Contextual data

KQ 9 – "Should surfaces and materials in healthcare facilities, Ebola treatment units (ETU) and community settings providing care to patients with Ebola or Marburg disease be disinfected using a wiping method versus a spraying method?"

**Guideline recommendations**

Table 1 summarizes recommendations regarding cleaning and disinfection of surfaces and materials potentially contaminated with Ebola or Marburg viruses by the WHO, US CDC and European CDC.[1] [2] [3] [4]

As part of the cleaning process, the WHO 2014 guides suggest, "do not spray occupied or unoccupied clinical area with disinfectant. This potentially dangerous practice has no proven disease control benefit."[1]

The US CDC 2014 Considerations for Chlorine Use did not mention spray as a mode for disinfectant application.[2]

The US CDC 2014 Interim Guidance for Environmental Infection Control in Hospitals for Ebola Virus recommends the use of a U.S. Environmental Protection Agency (EPA)-registered hospital disinfectant with a label claim for a non-enveloped virus (norovirus, rotavirus, adenovirus, poliovirus) to disinfect environmental surfaces in rooms of patients with confirmed EVD or persons under investigation.[4] Although there are no products with specific label claims against the Ebola virus, enveloped viruses such as Ebola are susceptible to a broad range of *hospital disinfectants* used to disinfect hard, non-porous surfaces. In contrast, non-enveloped viruses are more resistant to disinfectants. As a precaution, selection of a disinfectant product with a higher potency than what is normally required for an enveloped virus is being recommended at this time. EPA-registered hospital disinfectants with label claims against non-enveloped viruses (norovirus, rotavirus, adenovirus, and poliovirus) are broadly antiviral and capable of inactivating both enveloped and non-enveloped viruses.

As part of a guide for General Considerations for Decontamination Surfaces in Airplanes, the European CDC suggests that liquid chemical disinfectants should be applied by manually wiping the surfaces.[3] The effects take place immediately while the surface is drying. Some chemical disinfectants evaporate quickly; they should be used with caution. If applied improperly, they could pose a fire hazard or damage avionic equipment.

**Contextual data**

Table 2 summarizes the contextual data from ten studies identified during the study selection process.

Gallandat et al. 2021 conducted a systematic review of chlorine-based surface disinfection efficacy to inform recommendations for low-resource outbreak settings.[5] Of the 89 studies investigated, the most common disinfectant application modes were pipetting (n = 54, 61%), immersion (n = 20, 22%), spraying (n = 8, 9%), or wiping (n = 5, 6%). Because disinfection is often combined with cleaning procedures, wiping was investigated and was found to have an effect on viruses and spores even in absence of disinfectant, suggesting that the mechanical action of wiping contributes to reducing contamination levels on surfaces. A study that compared wiping and spraying showed similar efficacies against C difficile spores, though spraying was considered less appropriate for health care settings as it required extended drying times and would not remove dirt and debris.[6] Ensuring contact between disinfectant and test organisms can be challenging with spraying. In addition, chlorine loss during spraying − from spray nozzle to the targeted surface − is a concern.

Lantagne et al. 2018 conducted an experimental study to test the efficacy of disinfectants to prevent emerging infectious disease transmission.[7] To support disinfection recommendations, three research strands were conducted: (1) impacts of chlorine chemistry; (2) efficacy of surface cleaning recommendations; and (3) safety and efficacy of handwashing recommendations. A testing matrix was developed that included various surface types that are relevant in emergency health responses (nitrile, heavy duty tarp, stainless steel); chlorine types (NaDCC, HTH, generated NaOCl, stabilized NaOCl); soil load (with and without); and factors that varied between the Médecins Sans Frontières (MSF), WHO and CDC recommendations, including exposure time (10, 15 min) and recommended pre-treatments (none, covering, wiping, covering/wiping). The bacteriophage that was most similar to the Ebola virus was left to dry for one hour on a disc with a surface diameter of 8 cm, disinfection was carried out with or without pre-treatment and the residual contamination on the disc was measured at the end of the exposure time.

