

To determine the infection capability of viral particles after a certain amount of time, viral cultures of cells of interest (mammalian/avian etc) need to be prepared to assess if the remaining viral particles can still penetrate the cells of interest. For SARS-CoV-2, it's clear that more research is needed to more accurately determine the infection capability and survival of this novel virus.

Innovators in the hygiene and cleaning sectors will have the opportunity to leverage the wealth of data that is emerging from studies on viral survival on different surfaces to inform new product development. This will no-doubt inform future hygiene and cleaning behaviour of consumers also.

The issue of transmissibility also requires specific attention

At the time of writing, there appears to be no hard data on the transmissibility of SARS-CoV-2 from contaminated surfaces to hands. If it is like that observed for Influenza A, we have cause for concern: a study on the Influenza A virus[4] suggested 31.6% of viral load may transfer from contaminated surfaces to hands. Human behaviour also compounds risk as hand/face contact is typically high: one study showed students touched their face on average, 23 times per hour. This highlights why good personal hygiene, as well as the highest standards of surface cleaning are critical preventative strategies[4].

It should also be noted that a recent publication highlighted that it is plausible that Sars-CoV-2 may spread as an airborne aerosol, however this is not thought to be the primary driver of infection in everyday settings. Rather infection is mainly thought to be via larger respiratory droplets.[29]

Many organisations aiming to offer successful hygiene and cleaning products in consumer markets will look to research being generated across the global science and technology ecosystem in relation to that nature of viruses, survival and transmissibility in order to inform future product development. Significant opportunity will also be gained by forming collaborations with this emerging ecosystem in order to fast track the development of successful products.

Managing the immediate challenge with existing technology

Whilst progress is being made on topics that will inform longer-term solutions, strategies aimed at reducing the risk of infection from SARS-CoV-2 are an immediate priority.

In the US, the EPA has released (and is continuously updating) a long list of registered and approved disinfectants that could be used to eliminate the novel human coronavirus, as they have previous evidence of efficacy on other human coronaviruses. At the time of writing this article, no companies had sent material to the EPA specifically for SARS-CoV-2[3]. It is our understanding that the first lab to be able to start testing cannot do so until May. The lists of products on the EPA's List N[28] are those that qualify as effective for SARS-CoV-2 under EPA's Emerging Pathogen Policy. This lists quaternary ammonium, hydrogen peroxide and peroxyacetic acid as active ingredients for disinfection for human coronavirus.

A search across Mintel Global New Products Database reveals 45 household cleaning products with claims relating to the elimination of human coronaviruses. These take a variety of product formats including wipes, sprays (for floor/surface cleaning), air sprays and hand sanitisers. The most common ingredient for these products appears to be benzalkonium chloride, which, according to a recent review, has conflicting evidence of efficacy[4]. Other common ingredients with coronavirus disinfection claims in the product list, include quaternary ammonium disinfectants and alcohol. These claims come from evidence based on the ability to eliminate the common cold viruses from surfaces but are thought to apply to the entire family of coronaviruses.

> Further research is needed to clarify which chemical disinfection solution offers most hope, specifically in the fight against SARS-CoV-2.

Innovations that may gain interest and traction as a result of this pandemic

Chemical products currently form the backbone of the personal hygiene and home cleaning/ disinfection product market; however it is expected that future innovation may involve a variety of different strategies. The current portfolio of formulated products may be enhanced in terms of their primary functionality by leveraging new chemical strategies to improve efficacy or duration of action, and/or look to improve the overall use experience as outlined below. Beyond chemical strategies we see the emergence of physical and/or biological approaches.

Physical strategies could involve the use of electromagnetic radiation through to thermal approaches. It's also likely we will see more hybrid solutions and systems on the market in the future. An initial scan of potentially interesting chemical, physical and biological strategies are captured on the next page.

Emerging technologies/products that could be used to address the challenge of COVID-19 pandemic

	Short term / Commercially Available	Medium term	Long term
Chemical	**Highlight® by Kinnos Inc, USA** Blue coloured chlorine disinfectant which claims to improve efficacy in killing human coronavirus, and improves disinfectant visibility[7,8]	**Hydrogen Peroxide Microgel by Michigan Technological University, USA** This microgel shows 99.99% efficacy in eliminating bovine viral diarrhoea virus, an enveloped virus similar to coronaviruses.[9]	**Hydrogen peroxide vapour by Bioquell, UK** Used in hospitals, hydrogen peroxide vapour is known to be extremely effective against coronaviruses[10]. Compact solutions such as Bioquell's BQ-50 have potential to be used in domestic settings for decontamination.[11]
Physical	**Antimicrobial polymer coating by Hong Kong University Science and Technology** This technology that prevents viral adhesion to surfaces was shown to kill 99.99% of bacteria and viruses and was used to coat air-particulate filters at Wuhan's Huoshenshan Hospital during the COVID-19 outbreak.[18] **Anti-microbial, curable coating by Jawaharlal Nehru Centre for Advanced Scientific Research, India** Scientists at JNCASR have developed a curable coating, which has shown efficacy against Influenza A, an RNA virus. To address the recent COVID-19 outbreak, the technology will now be tested against the novel coronavirus for efficacy.[19]	**Autonomous robots using UV light to kill COVID-19 by UVD Robots, Denmark** Coronaviruses are known for their susceptibility to UV irradiation and heat[20]. UVD Robots[21] make autonomous robots that can disinfect patient rooms and ORs in hospitals by using short wavelength ultraviolet-C lightwaves that can destroy DNA and RNA molecules. The robots have been operating in Wuhan through March 2020 to slow down the spread of COVID-19[22].	

