Clean, disinfect, and cover — Top activities for clinical contact surfaces in dentistry. 2018 update

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In collaboration with
Integrated Orthodontic Services srl, Lecco, IT.
This document is an update of the article entitled “Clean, disinfect and cover — Top activities for clinical contact services in dentistry” published in 2015, and an addition to the recent webinar “The daily fight to limit cross-infection in a dental office”. The aim is to show what is new and clarify certain decision-making and operational doubts that dentists and dental assistants may have.

Introduction

Irrespective of the legislative, insurance, and occupational safety requirements, today we need to follow all the standard precautions of Cross-Infection (CI) prevention to meet the needs of patients, who are increasingly attentive to their health. Dental patients are informed, aware of the risks of CI in dental care settings and consider prevention an important aspect to the quality of care they receive. A clean and hygienic appearance of the dental environment and the sterilisation of instruments is an absolute must for patients. Verbal and visual assurances (hand hygiene, PPE (Personal Protective Equipment) use, barriers) are important to ensure the basic need for personal safety, which is a critical aspect to the choice of facility and dental team and helps alleviate the fears associated with dental care.

The risk of infection in dentistry is difficult to quantify, but molecular biology techniques have identified recent cases of patient-to-patient transmission, outbreaks, and epidemics. It should be noted that fatal adverse events caused by infection are not negligible (12 percent) and have increased over the past 50 years. On the other hand, fatal ones caused by respiratory complications and bleeding remained the same, and those caused by cardiovascular events or those linked to anesthesia are decreasing.

The implementation of CI procedures is beneficial because it has led to a 65 percent reduction in infections in a stomatology clinic in one year. Chen et al. reported that the implementation of hand hygiene alone has resulted in a substantial cost/benefit gain ($1 invested vs. $23,7 saved). This information should make us reflect on the frequency of implant care (implants per year/million inhabitants: 20 vs. 4 respectively in Italy and the USA) carried out in outpatient dental facilities, the increasing related risks (e.g. antibiotic-resistance of species involved in periimplantitis) and the expected benefits resulting from properly implementing the precautions.

The important actions to be carried out between patients on Clinical Contact Surfaces (CCSs) — “Clean, disinfect and cover” with certified products — are confirmed in the “Summary of Infection Prevention Practices in Dental Settings: Basic Expectations for Safe Care” (Centers for Disease Control and Prevention, Atlanta, USA) (LG-CDC-2016). However, we must always remember that hand hygiene and PPE use are essential to reduce the transmission of infectious agents. We must avoid contaminating “clean areas” by transferring contaminated objects or touching objects in drawers with contaminated gloves or unwashed hands following the removal of gloves. Are we aware of how inadequate hand hygiene is in a dental practice? After removing gloves, only 30-40 percent of dentists and 7 percent of assistants wash their hands. Are we aware of how contaminated are halogen lamps (Fig. 1A), radiographs, phosphor plates, telephones, switches are (Fig. 1D)? In general, from an operational and ergonomic point of view, we must avoid contamination during clinical activity by using dams, surgical aspirators — mouthwash, surface barriers and then suitable products to clean and disinfect. But are we aware that poor compatibility between the surface to be treated and the disinfectants leads to surface alterations (cracks, porosity) favoring microbial colonisation (biofilm)?
Contamination of Clinical Contact Surfaces in dentistry

As previously reported, blood and microbial contamination of several CCSs is very high (approx. 50 percent). In general, surface contamination is not surprising considering the levels of air contamination (caused by 13 fungi and 23 bacteria) during clinical activities, as recently reported by Zemouri. In addition, air contamination of certain pathogens (including Streptococci sp, Pseudomonas sp, Psychronobactersp) increases by 30 percent even after floor cleaning and is not negligible (899 CFU/m³).

Microbial contamination of endoral radiographs (70 percent) and phosphor plates (50-73 percent) is considerable, even when using different types of plastic protection (10 percent). Direct (hand) and aerial transmission contribute to the high surface contamination (often polymicrobial) of telephones. The contamination of telephones used by dental personnel is: 32.8-61 percent and 65-100 percent respectively for fixed and mobile phones. Therefore, phones represent a reserve of microbial species and pose a risk in the control of the CI, but, unfortunately, there are no specific guidelines.

