**Research into non-chlorine disinfectants for use in care homes that are effective against SARS-CoV-2**

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**With contributions / review from:**

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| Alison Criado-Perez, RN, DTN, Rutland, UK Dr Sarah House, BEng, DIS, MSc, D.Litt, CEng, MICE, C.WEM, FCIWEM, Independent Water Sanitation & Hygiene (WASH) Consultant / Public Health Engineer, Leicester, UKEric Fewster, BA, MSc, C.WEM, MCIWEM, CEnv, Independent Water & Environmental Manager, Salford, UKDr Lucy Owen, RSci, MRSB, Postdoctoral Researcher, Infectious Disease Research Group, De Montfort University, Leicester, UKDr Katie Laird, CBiol, FRSB, FHEA, Reader in Microbiology, Associate Professor of Research, Head of the Infectious Disease Research Group, De Montfort University, Leicester, UKJackie Hook CChem MRSC, Technical Support Chemist, JLA Limited, Ripponden, UK |

**This document continues to be subject to modification, given new evidence and information that comes in.**

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1. Purpose of this document

There is a huge range of non-chlorine disinfectant products available, for example different types of alcohols and quaternary ammonium compounds (QACS). This document therefore attempts to understand more about the effectiveness of non-chlorine disinfectant products that might be typically used in care homes at present, in order to establish which may or may not be effective against the virus SARS-CoV-2.

1. Main findings

In conclusion for care home settings:

* Our recommendation is that if using non-chlorine disinfectant products, to use only those that conform to the EN 14476 standard. Note that this is a higher recommendation than required by UK government guidance (which correctly states that disinfectants that meet lower standards – for example against only enveloped viruses – will also inactivate the SARS-CoV-2 virus). But our recommendation exists because care homes also have to deal with other viruses (e.g. norovirus, which being a non-enveloped virus is more resistant) that might not be inactivated by a lower standard product, so it makes sense to have cleaning products that deal with all of them at the same time.
* Note that it is a bit confusing that handrub / handwash products, as well as those for surface disinfection, can still be stated to meet the EN 14476 standard if they have only been proven for enveloped viruses, but not the more resistant viruses (e.g. Noroviruses). Therefore it is important to make sure that any product used is stated to both meet the EN 14476 standard AND they have “full-virucidal activity”.
1. UK Government guidelines

Where cleaning products are mentioned, there is no particular detail for non-chlorine disinfectants – what is said is summarised as:

* Seek advice from an IPC/HPT specialist for non-chlorine disinfectants.
* Ensure that they are effective against enveloped viruses.

Below are the relevant paragraphs under these sections.

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| **Document** | **Date & web link** | **Relevant sections** |
| **Admission and Care of Residents in a Care Home during COVID-19**  | The latest version of this document (16 September 2020) is available here:<https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918211/covid-19-care-homes-guidance-on-admission-and-care-of-residents.pdf> | In Annex G (on decontamination and cleaning processes) it states the following:* *Use disposable cloths/paper roll/disposable mop heads to clean and disinfect all hard surfaces/floor/chairs/door handles/reusable non-invasive care equipment/sanitary fittings in the room, following one of the 2 options below:*
	+ *Use either a combined detergent disinfectant solution at a dilution of 1000 parts per million (ppm) available chlorine (av.cl.)*

*or* * + *A neutral purpose detergent followed by disinfection (1000 ppm av.cl.).*
	+ *If an alternative disinfectant is used within the organisation, the care home should seek advice from a local infection prevention and control specialist to ensure that this is effective against enveloped viruses.*
* *Follow manufacturer’s instructions for dilution, application and contact times for all detergents and disinfectants.*
* *Any single-use cloths and mop heads must be disposed of and reusable ones must be laundered.*
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However, since some care homes might not have immediate access to an IPC specialist, we have attempted to decipher what the standards are regarding these non-chlorine disinfectants in terms of efficacy against various types of virus and have made a higher recommendation than that by the UK Government.

1. Definition of enveloped versus non-enveloped viruses[[1]](#footnote-1)

Viruses can be classified based on their type of viral genetic material (DNA or RNA) and on their structure. Looking at structure, all viruses have a protein shell called a ‘capsid’ but they differ in whether they have an extra layer (enveloped) or not (non-enveloped).

