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Commentary

Wet contact time directly impacts antimicrobial efficacy of Environmental Protection Agency–registered disinfectants

Peter J. Teska MBA *, Xiaobao Li PhD, Jim Gauthier MLT, CIC

Diversey, Charlotte, NC

Routine use of disinfectants is recommended by the Centers for Disease Control and Prevention to prevent transmission of pathogens that may cause healthcare–associated infections.[1,2] Although the Environmental Protection Agency (EPA) regulates the registration process of disinfectants, there are a number of key issues with disinfectant use that are not currently addressed by the Centers for Disease Control and Prevention or EPA guidance, which can lead to suboptimal performance of disinfectants. This article discusses the issue of inconsistent interpretation and practice of contact time specified on disinfectant labels.

Prior to discussing contact time, it is important to understand how antimicrobial efficacy is tested and how contact time is determined by disinfectant manufacturers. For liquid disinfectants that were registered 20 years ago, the main test method for evaluating efficacy was a suspension test in which a bacterial suspension was placed in a test tube and then exposed to a disinfectant for a specified contact time (up to 10 minutes).[3] At the point of the specified contact time, the bacteria and disinfectant suspension was neutralized to stop further antimicrobial action. The surviving bacteria were incubated and counted. In the suspension test, there was never a concern about the disinfectant drying because the volume of liquid had minimal evaporation even at the maximum contact time (10 minutes) allowed by the EPA.

As testing methods evolved and carrier tests were developed, there were legitimate concerns, raised by Sattar et al[4] and Best et al,[5] that suspension tests were generally easier to pass. Side-by-side testing often showed that suspension tests yielded results with better antimicrobial efficacy.[5] There has been significant work by the EPA (with academic and industry collaboration) to develop and validate microbiological testing methods based on the use of carriers, with quantitative log reduction requirements for passing the test. This has led to test methods such as the germicidal spray test,[7] the quantitative carrier test, and the quantitative Petrifilm (3M Corp, St Paul, MN) method for premoistened disinfectant wipes.[6] In carrier tests, inoculum is dried on a glass or stainless steel carrier, and the disinfectant is applied to the carrier by dropping, spraying, or wiping with a premoistened disinfectant wipe, following steps detailed in the test protocol. At the contact time, the carrier is neutralized to prevent further disinfectant activity. and the bacteria are incubated and enumerated.

One of the conditions that is not specifically addressed by these test methods is whether, in application, the surface needs to remain wet for the full duration of contact time. This particular issue has recently sparked significant controversy. Rutala and Weber[8] stated that because the methodology is unclear—according to the test method for premoistened wipes—regarding whether the carrier must remain wet during the entire contact time, the wet time (ie, the amount of time during the test the carrier is visibly wet), or surface dry time, is unimportant. This line of thinking is based on an argument that states if the needed efficacy is demonstrated in the EPA-required test, it does not matter if the carrier or surface used in the actual application actually remains wet for the entire contact time used in the test.

The contact time for a disinfectant is chosen by the manufacturer during product development as the time at which the test shows that needed efficacy has been achieved. Manufacturers often test multiple contact times during product development to determine the *minimum* time at which the product passes the efficacy test. Generally, manufacturers do not provide detailed data to show what efficacy is achieved at time points shorter than the stated label contact time. Therefore, as a general rule in healthcare, it is advised to keep the disinfected surface wet for the label contact time to ensure that efficacy is achieved.

Recent work from Rutala and Weber[8] challenges this by stating that the surface does not need to stay wet for the full contact time. Instead, the surface can be wet for a portion of the contact time and then remain “undisturbed” for the remainder of the time, which is referred to as “treatment time.” However, we find that such statements are inconsistent with a number of previous studies that highlight the importance of wet contact time and are not supported by systematic laboratory or field studies:

1. Wet contact time is a key attribute of disinfectant performance and the time that a surface is wet directly impacts the amount of efficacy achieved. Multiple studies have shown that the amount of time the disinfectant keeps the surface wet improves the disinfection efficacy on the surface. Hong et al[9] showed that a quaternary

* Address correspondence to Peter J. Teska, MBA, 2415 Cascade Point Blvd, Charlotte, NC 28208.

E-mail address: pjteska2@gmail.com (P.J. Teska).

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ammonia-based disinfectant with a 10-minute contact time on the label only achieved 70% of the required efficacy against *Staphylococcus aureus* and 40% of the required efficacy against *Pseudomonas aeruginosa* after a 4-minute contact time, suggesting that shorter contact time results in compromised efficacy. Omidbakhsh[10] showed that among the 7 disinfectants tested in this study, at the time the carriers were visibly dried, only the improved hydrogen peroxide disinfectant with a 1-minute contact time meets the passing criteria by achieving a 6 $\log_{10}$ reduction for both *S aureus* and *P aeruginosa*. The other 6 disinfectants achieved from 0.96 $\log_{10}$ to 6 $\log_{10}$ reduction for *S aureus* or *P aeruginosa* by the time the carriers dried, but none of the 6 showed a 6 log reduction on both *S aureus* and *P aeruginosa*, demonstrating a significant variability in efficacy for carriers. Boyce[11] and Gebel et al[12] both comment that disinfectants applied using inadequate contact times can have a negative effect on disinfection. Boyce[11] further comments that inadequate disinfection can lead to cross contamination of other surfaces. Havill[13] further states that ensuring enough disinfectant on a surface to achieve sufficient wetness and the correct disinfectant contact time is the *most important factor* [added emphasis is ours] in the application of disinfectants to surfaces. Otter et al[14] similarly state that cleaning and disinfection are often inconsistent in eliminating contamination of surfaces with pathogens, and the inconsistency is most likely explained by a lack of consistent and adequate distribution of disinfectant and the contact time achieved. Rutala and Weber[15] characterize the properties of an ideal disinfectant and state that an ideal disinfectant would "keep surfaces wet long enough to meet the listed kill/contact times with a single application or meet wet times recommended by evidence based guidelines." In a later article, Rutala and Weber[16] discuss how "wet contact time is also a critical component of product evaluation because if the product evaporates too quickly, it will not remain in contact with microorganisms for the necessary kill/contact time." The authors further state that "the best disinfecting products will have a wet contact time greater than or equal to the kill times listed on the label." These studies show high consistency in stating the importance of wet contact time. However, there is a lack of scientific evidence to support the claim that wet contact time is irrelevant, which is made by Rutala and Weber.[8]

