



# Disinfection of Contaminated Heritage Surfaces from SARS-CoV-2 Virus

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SHORT REPORT

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## ABSTRACT

For the heritage sector the global pandemic has introduced unique challenges; with infectious viral particles persisting on some surfaces for days, people must be protected from objects as much as the objects need to be protected from people.

Until recently information on persistence of the SARS-CoV-2 virus (which causes COVID-19) on different materials has been dispersed through the scientific literature, often with access limitations. Similarly it has been difficult to find information on how to disinfect heritage surfaces using methods which avoid the damage to the surface.

Recent work by Historic England has collated information from Conservators and Microbiologists on the cleaning of viral particles from historic surfaces to combine the current information in one, accessible, place.

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By early July 2020, it became clear that the general guidance provided for safe working in the heritage sector (Department for Digital Culture Media and Sport, 2020) lacked detail on the safe disinfection of historic surfaces. Following the trail of hyperlinks would eventually uncover the generic advice to use bleach based compounds or other disinfectants (Public Health England, 2020), which while protecting workers and visitors from infection would result in damage to the surfaces it was used on. In museums, historic houses and other heritage venues the main contact risk to the public is from touching the surfaces of historic fixtures and fittings such as display cases, stair bannisters, door handles etc. As many of these touch surfaces are historic materials they are considered vulnerable to proprietary and bleach based cleaning products.

Developing guidance which takes into account disinfectant efficacy and the effects of its chemical constituents when used on heritage surfaces is a multidisciplinary challenge. In addition to the microbiology and chemistry skill sets needed for understanding the action and efficacy of the disinfectants, a deep understanding of the appropriate treatments of materials specific to their conservation is also needed. With this in mind, Historic England put together a small team to develop guidance for the heritage sector. This involved gathering information on disinfectants and how they would affect surfaces, the persistence of the virus on different surface materials, and advice emerging in the heritage sector.

## METHODOLOGY

### SEARCH STRATEGY

Literature searches for disinfectants and the persistence of the virus on surfaces were carried out using Pubmed and Medline databases (NCBI), the ScienceDirect database (Elsevier), the REALM project (Murphy, 2020) and Google Scholar. Search terms used included COVID-19, SARS-CoV-2, HCoV-19 (a synonym for SARS-CoV-2) combined with terms such as surface, disinfection, decontamination and contact time amongst others.

A search of guidance emerging in the heritage world was undertaken. The Canadian Conservation Institute, National Center for Preservation Technology and Training, and the Library of Congress amongst others had produced useful information in this area. Additional information was sourced through emails to heritage organisations and museums in the UK and by posting on social media.

Surface compatibility with the disinfectants which were identified through screening was confirmed by consultation with senior members of the conservation community identified as experts on the material in question.

### EXCLUSION CRITERIA AND SCREENING

Manufacturers advertising literature and press articles were not included. Where such documents included references to peer reviewed publications these were investigated to see whether they were suitable for inclusion in the review.

In order to be included testing for disinfection and contact time must have been against the SARS-CoV-2 virus. Many papers included a combination of data from SARS-CoV-2 along with data from previous publications on Feline coronavirus and Influenza. In these cases unless there was evidence that the decay rate of the virus was shown to be the same as SARS-CoV-2, only the data relevant to SARS-CoV-2 was included. Disinfectants were also excluded if they did not meet the minimum standard for effectiveness of disinfectants, 6 log (99.9999%) reduction of viral load in 10 minutes (Kochelek, 2019).

Studies which looked at the efficacy of branded products were not included as the additional, unlisted, ingredients may change efficacy or have the potential to cause damage to surfaces, in addition the brands may only be available in specific countries.

Disinfectant processes which were not suitable for heritage surfaces, e.g. chlorine based compounds, were excluded, these are covered in [Table 1](#).

Once the excluded material was removed, the data set was screened to separate the information into that relevant to the mitigation of damage and information on appropriate disinfectants.

DISINFECTANT PROCESS	CONTACT TIME	REASON FOR REJECTION
Hypochlorite and chlorites (chemical)	10 minutes [1]	Chlorine anions can produce permanent damage to surfaces in short periods of time or with prolonged use.
Quaternary Ammonium compounds (chemical)	10 minutes [1]	Could result in damage due to salting, are often strongly acidic or alkaline and leave residues.
Heat/Steam at 92°C	15 minutes [2]	The high temperature and sustained time period required for deactivating this virus (92°C for 15 minutes) is not safe for historic materials.
UVC light (254nm)	5 minutes [3]	Potentially damaging to historic textiles, paper, wood and pigments. Also requires specialist knowledge and PPE for use.
Ozone fogging (chemical)	Unknown	Currently insufficient evidence for efficacy against viral particles and effect on heritage surfaces. Also requires specialist knowledge and PPE for use.

The practicalities of purchasing, storing and using the disinfectants were also considered, for example purchasing industrial denatured alcohols requires a licence in the UK so isopropanol was suggested as an effective alcohol. Advice on safe storage and use were included in the final document.

## RESULTS

The literature review identified two main approaches for addressing potentially contaminated surfaces, mitigation and disinfection. Mitigation looked at the potential to avoid the need for potentially damaging disinfection, or mitigate their effects on the surfaces. Disinfection identified the most suitable disinfectants for heritage materials.