**Enveloped viruses**

This extra layer for enveloped viruses consists of lipids and proteins that it ‘stole’ from host cells and viral glycoproteins (the bumps, knobs and spikes that artists use in images of enveloped viruses like SARS-CoV-2 depict structures on the viral envelope). The envelope helps the virus avoid detection by the host immune system because it makes the virus look like just another host cell.

While it might appear that having an extra layer should make a virus more resistant to disinfection, the key thing here is that enveloped viruses need both an intact capsid as well as this envelope to be able to infect cells – if one or other is not present, then the virus is not able to infect host cells. As the oily outer envelope can be quite easily disrupted using common disinfectants including alcohol, detergents or soap, it means that enveloped viruses can be more easily inactivated.

Examples of enveloped viruses include ones that cause notorious diseases in humans, such as COVID-19, Influenza, Hepatitis B and C, Herpes, ZIKA and Hemorrhagic Fever (Ebola Virus Disease).

**Non-enveloped viruses**

Non-enveloped viruses only need their protein-based capsid and host detector proteins to infect host cells, and they don’t have (or rely on) an outer lipid layer to remain infectious. Because the capsid is more resistant to many disinfectants and other stresses like drying out or heat, it means that non-enveloped viruses are harder to inactivate.

Examples of non-enveloped viruses include types that can cause diarrhoea (Norovirus), common colds (Rhinovirus) and Polio (Poliovirus).

1. Disinfectant standards for viruses

When looking at any particular disinfectant product, the question we need to ask is how effective that product is for inactivating a particular virus. Since disinfectant products come in a range of different formulations and concentrations, and since viruses differ in how easily they are inactivated (enveloped or non-enveloped), it means that there needs to be a standard way to know if a product is effective or not, and against what virus.

This is where standards come in. For inactivation of viruses in medical settings, the standard we need to check products against is EN 14476.[[2]](#footnote-2)

**EN 14476 – Quantitative suspension test for the evaluation of virucidal activity of disinfectants intended for use in the medical area**

Disinfectant products tend to be produced for a particular application – for example, for cleaning surfaces compared to a hand hygiene rub which is only used for hands. Therefore when a product states that it conforms to EN 14476, it means that it will have been tested for efficacy against specific viruses for the application in question – these are shown in the table below.[[3]](#footnote-3) This standard is designed to evaluate the activity of premade disinfectants and is not suitable for in-situ generated disinfectant products.

In terms of the levels of virucidal efficiency there are three levels:

* **Full virucidal activity** (tested against Adenovirus, Norovirus and Poliovirus)
* **Limited spectrum virucidal activity** (tested against Adenovirus and Norovirus)
* **Activity against enveloped viruses** (effective only against enveloped viruses – tested against Vaccinia Virus)

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| **What product is used for** | **Mandatory viruses that product must be tested against for compliance with the EN 14476** |
| Hygienic handrub and handwash | **For hygienic handrub and handwash products specifically, to meet the EN 14476 these only need to meet the lowest level disinfection to be stated as meeting the standard – i.e. activity against enveloped viruses:*** **Activity against enveloped viruses** (effective only against enveloped viruses – tested against Vaccinia Virus)

**But they can also be tested against higher levels of virucidal efficiency:** * **Full virucidal activity** (tested against Adenovirus, Norovirus and Poliovirus)
* **Limited spectrum virucidal activity** (tested against Adenovirus and Norovirus)
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| Instrument disinfection | **This has to meet the highest standard – full spectrum virucidal activity:** Adenovirus, Norovirus, Poliovirus (or where over 40°C only Parvovirus) |
| Surface disinfection | **For surface disinfection products specifically, to meet the EN 14476 these only need to meet the lowest level disinfection to be stated as meeting the standard – i.e. activity against enveloped viruses:*** **Activity against enveloped viruses** (effective only against enveloped viruses – tested against Vaccinia Virus)

**But they can also be tested against higher levels of virucidal efficiency:** * **Full virucidal activity** (tested against Adenovirus, Norovirus and Poliovirus)
* **Limited spectrum virucidal activity** (tested against Adenovirus and Norovirus)
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| Textile disinfection | **This has to meet the highest standard – full virucidal activity:**Parvovirus |

We can see that the standard is fairly rigorous, since the types of viruses that must be tested against under the standard, are mostly the more resistant non-enveloped viruses (Adenovirus, Norovirus, Poliovirus, Parvovirus), as well as one enveloped virus (Vaccinia virus). But what this means is that all products that conform to EN 14476 will be adequate to inactivate enveloped viruses including SARS-CoV-2.