2. Rutala and Weber[8] claim that wet contact time is not relevant *in application* for wipe products by analyzing how disinfection efficacy is determined *in the laboratory* using EPA methods. However, gaps exist in the disinfection achieved in laboratory test versus real-world application. The current EPA method for disinfectant towelettes (EPA method MB-09-06)[6] requires that after wiping the inoculated slide with the disinfectant wipe, the slide is placed in a Petri dish, covered, and allowed to stay undisturbed for the contact time until the neutralization of the disinfectant. The covering of the slide slows evaporation of volatile chemicals (alcohol and other solvents) and could potentially extend the efficacy of the disinfectant. However, the test protocol specified in the current EPA method is not a full representation of real-world application, in which environmental conditions and the amount of disinfectant applied impact how quickly a surface dries. Such a gap can be more significant for disinfectants that are fast evaporating, such as high-content alcohol-based formulations. In addition, the disinfectant wipes are only used to wipe a small area (about 10 square inches) in the lab test, whereas wipes cover a much larger area in real-world application.
3. The argument of Rutala and Weber[8] suggests that there is an equivalence in how a disinfectant will perform on an uncovered environmental surface in a healthcare facility and in the covered Petri dish during the laboratory test by stating that the duration of wet time is not relevant for prewetted disinfectant wipes or sprays. We do not believe that this is the case for all types of disinfectants, particularly for disinfectants that use fast-evaporating actives such as alcohol.
4. To assess whether the desired disinfection efficacy is achieved, the only common indicator that a healthcare facility has is whether the surface remains wet for the full contact time. Visual wetness is an appropriate point of use method commonly used by facilities to rapidly determine the effectiveness of disinfection. Although environmental sampling with swabbing and microbial analysis provides a better assessment of overall surface risk, visual wetness is a better proxy for determining effective disinfection in a rapid and cost-effective manner. If the current standard for efficacy assurance is changed to be a combination of wet time plus undisturbed time ("treatment time") as suggested by Rutala and Weber,[8] then this can cause confusion and practical difficulties for facilities to follow. Prewetted disinfectant wipes release less liquid as more surface area is wiped for a wide range of commercial disinfection wipes (authors' unpublished data). Thus, wet contact time will steadily decrease over the surface area wiped, and the dry undisturbed time would steadily increase during the life of the wipe's use. Considering that there inevitably will be some point at which the wipe is no longer disinfecting the surface but still applies a minimal wetness to the surface, we strongly believe that the new standard or terminology of treatment time proposed by Rutala and Weber[8] would lead to confusion on the part of facilities on how far they can stretch a wipe and thus increase the risk to patient safety. It would be clearer and risk free to advise facilities that the disinfectant wipe should be changed when it can no longer keep the surface wet for the contact time on the label. In addition, the longer a wipe is used, the more chance of spreading microorganisms to surfaces.[4,17,18]
5. Continuous wetness during microbial efficacy testing is currently required by the EPA for *Candida auris* and *Clostridium difficile* spores (EPA methods MB-35-00 and MB-31-03).[7] For disinfectants using these carrier tests to achieve these claims, the EPA test method requires determining that the surface is continuously wet for the full contact time. Currently, the EPA does not allow the concept of using an undisturbed time as part of the contact time to show on the product label when the disinfectant is being used to disinfect against *C auris* or *C difficile*. Teaching staff that they need to keep surfaces wet for the full contact time to achieve efficacy against certain microorganisms but that a lesser contact time is acceptable for other microorganisms will likely create confusion and result in misuse of the disinfectant.

The precautionary principle,[19] as applied to healthcare, advises that in the case of a serious threat to health (eg, the risk of a healthcare–associated infection from a surface not properly disinfected), we should use preventative measures to protect human health even when faced with scientific uncertainty. Thus, we contend that although the issue of contact time is being resolved through further research and clarifications from governmental and regulatory organizations and research institutions, to protect patient safety, the prudent approach is to treat the contact time on the disinfectant product label as the minimum wet contact time required to achieve acceptable efficacy of disinfection.

In summary, different interpretations of academic and industrial opinions regarding the contact time of a disinfectant create confusion in healthcare infection prevention staff. This article presents a series of arguments that advocate for the use of disinfectants with a wet time that exceeds the contact time listed on the label.

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