Across the entire test matrix, there was always a reduction of > 99.9% in Phi6. [7] The results suggest that: (1) surface type influenced disinfection efficacy; (2) chlorine type and soil load did not impact disinfection efficacy when using 0.5% chlorine; (3) contact time did impact efficacy against Phi6; and (4) wiping or covering did not increase disinfection efficacy, but the latter could limit splashing. The authors suggest that surface cleaning with 0.5% chlorine solutions with a 15-min exposure time is efficacious in reducing transmission risk.

Gallandat et al. 2017 compared the efficacy of four chlorine solutions (sodium hypochlorite, sodium dichloroisocyanurate, hightest hypochlorite, and generated hypochlorite) for disinfection of three surface types (stainless steel, heavy-duty tarp, and nitrile) with and without pre-cleaning practices (pre-wiping, covering, or both) and soil load.[8] The test organisms were Escherichia coli and the Ebola surrogate Phi6. The results support the recommendation of a 15 min exposure to 0.5% chlorine, independently of chlorine type, surface, pre-cleaning practices, and organic matter, as an efficacious measure to interrupt disease transmission from uncontrolled spills in Ebola outbreaks.

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Table 1: Summary of guideline recommendations regarding disinfection of Ebola-exposed surfaces by the WHO, US and European CDC

| Source | Should surfaces and materials in healthcare facilities, Ebola treatment units and community settings providing care to patients with Ebola or Marburg disease be disinfected using a wiping method versus a spraying method? |
|---|---|
| WHO [1] | 2014 |
| Recommendation - Cleaning process: | Environmental surfaces or objects contaminated with blood, other body fluids, secretions or excretions should be cleaned and disinfected as soon as possible using standard hospital detergents/disinfectants (e.g. a 0.5% chlorine solution or a solution containing 5 000 ppm available free chlorine)11. Application of disinfectants should be preceded by cleaning to prevent inactivation of disinfectants by organic matter.<br><br>If locally prepared, prepare cleaning and disinfectant solutions every day. Change cleaning solutions and refresh equipment frequently while being used during the day, as they will quickly become contaminated (follow your hospital protocols if available). For preparing chlorine-based solutions, see instructions in Annex 6.<br><br>Clean floors and horizontal work surfaces at least once a day with clean water and detergent. Cleaning with a moistened cloth helps to avoid contaminating the air and other surfaces with air-borne particles. Allow surfaces to dry naturally before using them again.<br><br>**Do not spray (i.e. fog)** occupied or unoccupied clinical areas with disinfectant. This potentially dangerous practice has no proven disease control benefit. |
| US CDC [4] | 2014 Interim Guidance for Environmental Infection Control in Hospitals for Ebola Virus<br>Use a U.S. Environmental Protection Agency (EPA)-registered hospital disinfectant with a label claim for a non-enveloped virus (norovirus, rotavirus, adenovirus, poliovirus) to disinfect environmental surfaces in rooms of PUIs or patients with confirmed EVD. Although there are no products with specific label claims against the Ebola virus, enveloped viruses such as Ebola are susceptible to a broad range of hospital disinfectants used to disinfect hard, non-porous surfaces. In contrast, non-enveloped viruses are more resistant to disinfectants. As a precaution, selection of a disinfectant product with a higher potency than what is normally required for an enveloped virus is being recommended at this time. EPA-registered hospital disinfectants with label claims against non-enveloped viruses (norovirus, rotavirus, adenovirus, poliovirus) are broadly antiviral and capable of inactivating both enveloped and non-enveloped viruses. |
| US CDC Considerations for Chlorine Use[2] | 2014 - Disinfection requires a wet contact time (amount of time the disinfectant is required to be left on the surface to be effective). |
| ECDC - Assessing and planning medical evacuation flights to Europe for patients with Ebola virus disease and people exposed to Ebola virus [3] | 2014 - General considerations for decontaminating surfaces in airplanes<br> The cabin of an aircraft should be manually cleaned with cleansing agents and liquid chemical disinfectants; liquid chemical disinfections are suitable to decontaminate surfaces contaminated with Ebola virus or Ebola virus particles.<br> Surfaces should be resistant to the use of chemical disinfectants to avoid damage to the interior or avionic equipment. Flat, smooth surfaces can be disinfected relatively easily using traditional liquid chemical disinfectants.<br> Liquid chemical disinfectants should be applied by manually wiping the respective surfaces. The effects take place immediately while the surface is drying.<br> Some chemical disinfectants evaporate quickly and should be used with caution. If applied improperly, they could pose a fire hazard or damage avionic equipment. |

