

Considerations for the Selection and Use of Disinfectants Against SARS-CoV-2 in a Health Care Setting

Kevin Tyan,^{1,2}  Adriane Levin,^{1,3} Alejandra Avalos-Pacheco,^{1,4,5} Deborah Plana,^{1,6,7} Eleanor A. Rand,^{1,8} Helen Yang,^{1,4} Laura E. Maliszewski,^{1,4,9,10} Lily A. Chylek,^{1,10} Lyla Atta,^{1,11} Mark A. Tye,^{1,12,13} Mary M. Carmack,^{1,4,14} N. Synclaire Oglesby,^{1,9} Susan Burgin,^{1,2,15} Sherry H. Yu,^{1,16} Nicole R. LeBoeuf,^{1,3,5} and Jacqueline M. Kemp^{1,3}

¹Greater Boston Pandemic Fabrication Team (PanFab) c/o Harvard-MIT Center for Regulatory Science, Harvard Medical School, Boston, Massachusetts, USA, ²Harvard Medical School, Boston, Massachusetts, USA, ³Department of Dermatology, Brigham and Women's Hospital, Boston, Massachusetts, USA, ⁴Harvard-MIT Center for Regulatory Science, Harvard Medical School, Boston, Massachusetts, USA, ⁵Dana-Farber Cancer Institute, Boston, Massachusetts, USA, ⁶Harvard-MIT Division of Health Sciences & Technology, Cambridge, Massachusetts, USA, ⁷Harvard Ludwig Cancer Research Center and Department of Systems Biology, Harvard Medical School, Boston, Massachusetts, USA, ⁸Harvard University Department of Systems Biology, Cambridge, Massachusetts, USA, ⁹Harvard Program in Therapeutic Science, Cambridge, Massachusetts, USA, ¹⁰Laboratory of Systems Pharmacology, Department of Systems Biology, Harvard Medical School, Boston, Massachusetts, USA, ¹¹Johns Hopkins University School of Medicine, Baltimore, Maryland, USA, ¹²Harvard University Graduate School of Arts and Sciences, Cambridge, Massachusetts, USA, ¹³Massachusetts General Hospital Center for Systems Biology, Boston, Massachusetts, USA, ¹⁴Computational Health Informatics Program, Boston Children's Hospital, Boston, Massachusetts, USA, ¹⁵Brigham and Women's Hospital, Boston, Massachusetts, USA, ¹⁶Department of Dermatology, Yale University School of Medicine, New Haven, Connecticut, USA

Proper disinfection using adequate disinfecting agents will be necessary for infection control strategies against coronavirus disease 2019 (COVID-19). However, limited guidance exists on effective surface disinfectants or best practices for their use against severe acute respiratory coronavirus 2. We outlined a process of fully characterizing over 350 products on the Environmental Protection Agency List N, including pH, method of delivery, indication for equipment sterilization, and purchase availability. We then developed a streamlined set of guidelines to help rapidly evaluate and select suitable disinfectants from List N, including practicality, efficacy, safety, and cost/availability. This resource guides the evaluation of ideal disinfectants amidst practical considerations posed by the COVID-19 pandemic.

Keywords. COVID-19; disinfectant; EPA; infection control; List N; surface disinfection.

There is increasing evidence that rigorous disinfection will be needed to prevent surface transmission of severe acute respiratory coronavirus 2 (SARS-CoV-2). Studies have demonstrated that SARS-CoV-2 can remain viable on surfaces for up to 72 hours [1], while other human coronaviruses can remain infectious on inanimate surfaces for up to 9 days [2]. Viral shedding from COVID-19 patients can contaminate >75% of the surfaces inside a hospital

room [3, 4]. One plausible pathway of transmission includes direct deposition of respiratory droplets onto surfaces and re-aerosolization off hospital floors and personal protective equipment (PPE) [5]. Thus, careful and thorough disinfection using proper technique and adequate disinfecting agents must be part of an effective infection control strategy against COVID-19 [3, 6].

