# Diagnosing disinfectant efficacy

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An ideal disinfectant that is effective on all farms under all conditions unfortunately does not exist. As veterinarians, we must use the tools available to us to recommend the best disinfectant for use by our clients on the basis of disinfectant class and properties, label claims, independent claims, field efficacy, and cost. We must remember that disinfectant choice is pathogen specific, farm specific, and use specific; thus, label claims do not always translate into effectiveness in field situations.[1]

## Field efficacy

Field efficacy of a disinfectant depends on a variety of factors, including, but not limited to, cleanability and other properties of the surface, water quality (hardness, pH, inorganic ions), and organic material (feed, excreta, secreta). Cleanability varies among surfaces. Wood is recognized as being difficult to clean, but laminated plastics, PVC plastic, and galvanized steel may also be difficult to power wash because the water jet does not work as effectively on a smooth surface as on a rough surface.[2] The type of surface must also be considered when highly corrosive disinfectants are used. Disinfection of slurry requires a different approach than disinfection of smooth surfaces. Formalin added at 9 to 15 kg per $m^3$, 40% calcium hydroxide added at 25 to 40 kg per $m^3$, and sodium hydroxide added at 8 to 12 kg per $m^3$ have been recommended for slurry disinfection.[3] Hard water, which contains dissolved calcium, magnesium, manganese, or iron, may affect disinfectants. Curds form when soaps or disinfectants are added to hard water, making it difficult for the soap to remove the dirt. [4] Organic material interferes with efficacy by either inactivating the disinfectant or blocking it from surface contact.

Hot water and detergents have been used to enhance disinfectant efficacy. However, in laundry studies, 22°C was just as effective as 71.1°C in reducing bacterial counts.[5] Power washing with detergents did not enhance bacterial kill, compared to power washing with water alone.[6] Moreover, detergent did not decrease cleaning time or improve cleanability. There is evidence that dirt is more efficiently dissolved when detergents are used. The resulting solution may then be more easily absorbed into the surface, making it more difficult to rinse away the dirt.[2] Presoaking the room with water before cleaning is another method to improve cleanability.

Routine rotation of disinfectants without field testing is not recommended by the author. Resistance to disinfectants may be intrinsic (ie, the outer membrane of gram-negative bacteria blocks entry of disinfectant) or acquired by bacteria (ie, plasmid mediated).[7]

### Selection of a disinfectant

The following are recommendations for disinfectant selection:

- Select an initial disinfectant on the basis of disinfectant class properties, label claims, and independent data if available.
- Remove all visible organic material (feed, urine, manure, secretions) from the surface(s) to be disinfected. Pressure washing at 700 PSI is recommended.[8]
- Follow label instructions of the disinfectant for dilution rates and contact times. In the author's experience, a more concentrated solution does not usually increase kill rate. Moreover, using certain disinfectants in an extra-label manner is a violation of federal law.
- Allow the disinfectant to dry (ideally) or allow the contact time recommended on the label to elapse (contact time for most disinfectants is approximately 10 minutes).
- Aerobic bacterial count may be used as a marker to assess contamination. Collect a statistically valid number of representative swab samples of surfaces (eg, flooring, equipment, walls). Measure and record the area that you are sampling so that you can later determine colony forming units (cfu) of bacteria per $cm^2$. Sterile Replicate Organism Detection and Counting (RODAC) plates (BD Diagnostic Systems, Sparks, Maryland) are commercially available for determining aerobic bacterial counts during environmental sampling. Use RODAC plates with D/E Neutralizing Agar (BD Diagnostic Systems) to neutralize residual disinfectant activity. One cfu per $cm^2$ is recommended as a general target for disinfection.[9] Rapid tests, such as Lightning (BioControl Systems Inc, Bellevue, Washington) and BioClean (BioVet, St Anthony, Minnesota), were not effective in assessing sanitation levels, compared to aerobic bacterial culture.[10] Sentinel animals may also be used to monitor for specific pathogens after depopulation of a facility. Similarly, targeted culture procedures may be used if there is a specific organism of interest.

## Troubleshooting

Further investigation is warranted if the target aerobic bacterial count is not achieved. In the author's opinion, insufficient cleaning is the primary reason for disinfectant failure. Cleaning effectiveness may be tested by using the set of disinfectant selection procedures outlined above, but adding the additional step of performing an aerobic bacterial count after cleaning and prior to disinfection. A general target of $10^3$ cfu per $cm^2$ is recommended for the number of bacteria present following cleaning of surfaces and prior to disinfection.[11]

Water quality and disinfectant preparation should be investigated if cleaning is sufficient but disinfection is inadequate. Water hardness and bacterial counts are easily determined using test kits or commercial water quality analysis services. Disinfectants should be prepared according to label directions and used promptly. Activity of disinfectants after mixing varies with disinfectant

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class. For example, bleach solutions should not be used for more than 24 hours after preparation, while some phenol mixtures remain stable for weeks or months if stored in a clean airtight container. Check with the manufacturer of specific disinfectants for stability times after mixing.

Failure of disinfectant to work after troubleshooting suggests that a different disinfectant should be selected for use on the production unit.

## Conclusion

We have the tools to determine which disinfectants are likely to be most efficacious on specific farms. Proactive, strategic testing of disinfectants may be a beneficial part of herd health management procedures.


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