Table 2. Summary of contextual data

| Author | Year | Study methods | Method details, measures or findings relevant to the extraction of contextual data | Data type | Contextual data |
|---|---|---|---|---|---|
| **Gallandat**[5] | 2021 | Systematic review | A systematic review of chlorine-based surface disinfection efficacy to inform recommendations for low-resource outbreak settings. Of the 89 studies investigated, the most common disinfectant application modes were pipetting (n = 54, 61%), immersion (n = 20, 22%), spraying (n = 8, 9%), or wiping (n = 5, 6%). Because disinfection is often combined with cleaning procedures, wiping was investigated and was found to have an effect on viruses and spores even in absence of disinfectant, suggesting that the mechanical action of wiping contributes to reducing contamination levels on surfaces.49,74 | Implementation | A comparison of wiping and spraying showed similar efficacies against C difficile spores, though spraying was considered less appropriate for health care settings as it required extended drying times and would not remove dirt and debris. |
| **Gallandat**[5] | 2021 | | | Implementation | With spraying, ensuring contact between disinfectant and test organisms can be challenging.75,76 Additionally, chlorine loss during the process − from spray nozzle to the targeted surface − is a concern.77 Ni et al (2016) found consistent increases in efficacy with increasing disinfectant spraying time from 0.5 to 2 minutes and keeping similar exposure times after spraying. A proposed explanation for variable efficacies observed between studies is the use of different spraying equipment, such as gas-powered pressurized sprayers producing high spray velocities and handheld spray bottles.78 |
| **Gallandat** [8] | 2017 | Testing study | We compared the efficacy of four chlorine solutions (sodium hypochlorite, sodium dichloroisocyanurate, hightest hypochlorite, and generated hypochlorite) for disinfection of three surface types (stainless steel, heavy-duty tarp, and nitrile) with and without precleaning practices (prewiping, covering, or both) and soil load. The test organisms were Escherichia coli and the Ebola surrogate Phi6. | Implementation | Our results support the recommendation of a 15 min exposure to 0.5% chlorine, independently of chlorine type, surface, pre-cleaning practices, and organic matter, as an efficacious measure to interrupt disease transmission from uncontrolled spills in Ebola outbreaks. |
| **Calfee** [9] | 2021 | Testing study | Evaluate virucidal efficacy of antimicrobial surface coatings against the enveloped bacteriophage Φ6. Twenty antimicrobial coating products, predominantly composed of organosilane quaternary ammonium compounds, were applied to stainless steel coupons, dried overnight and evaluated for efficacy against Φ6, an enveloped bacteriophage. Liquid-based products were applied in accordance with product labels, using either an electrostatic sprayer, common trigger-pull hand-held sprayer, submersion, or a spray-then- wipe application. Twenty-six commercially available antimicrobial coatings, films or alloy products were evaluated for residual antiviral activity. | Usage | In general, enveloped viruses are more susceptible to disinfectants than non-enveloped viruses. Ebola is an enveloped virus. In a study evaluating virucidal efficacy of antimicrobial surface coatings against the enveloped bacteriophage Φ6, none of the spray-based products retained efficacy after subjecting the coating to abrasion with either a hypochlorite or quaternary ammonium-based solution applied in accordance with EPA Interim Guidance for Evaluating the Efficacy of Antimicrobial Surface Coatings. (N.B. For electrostatic sprayer applications, coupons were sprayed for 10 s from a 0.9–1.2- m distance with the electrostatic sprayer pointed towards the array of coupons at a ~0° to 30°angle and then allowed to dry overnight at ambient laboratory conditions, uncovered and inside a laboratory fume hood.) |
| **Casey** [10] | 2015 | Field study | Transporting ill persons from the community to Ebola care facilities can stop community spread. Vehicles used for patient transport in infectious disease outbreaks should be evaluated for adequate infection prevention and control. Problem: An ambulance driver in Sierra Leone attributed his Ebola infection to exposure to body fluids that leaked from the patient compartment to the driver cabin of the ambulance. Methods: A convenience sample of 14 vehicles used to transport patients with suspected or confirmed Ebola in Sierra Leone were assessed. | Usage | Many vehicles used by ambulance staff in Sierra Leone were not traditional ambulances, but were pick-up trucks or sport-utility vehicles that had been assembled or modified for patient transport. The wall separating the patient compartment and driver cabin in many vehicles did not have a waterproof seal around the edges. Staff responsible for cleaning and disinfection did not thoroughly clean bulk body fluids with disposable towels before disinfection of the patient compartment. Pressure from chlorine sprayers used in the decontamination process may have pushed body fluids from the patient compartment into the driver cabin through gaps around the wall. Ambulance design standards do not require a waterproof seal between the patient compartment and driver cabin. Sealing the wall by tightening or replacing existing bolts is recommended, followed by caulking of all seams with a sealant. |
| **Casey** [10] | 2015 | Field study | | Usability | Staff responsible for cleaning and disinfecting ambulances often did not remove bulk body fluids with disposable towels before disinfecting with chlorine sprayers. Body fluids remained in the patient compartment during chlorine disinfection. Pressure from chlorine sprayers used in the |