Limited guidance exists on effective surface disinfectants or best practices for disinfectant use against SARS-CoV-2. On March 3, 2020, the US Environmental Protection Agency (EPA) released List N, a list of commercially available disinfectants that qualify under the EPA emerging viral pathogens program for use against SARS-CoV-2 [7]. As of the time of publication, this list includes >400 unique products encompassing 33 different types of active ingredients. While this list appears extensive, it lacks guidance or discussion of practical concerns that must be taken into consideration when selecting a disinfectant during this pandemic,

including efficacy, practicality, safety profile, and availability.

As a consequence, health care institutions may not be able to dedicate their limited resources to fully understand the scope of available options and their appropriateness in each unique health care setting. With dwindling availability of many commercial disinfectants [8], a resource is needed to help both health care institutions and consumers navigate the list of alternative disinfectants suitable against SARS-CoV-2.

Considerations that factor into the selection of the ideal disinfectant have previously been discussed [9]. However, the effects of the COVID-19 pandemic on global supply chains, disinfectant availability, and hospital operations have created new challenges [10]. In attempting to navigate the extensive catalog of disinfectants on the EPA List N, we sought to fill critical data gaps in the listing of each product, including active ingredient concentrations, method of delivery, pH, compatibility for equipment disinfection,

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Correspondence: Kevin Tyan, BA, Harvard Medical School, 25 Shattuck Street, Boston, MA 02115 (kevin_tyan@hms.harvard.edu).

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and purchase availability (Supplementary Table 1). In order to simplify the process of rapidly evaluating and selecting disinfectants in the context of this pandemic, we offer a contemporaneous set of guidelines (Table 1).

EFFICACY AGAINST SARS-COV-2

Disinfectants qualify for an emerging viral pathogen claim against SARS-CoV-2 if they demonstrate efficacy against a harder-to-kill virus than SARS-CoV-2 [7, 11]. List N was created on the basis that SARS-CoV-2 is an enveloped virus, the subgroup easiest to inactivate compared with hardier large nonenveloped (eg, adenovirus) and small nonenveloped viruses (eg, norovirus) [11]. Some products on List N do not have an emerging viral pathogen claim but have been included because they (1) demonstrate efficacy against another human coronavirus similar to SARS-CoV-2 or (2) are EPA-approved against select viruses that are harder to kill [5].

Crucially, a disinfectant must remain undisturbed and air dry on a surface for a sufficient period of time to inactivate the target pathogen. This contact time is based on efficacy testing submitted to the EPA [9, 11]. Health care institutions should take into account the time needed to fully inactivate SARS-CoV-2, as unrealistic contact times (eg, 10 minutes) may be impossible to adhere to in hospital settings [8]. Hospitals should implement auditing, training, and visual feedback

mechanisms that ensure that staff are fully complying with the stated contact times required to disinfect SARS-CoV-2 [12, 13].

SAFETY PROFILE

User safety is paramount when selecting disinfectants against SARS-CoV-2. Health care institutions should prioritize disinfectants that have low toxicity ratings according to the Hazardous Materials Identification System (HMIS). Furthermore, the pH of the product should be considered, as those in extreme ranges may be unsafe for skin contact or affect environmental safety and disposal requirements [14, 15]. Ready-to-use (RTU) products may be preferable to concentrated solutions by eliminating the risk of improper dilution or exposure to concentrated disinfectants. Finally, the method of application of the disinfectant can impact its safety profile, as disinfectant spray aerosolization has been associated with respiratory irritation and poor asthma control in workers [16, 17].

PRACTICALITY

Given the added time and resource constraints of managing a busy facility during this pandemic, disinfectants should be as practical and easy to use as possible. A key ease-of-use consideration when selecting a disinfectant includes the method of delivery.

Premoistened wipes are generally easiest to implement, as they do not require liquid dilution or saturation of a wiping material. Furthermore, studies have established that premoistened wipes are equally as effective as sprays in reducing bacterial load [18], although workers may prefer sprays for more irregular surfaces [19]. Critically, when choosing a spray disinfectant that must be wiped after use, it is important to note that some wipe fabrics may inactivate disinfecting agents (eg, cotton or cellulose binding of quaternary ammonium compounds) [20].