	Short term / Commercially Available	Medium term	Long term
Biological	**Anti-pathogen fabric by Sonovia, Israel** Developed originally at Bar Ilan University, nanoparticles infused onto textiles help block bacteria and fungi. The technology is currently being tested against COVID-19 in China.[12]	**Anti-virus snood by Manchester University and Virustatic, UK** Can capture 96% of airborne viruses by attaching glycoproteins to carbon cloth, and then to other materials such as cotton.[13] The material is effective against a range of coronaviruses, including SARS and MERS.[14]	

Natural solutions against coronavirus

As the scientific community gathers more information about this virus and gains confidence in elimination technologies, we expect to see more products emerge with natural, safe, and gentle claims driven by the sustainability agenda. There are already products on the market with such claims, highlighting the gentle efficacy of chemical approaches.

Eco-friendly chemical approach

Thymox is an eco-friendly, EPA-registered cleaning agent which has been shown to eliminate human coronaviruses within one minute of application. It is the first agricultural disinfectant in Canada to obtain UL-Ecologo certification and is available for private labelling.[16]

Sugar virucides

A collaborative research project between The University of Manchester, University of Geneva and the EPFL in Switzerland have developed sugar based antiviral materials. The broad-spectrum activity of these materials against different types of viruses (herpes simplex, respiratory syncytial virus, hepatitis C, HIV, and Zika virus) shows promise of efficacy against newly prevalent SARS-CoV-2.[15]

Conclusions

Given the scale of the impact of the COVID-19 pandemic on global health, we anticipate that the current heightened consumer awareness of the importance of hygiene, inside and outside of the home, will continue after the pandemic passes.

Now that consumers have increased understanding of correct hygiene procedures, we expect them to continue to make every effort to protect themselves and their loved ones from any future potential pandemic. It will also be interesting to consider how attitudes towards hygiene and safety will change outside of the home.

We anticipate hygiene standards will rise in places of employment, education, leisure, travel etc. and we expect to see more demand for, as well as obligatory usage of, effective hygiene and cleaning products, as well as dispense mechanisms outside of the home.

In addition, as we have outlined in this paper, there has been a significant increase in the level of research activity since the emergence of pandemic crisis. This has focused on understanding the nature of the virus, its survival on different environments, transferability and the efficacy of current and emerging technologies.

There is a significant opportunity for those operating in the hygiene and cleaning categories to leverage this emerging science and technology and to draw inspiration from it for the development of the next generation of products. It will also be important to forge collaborations with key players in the emerging ecosystem in order to fast track to effective solutions.

When it comes to emerging technologies to inactivate the virus, we are already seeing several interesting strategies in response to the pandemic challenge: the development of new chemistries to augment the functionality of existing solutions such as the addition of sensory cues for the consumer, physical strategies involving the use of novel coatings, device and robotic technology, and biological strategies such as the use of glycoprotein on textiles to trap the virus.

We know from experience that some of the most interesting innovations emerge from combination strategies e.g. chemical combined with physical approaches. We have also seen many interesting innovations emerge when solutions from extreme situations are transferred to a domestic setting so we will be keen to see how solutions from hospital settings, for example, may find their way into domestic settings.

We are also considering how the impact of the COVID-19 pandemic will impact on consumer demand for sustainable products. For example, will efficacy prevail over natural solutions? Given the emphasis Gen Y and Z (the key future consumer groups) place on the importance of sustainability, we do not expect sustainability to be taken off the agenda in our post COVID-19 world.

Across commerce, government and society we believe the strong intent to protect against future pandemics through hygiene and cleaning strategies will continue. Innovations based on collaborative ecosystems and open strategies are likely to be central to the development of successful innovations and we anticipate that we will continue to work with many of our clients in the quest for new innovations and successful external partnerships.

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We help companies make the best choices on what and how they should direct their innovation / R&D effort and resources. We provide a techno-commercial perspective to help them explore and understand the opportunities they face and so enable them to make informed decisions on the best path forward.

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