We know that Enterococcus faecium (E. faecium) is found in circa 30 percent of endodontic infections, but it is not a microorganism present in the mouth. Therefore, we can reasonably assume a CI where contamination of the hands, surfaces, root canal instruments, accessories and dental unit water is involved.

Special opportunistic pathogens are present on new and packaged materials, exposure to the clinical environment (e.g. ampoules of anesthetic, endodontic, and orthodontic instruments) and the use of superficial disinfectants can alter their characteristics (e.g. elastic orthodontic chains).

Khairallae recently reported contamination with Staphylococcus aureus (SA) and Methicillin Resistant Staphylococcus aureus (MRSA). Dental chairs, dynamic instruments and sink faucet are the most contaminated surfaces, 8 percent, 7.1 percent and 6.2 percent, respectively. MRSA is present on the hands (patients: 9.8 percent, assistant: 6.6 percent, dentist: 5 percent), in the nose (patients: 11 percent, assistant: 6.7 percent, dentist: 9.7 percent) and on inanimate surfaces (1.3 percent, represented by 70 percent multi-resistant species, or 52 percent moderate and strong biofilm formers), and mainly...
associated with pre-prosthetic, periodontal, and surgical treatments. The alarming aspect is that seven isolated strains of MRSA have genetic characteristics similar to a very virulent strain (EMRSA-15), which was responsible for epidemics in the European population. MRSA contaminates other inanimate objects such as dental impressions (27 percent) and study models (15 percent); we do not know the degree of contamination of orthodontic study models over time. Torlak recently reported that 13 percent of surfaces are contaminated with SA and a high percentage of these strains (49-90 percent) are biofilm producers.

Several studies indicate that the resistance of microorganisms depends on the material/surface. *S. aureus* and spores of Aspergillus niger survive for 28 days on vinyl and porcelain floors. *S. aureus* and *E. faecium* can retain their vitality on plastics for more than a year. Surface chemical-physical characteristics (such as roughness, stickiness) are crucial to prevent biofilm formation. SA can adhere and form biofilms in different ways depending on the different materials of inanimate surfaces, such as steel (dental braces, sinks), polyethylene (fiber pins), polyvinyl chloride (gloves) and human tissues. SA’s adhesion is higher on polyethylene and steel, so take particular care of the surfaces made of these materials as a source of contamination.

Recently, dental unit “design” and availability of non-touch switches or keyboards to prevent CIs has become increasingly important (Figs. 2 and 3). New technologies (CAD-CAM, KaVo DIAGNOcam) are useful to limit the problem of contamination of dental impressions or phosphorous plates, but they pose problems related to their reconditioning; therefore, we must comply with the manufacturer’s instructions and exclude impregnated wipes that leave stains and fibers on optical sensors. Priority should be given to the use of single-use products and barriers should be used to avoid the clinical contamination of all products for dental use (composite syringes, bonding, etc.).

**Fig. 2.** KaVo ESTETICA™ E70/E80 dental unit:
The parts that are most easily and/or frequently contaminated with infectious agents and blood are highlighted in orange or red.

**Fig. 3.** Constructive solutions to limit decontamination or render it more ergonomic: 3A) smooth and curved surfaces, small-sized joints; 3B and 3C) removable parts; 3C) non-touch switches; 3D) automatic decontamination system for the suction and water circuits, cords and quick couplings.
Recent Guidelines “Summary of Infection Prevention Practices in Dental Settings”

In March 2016, a guideline issued by the “Centers for Disease Control and Prevention” was published, which states that “All dental settings, regardless of the level of care provided, must make infection prevention a priority and should be equipped to observe Standard Precautions and other infection prevention recommendations contained in CDC’s Guidelines for Infection Control in Dental Health-Care Settings — 2003”.

The new document is based on the 2003 Dental Guidelines but is innovative. It is intended to help dental operators by indicating all the standard precautions in a clear and concise manner and, in particular on page 16, the specific standard precautions for the prevention and control of environmental contamination in dentistry. It also provides two checklists: the first one for planning and organisation (Annex A, section 1.11, page 27), the second one for assessment of compliance with the given recommendations (Annex A, section 2, page 36).