But for hand hygiene products specifically, note that there is a range of efficacy. As Poliovirus is the most resistant among non-enveloped viruses, some manufacturers struggle to attain efficacy against this microorganism. What this means is that:

* For a hand product to be fully virucidal or acknowledged as capable of inactivating all enveloped and non-enveloped viruses, it must be effective against the main three viruses: Adenovirus, Norovirus and Poliovirus.
* However, a handrub might also be sold with a lower efficacy (as in, it failed to inactivate all viruses) – in these cases, it should state “limited spectrum virucidal” or “limited virucidal” even if it says that it meets **EN 14476**. For example, a product that has been tested against Adenovirus, Norovirus and Poliovirus, but failed to sufficiently inactivate Poliovirus, cannot be considered as fully effective.
* Also some handrubs might have lower efficacy still, stating “activity against enveloped viruses”, meaning that they will not be effective for more resistant viruses (e.g. Adenovirus, Norovirus and Poliovirus). But they will still be effective against other enveloped viruses (e.g. SARS-CoV-2).

Textile disinfectants must be tested at 30°C and 70°C against parvovirus. Parvovirus is a thermotolerant virus and can withstand heating to 70°C.[[4]](#footnote-4) This allows EN 14776 to test the efficacy of textile disinfectants at elevated temperatures such as those used in laundry thermal disinfection cycles. Textile disinfectants may not always relate to use in laundry, other uses may include for example disinfection of mattresses that are not laundered. It is important to note that the EN 14776 standard is a preliminary test that provides information on the viricidal activity of a disinfectant within a suspension. It does not validate performance of the textile disinfectant under laundry conditions. Further testing within a wash cycle would be required to validate the efficacy of the product as a laundry disinfectant; such a standard does not appear to be available for viruses.

The advantages of testing products using the EN 14476 standard include that several active ingredient concentrations can be evaluated efficiently over various contact times, and that it accounts for product dilution that occurs when in use (e.g. from interfering substances and the viral inoculum). A disadvantage is that any data generated is valid for product formulations against viruses in suspension, which may not translate to efficacy against dried virus films on hard, non-porous surfaces.[[5]](#footnote-5)

In conclusion for care home settings:

* If using non-chlorine disinfectant products, use only those that conform to the EN 14476 standard. Note that this is a higher recommendation than required by UK government guidance (which correctly states that disinfectants that meet lower standards – for example against only enveloped viruses – will also inactivate the SARS-CoV-2 virus). But our recommendation exists because care homes also have to deal with other viruses (e.g. norovirus, which being a non-enveloped virus is more resistant) that might not be inactivated by a lower standard product, so it makes sense to have cleaning products that deal with all of them at the same time.
* Note that it is a bit confusing that handrub / handwash products, as well as those for surface disinfection, can still be stated to meet the EN 14476 standard if they have only been proven for enveloped viruses, but not the more resistant viruses (e.g. Noroviruses). Therefore it is important to make sure that any product used is stated to both meet the EN 14476 standard AND they have “full-virucidal activity”.
1. Research into efficacy of disinfectants specifically against SARS-Cov-2

Although products that conform to the EN 14476 standard must mean that they are also effective against SARS-CoV-2, there has also been some recent research that looked specifically at the efficacy of different products against this more recent virus. These are summarised below.