| Author | Year | Study methods | Method details, measures or findings relevant to the extraction of contextual data | Data type | Contextual data |
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| | | | | | decontamination process could push body fluids in the patient compartment through gaps around the separating wall into the driver cabin. |
| **Cook** [11] | 2015 | Testing study | Evaluating environmental persistence and disinfection of the Ebola Virus Makona variant. For the evaluation of disinfectants, EBOV/Mak in a simulated organic soil was dried onto stainless steel carriers and disinfected with 0.01% (v/v), 0.1% (v/v), 0.5% (v/v) and 1% (v/v) sodium hypochlorite solutions or 67% (v/v) ethanol at contact times of 1, 5 or 10 minutes. | Usage | Sodium hypochlorite and ethanol effectively decontaminate EBOV/Mak suspended in a simulated organic load; however, selection of concentration and contact time proves critical. |
| **Cutts** [12] | 2020 | Testing study | Microbicides play critical roles in infection prevention and control of Ebola virus by decontaminating high-touch environmental surfaces (HITES), interrupting the virus-HITES-hands nexus. We evaluated the efficacy of formulations containing different microbicidal actives for inactivating Ebola virus– Makona strain (EBOV/Makona) on stainless-steel carriers per ASTM E2197-11. Formulations of sodium hypochlorite (NaOCl) (0.05–1%), ethanol (70%), chloroxylenol (PCMX) (0.12–0.48% by weight) in hard water, and a ready-to-use disinfectant spray with 58% ethanol (EDS), were tested at contact times of 0, or 0.5 to 10 min at ambient temperature. | Implementation | The carrier inactivation data for EBOV/ Makona presented here demonstrate that a variety of microbicides should be useful for effective inactivation of Ebola virus on stainless steel surfaces. These microbicides include 70% ethanol at contact times ≥ 5 min, NaOCl at concentrations of 0.5% or greater, at contact times ≥ 5 min, PCMX at concentrations of 0.48% and contact time of ≥ 5 min, and a ready-to-use disinfectant spray with 58% ethanol (EDS) used as supplied at contact time ≥ 5 min. Under these conditions, no residual EBOV/ Mak virus was detectable (≥ 6.3 log10 inactivation) as indicated by the TCID50 assay and the plate safety assay. |
| **Cutts** [13] | 2020 | Testing study | Disinfectant pre-soaked wipes (DPW) containing activated hydrogen peroxide (AHP) or quaternary ammonium compounds (QAC) were tested using ASTM E2967-15 to determine removal, transfer, and inactivation of Ebola virus Makona variant (EBOV/Mak) and vesicular stomatitis virus (VSV) from contaminated stainless steel prototypic environmental surfaces. | Implementation | In the case of Ebola virus, it is essential that disinfectant pre-soaked wipes with an appropriate microbicidal active, following the appropriate contact time, be used to prevent unintended transfer of infectious virus to a clean secondary surface. Otherwise, there exists the possibility of dissemination of Ebola virus and the associated risk of transmission of Ebola virus disease. |
| **Cutts** [14] | 2021 | Testing study | The authors evaluated four disinfectant pre-impregnated wipes (DPW) for efficacy against Ebola virus Makona variant (EBOV) and vesicular stomatitis virus (VSV), Indiana serotype. Steel carriers were inoculated with the infectious virus and then were wiped with DPW in the Wiperator instrument per ASTM E2967-15. Following the use of J-Cloth impregnated with medium (negative control wipes) or the use of activated hydrogen peroxide (AHP)-, ethanol-, sodium hypochlorite (NaOCl)-, or single or dual quaternary