Three specific recommendations are given on page 17:

1. Defining protocols and procedures for the cleaning, disinfection and protection of environmental surfaces.

2. Selecting a disinfectant or detergent/disinfectant certified for dental use.

3. Compliance with the manufacturer’s instructions for preparation and use.

LG-CDC-2016 is therefore the "current standard for good dental practice” as it is aimed at all dental facilities irrespective of their organisation (single-professional private practices, dental clinics, dental chains). However, there are some pitfalls in the application (operational constraints — e.g. contact time of a surface disinfectant — compared to high patient turn-over, unmotivated and/or untrained personnel; use of disinfectants with inadequate certifications). Therefore, we must pay attention to the planning with updated and clearly written protocols, training, use of suitable PPE, knowledge of SDS (safety data sheets).
New strategies, procedures, barriers and disinfectants for medical device surfaces

Table 1 shows the "top five" strategies and questions to ask tailored to the dental field.²,²⁷,³⁴-³⁶

<table>
<thead>
<tr>
<th>Main question</th>
<th>Specific questions</th>
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| How do you choose the right surface disinfectant for medical devices?         | • Do you have a contact time and spectrum of action appropriate to your needs, considering the time “available” for the reconditioning of a dental surgery and dental office between patients?  
  • Is it compatible with the surfaces/materials to be treated?  
  • Does it leave faded stains or brownish ones (e.g. phenols)?  
  • Is it perfumed or does it smell? |
| Do you know the material safety data sheet?                                  | • Have you chosen suitable PPE?  
  • Are there reports of occupational hazards for the personnel, in particular for those who are more susceptible (e.g. women during pregnancy or maternity)? |
| Is contact with the residual product harmless?                               | • How many times a day do you need to use it on glasses, magnifiers, scanners, etc., which will come into contact with the patient and/or operator?  
  • Did you know that CaviCide is also used for cradles in neonatal wards? |
| Which medical devices surface disinfectant do you choose: sprayed liquid, ready-to-use wipes impregnated with disinfectant or solutions that need to be prepared? | • Have you rated in succession: 1) effectiveness, 2) practicality, 3) ergonomics, and only finally cost?²  
  • Are there any residual stains or fibers on optical parts, and how do they affect them: glasses, magnifiers, scanners?  
  • Do dynamic instruments tolerate direct splashing or immersion in a liquid disinfectant? |
| What procedure do you choose for the surface disinfection of medical devices? | • Is it easy to carry out?  
  • Does the procedure move from the cleanest area to the dirtiest and pay attention to critical points?  
  • Is the dispersion of the liquid product (distance from the object, quantity) adequate?  
  • What about the contact time?  
  • What did you choose for terminals, scanners, turbines?  
  • What did you choose to protect against contamination or to decontaminate: impression material and composite dispensers for reconstruction, composite syringes, bonding bottles, PC keypads?  
  • Do you carry out the visual inspection standing up and sitting on the dental unit like a patient? |
Disinfectants of medical devices vs. detergents

The characteristics of disinfectants of medical instruments with different alcohol bases (ethanol vs. isopropanol) combined with other products (Quats, surfactants, solubilisers, etc.) have been discussed in detail in the recent Boyce review. The disinfectants with high alcohol content (55-70 percent) (refer to “Components and characteristics” in Table 2, Reference 1), evaporate quickly, so to ensure adequate contact time they often need to be reapplied, resulting in a cost increase. On the other hand, the advantage brought by CaviCide (Kerr) and other products with reduced alcohol content, or without alcohols (e.g. disinfectants based on hydrogen peroxide — DBHP), is to allow a better dispersion of the product, avoiding protein precipitation and ensuring adequate evaporation to maintain the correct contact time of the disinfectant. Stabilised DBHPs have been proposed to avoid some operational and occupational disadvantages (e.g. asthma in workers) of Quats-based disinfectants. However, some doubts have been reported:

1) In the hospital environment, although DBHP’s microbial activity resulted to be more effective, the difference in the frequency of hospital infections would not be significant compared to other products.

2) In conditions simulating hospital operating conditions, Kenters et al evaluated the effectiveness of sprays and wipes impregnated with disinfectants with different active ingredients on antibiotic-resistant infectious agents: one DBHP was the only disinfectant not to reach the established limits (log10>5 reduction) on Vancomycin-resistant E. faecium. We assume that some additives (organic solubilisers) modify the surface load of a DBHP and therefore its activity and dispersion.