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| **Research** | **Main conclusions** |
| Schrank, C.L. *et al* (2020) Are Quaternary Ammonium Compounds, the workhorse disinfectants, effective against Severe Acute Respiratory Syndrome-Coronavirus-2? *ACS Infect. Dis.* 2020, 6, 7, 1553–1557Published: 15 May, 2020.<https://pubs.acs.org/doi/10.1021/acsinfecdis.0c00265> | This article was questioning in particular the efficacy of Benzalkonium chloride (BAC) against SARS-CoV-2.* *“It appears that the reluctance of the CDC in endorsing BAC as a disinfectant against SARS-CoV-2 is based upon an outlier in one paper.”*
* *“It has frequently been confirmed that QACs are effective against influenza viruses as well as both Gram-positive and Gram-negative bacterial strains. In comparing the outer membranes between these and SARS-CoV-2, we postulate that QACs should be effective in decreasing the viral load for disinfection procedures against COVID-19 as both contain relatively similar phospholipid bilayers.”*
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| Kampf, G. *et al* (2020) Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *Journal of Hospital Infection,* 104 (2020) 246-251.Published: 6 February, 2020.[https://www.journalofhospitalinfection.com/article/S0195-6701(20)30046-3/fulltext](https://www.journalofhospitalinfection.com/article/S0195-6701%2820%2930046-3/fulltext) | This paper reviewed the literature on all available information about the persistence of human and veterinary coronaviruses on inanimate surfaces as well as inactivation strategies with biocidal agents used for chemical disinfection.* *“Surface disinfection procedures with 0.1% sodium hypochlorite or 62–71% ethanol significantly reduces coronavirus infectivity on surfaces within 1 min exposure time.* *We expect a similar effect against the SARS-CoV-2.”*
* *“Other biocidal agents such as 0.05 - 0.2% Benzalkonium chloride or 0.02% chlorhexidine digluconate are less effective.”*
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| [Ijaz](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ijaz%20MK%5BAuthor%5D&cauthor=true&cauthor_uid=32461067), M.K. *et al* (2020) Microbicidal actives with virucidal efficacy against SARS-CoV-2, *American Journal of Infection Control*, 48 (2020) 968-973.Published: 24 May, 2020.[https://www.ajicjournal.org/article/S0196-6553(20)30313-8/fulltext](https://www.ajicjournal.org/article/S0196-6553%2820%2930313-8/fulltext) | * *“To our knowledge, this is the first report of the virucidal efficacy of formulated microbicidal actives, determined using industry/regulatory-relevant global standardized (ASTM International, EN) methodologies, for inactivating SARS-CoV-2.”*
* *We provide definitive evidence of efficacy for inactivation of SARS-CoV-2… of products formulated with the following microbicidal actives: ethyl alcohol, para-chloro-meta-xylenol, salicylic acid, and quaternary ammonium compounds. All of the microbicidal actives were effective for inactivating SARS-CoV-2, demonstrating ≥3.0 to ≥4.7 log10 reduction of infectious virus within the tested 1 to 5 minutes contact time in virucidal efficacy testing conducted per applicable ASTM International and EN standards.”*
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1. Further resources

Note that guidance for approved chemicals and products through the links in this table, have been approved or are under review for use in the USA and the EU. They may or may not also be approved to EN 14476, and may only be proven to be effective against enveloped viruses.

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| **Institution** | **Links** |
| **The US Environmental Protection Agency** | List N: a database of suppliers and products that are approved for surfaces against SARS-CoV-2: <https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2-covid-19>All surface disinfectants on List N can be used to kill viruses on surfaces such as counters and doorknobs. While surface disinfectant products on List N have not been tested specifically against SARS-CoV-2, EPA expects them to kill the virus because they either:* Demonstrate efficacy (e.g. effectiveness) against a harder-to-kill virus; or
* Demonstrate efficacy against another type of human coronavirus similar to SARS-CoV-2.
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| **The European Centre for Disease Prevention and Control (ECDC)**  | Guidance to Member States on environmental cleaning in healthcare and non-healthcare settings during the COVID-19 pandemic: <https://www.ecdc.europa.eu/sites/default/files/documents/Environmental-persistence-of-SARS_CoV_2-virus-Options-for-cleaning2020-03-26_0.pdf> |
| **European Chemicals Agency (ECHA)** | Lists of disinfectant active substances that are approved or under review for Covid-19 (two separate lists): <https://data.europa.eu/euodp/en/data/dataset/biocidal-products-lists-of-disinfectant-active-substances-and-products> |

1. Good overview here which was used to inform this section: <https://www.contecinc.com/articles/viruses-are-not-the-same/> [↑](#footnote-ref-1)
2. For a review of the EN standard, see: <https://www.viroxylabs.com/fileadmin/user_upload/pdf_files/Viroxy_standard_test_methods_used_to_substantiate_claims_for_products_A.....pdf> [↑](#footnote-ref-2)
3. Adapted from: <https://www.viroxylabs.com/microbiological-testing-services/disinfectant-efficacy-testing/en-144762013-a12015/>. Note that it was incomplete and we have added/modified it. [↑](#footnote-ref-3)
4. Eterpi, M., McDonnell, G. and Thomas, V. (2009) Disinfection efficacy against parvoviruses

compared with reference viruses. *Journal of Hospital Infection*, 73(1), pp. 64-70. [↑](#footnote-ref-4)
5. <https://microchemlab.com/test/en-14476> [↑](#footnote-ref-5)