## MITIGATION

As SARS-CoV-2 will naturally deactivate on surfaces over time (van Doremalen et al., 2020) (Table 2) the requirements for disinfections can be mitigated by isolating the surface for an appropriate time period. Damage may also be mitigated by treating some surfaces prior to public access, for example applying a surface layer of wax, so that any damage caused by the disinfectant will be absorbed by the treatment. Mitigation of damage through surface preparation is an established technique in conservation, examples include waxing of wooden and marble surfaces (National Trust (Great Britain), 2006).

SURFACE	PERSISTENCE OF SARS-COV-2 ON SURFACE (HOURS)
Ceramic (glazed)	120 [1]
Ceramic (unglazed)	120 [1]
Glass without applied surface coating	94 [2]
Glass with applied surface coating	94 [2]
Iron	120 [1]
Stainless steel	48 [3]-168 [1]
Bronze & Brass	72 [4]
Plastic	72 [3]-168 [2]
Stone	72 [5]
Textiles	48 [2]
Wallpaper	3 [2]
Wood	48 [2]

When reviewing the information available on the persistence of SARS-CoV-2, data was not available for leather, gilding, painted surfaces, plaster (lime or Plaster of Paris) or wall painting surfaces.

In the case of stainless steel and plastic there are conflicting reports for the persistence of the virus on the surfaces. It is worth noting that neither of the studies on plastics refer to the type of plastic tested.

**Table 1** Disinfection processes excluded from the literature review together with the reasons for rejection. [1] Chin et al., 2020, [2] Pastorino et al., 2020, [3] Patterson et al., 2020. Disinfectant rejection was determined through consultation with material-specific conservation experts.

**Table 2** Persistence of SARS-CoV-2 on surfaces. Source of persistence data [1] Carraturo et al., 2020, [2] Chin et al., 2020, [3] van Doremalen et al., 2020, [4] Warnes et al., 2015, [5] Striegel, 2020.

For the disinfection of surfaces three processes were found to be effective in deactivating SARS-CoV-2 on a variety of materials which correlated to historic surfaces:

- Ethanol and isopropanol at concentrations over 70% were shown to be effective in deactivating the virus (Kampf et al., 2020) given a suitable contact time (2 minutes for 70% or 30 seconds for 80%).
- Peroxygen based compounds were shown to be effective at 0.7% (7,000 ppm) with a contact time of 2 minutes (WHO Global, 2020).
- Surfactants or detergents and water were shown to be effective at the manufacturers recommended concentrations when given a 1 minute contact time (Ijaz et al., 2020).

In all cases the disinfectant activity was enhanced by careful and repeated wiping, as the mechanical activity aids in the disruption of the viral particles as well as cleaning the surface prior to disinfecting (WHO Global, 2020). Compatibility of materials with disinfectants (**Table 3**) was based on the surface, or surface coatings, being in good/sound condition (without cracks or losses) prior to the application of the disinfectant. Previously damaged surfaces were not included in this assessment.

SURFACE	DISINFECTANT SUITABILITY		
	ALCOHOLS	PEROXYGEN COMPOUNDS	SURFACTANT/DETERGENT AND WATER
Ceramics (glazed)	✓	✓	✓
Ceramics (unglazed)	✓		✓
Glass without applied surface coating	✓	✓	✓
Iron	✓		
Stainless steel	✓		✓
Copper	✓		
Bronze and Brass	✓		
Painted, oil based paint			✓
Plaster (lime)	✓	✓	✓
Plaster (Plaster of Paris, fibrous)	✓	✓	
Plastic	✓	✓	✓
Alabaster	✓		
Stone and Concrete	✓		✓
Wood (no applied surface finish)			✓
Wood (wax finish)			✓

**DISCUSSION**

During the development of the guidance for decontamination of surfaces for COVID-19 it became clear that isolation for materials which were incompatible with the disinfectants would be the most suitable approach. Isolation or quarantining heritage materials based on the known persistence of SARS-CoV-2 on the material is the simplest and most effective approach, but not always possible. Materials can also be isolated by restricting access to them by creating an environment where they couldn't be contaminated i.e. space closure or preventing them from being touched, or through covering surfaces with appropriate materials, e.g. Tyvek™ or Melinex™.

Other methods of protecting historic surfaces should also be considered, even when they may be chemically compatible with the disinfectant, for example regularly reapplying wax on existing waxed surfaces should give additional protection against the increased cleaning and disinfecting required during the pandemic.

Understanding the persistence of the virus on different surfaces also provides an option to mitigate the risk to both staff and heritage surfaces. If the rooms, areas or surfaces can be quarantined for the appropriate period then standard cleaning methods can be used.

**Table 3** Surface compatibility with disinfectants. In the case of generic designations such as 'plastic' the selection of disinfectant should be compatible with the specific material. Disinfectant suitability was determined through consultation with material-specific conservation experts.

Given the gaps in the available information it was deemed essential to cover why the disinfectants were not suitable for defined surfaces and to make the end user aware of when there was no information on the persistence of the virus on certain materials. With the global pandemic showing no signs of receding, combined with the political desire to reopen society as best as possible, it becomes clear that further research is required to build on the current data regarding the persistence of the viral particles on different materials. This is supported by the published persistence of the virus on plastic, the articles do not state which plastic was used and have substantially different periods of persistence. Similarly no information is available on common surfaces in buildings such as painted plaster. Hopefully with further research the published guidance can be updated in the future, and the authors would appreciate being made aware of any ongoing research in this area.

The final guidance for cleaning and disinfecting historic surfaces can be found at <https://historicengland.org.uk/coronavirus/historic-places/cleaning-disinfecting-historic-surfaces/>.

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## COMPETING INTERESTS

The authors have no competing interests to declare.

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