3) The cost per liter of a DBHP with similar characteristics is approximately double compared to CaviCide (Biosanitizer S 5L (17,5 euro/L) vs. CaviCide Kerr 5L (9,38 euro L; source www.dentaltrey.it; March 2018).

Recent data from an epidemiological study indicate that Quats and alcohols would not be associated with asthmatic forms in hospital paramedics. There are no data on the time spent cleaning and disinfecting a dental operation room, but if we assume around 7-10 minutes after each patient and for every hour of clinical dental treatment (which therefore caused considerable environmental contamination), I think it is reasonable to estimate that on average 8-15 percent of the dental assistant’s work involves occupational exposure to surface disinfectants, which is lower than the hospital one. In dentistry, however, the occupational hazard of disinfectants should be included in the broader problem of pulmonary diseases caused by allergenic infectious agents, prophylactic powders, nebulised cement residues (e.g. after orthodontic material removal), dentine adhesives dispersed in the aerosol during dental treatment. Therefore, ventilation (forced or non-forced) and/or air purification should be carried out regularly.

In addition, we must consider that the use of spray disinfectants compared to impregnated wipes is affected by the operating methods. You can spray the disinfectant on the towel or on the surface: in both cases the vaporisation of volatile substances and the surface dispersion is standardised with many difficulties and the nebulisation can be high due to the need to work fast, and not to make the next patient wait. In dentistry, spray nozzle technology is not given much attention, and dispensers of other products are often reused. However, the name of the product used and the rules of use must always be present on the spray; this problem does not occur with impregnated ready-to-use wipes, where the packaging is clearly labelled (Fig. 4).
Before cleaning and disinfecting, visible blood stains should be removed from exposed surfaces to avoid the “dispersion” of contamination and dirt. Please note that a disinfectant must be sprayed onto a surface from a distance of 15-20 cm. However, in dental operating rooms and on a dental unit, surfaces are at all angles, so a homogeneous dispersion is not “easy” to achieve. In addition, it is desirable that manufacturers provide instructions for use for the movement during cleaning and disinfection, as dental surfaces are smaller than those in hospitals. Thus, opposing or circular horizontal movements for the indicated contact time are not easily applicable on most CCSs in dentistry. At the time of writing, there are no products certified at European level for a one-step procedure, i.e. cleaning and disinfection in a single step, despite the fact that the cleaning effectiveness of CaviCide and CaviWipes is evident on video.

**Impregnated wipes**

Personally, I believe that it is preferable to use ready-to-use impregnated wipes, compatible and impregnated with disinfectant for greater ergonomics and occupational safety (Figs. 3 and 4).

Ready-to-use impregnated wipes are preferable to those prepared in reusable containers, due to the possibility of operational errors in container preparation and contamination. The cleaning action of CaviWipes is favored by the three-dimensional structure of the wipes and by the low quantity of impregnated alcohol (17.2 percent compared to other commercial products, which stand at 55-70 percent); this avoids the precipitation of blood and salivary proteins. Moreover, whatever the procedure (spray or impregnated towel), the surface must remain completely covered for the relevant amount of contact time and with the correct formulation of the disinfectant. This means that the disinfectant (e.g. Quats) should not be seised by the wipes material purchased at the supermarket and it is better to use wipes or microfiber wipes. Only good quality impregnated wipes are checked for these characteristics. The following types of CaviWipes are available:

- CaviWipes in canister (not currently available in Germany) (15.2x16.9 cm) are suitable for small surfaces and medical devices that must never be immersed in a liquid disinfectant or sprayed directly with it (turbines, scalers, KaVo DIAGNOcam, KaVo PROPHY handpieces), and to wrap the packaging of dental materials touched during treatment (e.g. composite syringes, multi-purpose bonding packages).
CaviWipes Flat Packs (not currently available in Germany) (17.8x22.9 cm) are suitable for tubular parts, such as tube sleeve.

CaviWipes in XL format (currently available in Germany only and marketed as KaVo Wipes) in canister (22.9x30.5 cm) for dental chairs (Fig. 4).

Please note that one of the most common errors is failing to fully close the packaging of the impregnated wipes (use the opened package within 15 days) and the packaging (2-5 L) of liquid disinfectants: which leads to evaporation of the alcohol component, thus reducing the active ingredient, compromising the effectiveness and increases the risk of product contamination.