To further reduce logistical burden on staff, selected disinfectants should also be compatible with a wide range of surfaces in the hospital. Certain disinfectants are compatible only on hard nonporous surfaces, whereas others can be applied to soft surfaces like chair cushions or privacy curtains [9]. Some agents, including chlorine bleach (sodium hypochlorite), may also be corrosive to metals and other hospital equipment [21] and should be implemented sparingly or in conjunction with anticorrosive agents.

AVAILABILITY AND COST

The COVID-19 pandemic has caused worldwide shortages of key supplies, including PPE, testing kits, hand sanitizers, and disinfectants. In particular, some of the most popularly used disinfectant products, including premoistened wipes, have become difficult to source [22].

Table 1. Considerations for the Selection of a Disinfectant Against SARS-CoV-2

Consideration	Key Questions
Efficacy against SARS-CoV-2	<ul style="list-style-type: none"> Does this product have an emerging viral pathogen claim? What is the wet-contact time required to kill SARS-CoV-2?
Safety profile	<ul style="list-style-type: none"> What is the pH of the product? Does the product have potential for toxicity or irritation?
Practicality (ease of use, surface compatibility)	<ul style="list-style-type: none"> What is the method of delivery (premoistened wipe, spray, concentrate requiring dilution, etc.)? Can this product be delivered through multiple modalities to allow for flexibility (spray bottle with dry wipe packs vs saturating wipe rolls in a bucket, etc.)? What surface types/equipment is the disinfectant compatible with?
Availability and cost	<ul style="list-style-type: none"> Is this product currently commercially available, and will it remain available for repurchase? Is this product economical for the health care institution?

Abbreviation: SARS-CoV-2, severe acute respiratory coronavirus 2.

With a disrupted supply chain and large health care systems aiming to source new products concurrently, the market for individual disinfectants is unpredictable. Hospitals must be prepared with a rank-ordered list of suitable products for their institution based on the aforementioned considerations as well as cost and future availability.

DISCUSSION

The publication of the EPA List N was an important step in providing a resource for selecting disinfectants against SARS-CoV-2 and can be more easily operationalized in health care settings when supplemented with additional data on safety, practicality, and availability. In [Supplementary Table 1](#), we curate and simplify relevant information obtained through our research on each product, which entailed locating material safety data sheets (MSDS) through online databases and manufacturer websites or extracting data from EPA registration paperwork. In attempting to better characterize each product on this list, we found that critical details, including pH, compatibility for equipment sterilization, and intended application (household vs health care settings), were difficult to extract or unavailable for many products; thus the resulting database has missing information for several disinfectant products. Only a minority of MSDS were readily available on consumer-facing websites, with most safety information hidden behind paywalls, requiring product purchase for access, or necessitating burdensome research into EPA registration paperwork. This was a major limitation of comprehensive and rapid evaluation of disinfectants, and a new system for making safety data publicly available must be considered in the future. While we also attempted to collect information regarding product cost, vendors, and availability, we found these properties to too dynamic to be reliable in a static resource and have omitted them from

the final database. Given the fluctuating nature of pricing and supply, particularly during the COVID-19 pandemic, we suggest that users curate a rank-ordered list of disinfectants that satisfy the unique considerations of their institution before contacting manufacturers and determining bulk availability and lead times. Ultimately, future guidance on disinfectants during times of increased demand must make information on safety, applicability, cost, and availability more accessible.

CONCLUSIONS

The barriers in evaluating and procuring disinfectants against SARS-CoV-2 for our health care institution compelled us to create this resource as a guide for hospital systems and other end users. We offer a set of important considerations as a framework for addressing institution-specific needs in the process of selecting the ideal disinfectant to protect patients and staff during this COVID-19 pandemic.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Patient consent. This study does not include factors necessitating patient consent.

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