ammonium compound (QAC)-based DPW, virus recovery from the carriers was assayed by titration assay and by two passages on Vero E6 cells in 6-well plates. The Wiperator also enabled the measurement of potential transfer of the virus from the inoculated carrier to a secondary carrier by the DPW or control wipes. | Implementation | DPW containing AHP, ethanol, NaOCl, or single or dual QAC as active microbicidal ingredients removed/inactivated ∼6 log10 of the virus, with minimal EBOV or no VSV virus transfer to a secondary surface observed. In Ebola virus outbreaks, a DPW with demonstrated virucidal efficacy, used as directed, may help to mitigate the unintended spread of the infectious virus while performing surface cleaning. |
| **Lantagne**[7] | 2018 | Experimental study to test the efficacy of surface cleaning | To provide evidence for the disinfection recommendations, three research strands were conducted: (1) impacts of chlorine chemistry; (2) efficacy of surface cleaning recommendations; and (3) safety and efficacy of handwashing recommendations. A testing matrix was developed that included various surface types that are relevant in emergency health responses (nitrile, heavy duty tarp, stainless steel); chlorine types (NaDCC, HTH, generated NaOCl, stabilized NaOCl); soil load (with and without); and factors that varied between the MSF, WHO and CDC recommendations, including exposure time (10, 15 min) and recommended pre-treatments (none, covering, wiping, covering/wiping) [13]. The bacteriophage that was most similar to the Ebola virus was left to dry for one hour on a disc with a surface diameter of 8 cm, disinfection was carried out with or without pre-treatment and the residual contamination on the disc was measured at the end of the exposure time. | Implementation | Across the entire test matrix, there was always a reduction of > 99.9% in Phi6 [13] The results suggest that: (1) surface type influenced disinfection efficacy; (2) chlorine type and soil load did not impact disinfection efficacy when using 0.5% chlorine; (3) contact time did impact efficacy against Phi6; and (4) wiping or covering did not increase disinfection efficacy, but the latter could limit splashing. Surface cleaning with 0.5% chlorine solutions with a 15-min exposure time is efficacious in reducing transmission risk. |
| **Poliquin**[15] | 2016 | Environmental surveillance study | This study conducted environmental surveillance in 2 ETCs in Freetown, Sierra Leone, during the 2014–2016 West African Ebola outbreak. Methods. ETCs were surveyed over a 3-week period. Sites to be swabbed were identified with input from field personnel. Swab samples were | Implementation | A finding of interest was the difference in the persistence of signal intensity between the vomitus that was sprayed with 0.5% chlorine solution compared with the unsprayed sample (Figure 2C). The counterintuitive, prolonged persistence of RNA in the sprayed sample may reflect the fact that natural RNA degradation enzymes (with or without |

| Author | Year | Study methods | Method details, measures or findings relevant to the extraction of contextual data | Data type | Contextual data |
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| | | | collected and tested for the presence of EBOV RNA. Ebola-positive body fluid-impregnated cotton pads were serially sampled. | | bacteria contamination) were inactivated by the 0.5% chlorine solution, thereby preserving the RNA. By extension this phenomenon might explain persistence of RNA on some other surfaces, such as concrete, although experimental evidence to support this conclusion is limited [15] |