**Barriers**

The foremost recommendation by LG-CDC-2016 is to use barriers to protect surfaces that are particularly difficult to clean and replace them between patients (page 17). These are especially useful for protecting areas that are difficult to recondition, such as certain parts of dental units (Fig. 5) or “old generation” instruments and designs (Fig. 1C).

There are, however, designs on the existing market that facilitate cleaning and disinfection: the KaVo ESTETICA ™ E70/E80 dental unit, for example, is easy to clean (smooth and rounded surfaces with removable parts) and is equipped with a system for automatic water circuit decontamination and dental unit suction (Figs. 2 and 3).

### Tab. 2. Quality of barriers for medical vs. food use.

<table>
<thead>
<tr>
<th>Quality</th>
<th>Medical barriers (Kerr)</th>
<th>Food use barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Feature</td>
<td>Water tightness</td>
<td>Coverage</td>
</tr>
<tr>
<td>Aesthetics and ergonomics.</td>
<td>Tidier and more pleasant appearance in the dental practice; easy to put on and take off</td>
<td>More “household” appearance, more versatility on different surfaces, but some replacement problems especially if of poor quality and in hot environments</td>
</tr>
<tr>
<td>Non-toxic, for food use</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>FDA registration (indication 21CFR§177 1350)</td>
<td>Yes</td>
<td>Not known</td>
</tr>
<tr>
<td>Blood penetration (ASTM F-1670-07 Indication)</td>
<td>Checked</td>
<td>Not known</td>
</tr>
<tr>
<td>Virus penetration (ASTM F-1671-07 Indication)</td>
<td>Checked</td>
<td>Not known</td>
</tr>
<tr>
<td>Protective Clothing Puncture resistance (ASTM 1342)</td>
<td>Yes</td>
<td>Not known</td>
</tr>
<tr>
<td>Resistant to the penetration of MRSA in culture medium (Molinari JA et al. The Dental Advisor, 2016)</td>
<td>Yes</td>
<td>Not known</td>
</tr>
</tbody>
</table>

Why is it important to use medical grade barriers? The quality differences between medical and food barriers are shown in Table 2. The Cover-All ™ thin (Metrex) disposable self-adhesive protectors are also very useful. They are easy to put on and take off and are a good solution to cover parts of the chair or old or very worn instruments or very difficult to recondition ones (PC keyboards, plexiglass displays of...
aesthetic dentistry appliances) (Figs. 1B and C). They are very useful for coordinators to prevent cross-infection and to report contamination:

a) with contaminated hands or gloves on the light switches (Fig. 1D),

b) in the operating rooms when caused by insufficient use of the dams and/or surgical aspirators.

Although several protections reduce the light emitted by a lamp for the polymerisation of composites, this does not significantly affect the polymerisation (verified using the hardness ratio) of the composite when using the "Complete LED Curing Light Sleeve" protections (Pinnacle, Kerr Total Care, Romulus, MI, USA) (Fig. 6), and other protections, except Latex-cut glove pieces (Nulife, Mumbai, India).48

An important aspect: new patients need to be informed about why we use barriers and the choice of barrier also needs to take into account aesthetic considerations (Figs. 5 and 6). The use of barriers does not lead to significant ecological problems in the disposal of special waste, and in any case is the only way to reduce manual labor (costs), occupational exposure to disinfectants and to indirectly limit the use of disinfectants and possible resistance of infectious agents.49
Importance of the certification obtained by the German Society for Hygiene and Microbiology

Although liquid CaviCide and CaviWipes comply with European Directive 93/42/EC and EPA-USA, CaviCide and CaviWipes XL have been certified by the German Society for Hygiene and Microbiology, an undisputed independent certification body. This document preempts the indications presented in Regulation No. 745/2017/EU, which will enforce high quality and safety standards on all medical devices. In addition, the certification also investigated the effectiveness of CaviCide and CaviWipes in off the label conditions; these tests are considered important because operational violations are very frequent.

The selection and purchase of surface disinfectants for medical devices should be carefully assessed, as equivalent or low-cost disinfectants often have insufficient certification and SDS or dubious FDA and CE markings. A very thorough evaluation should be made on products offered by grey markets, often lacking the necessary certifications or having counterfeit ones. Some antibiotic resistant microorganisms (MRSAs, VREs-Vancomycin-resistant Enterococci) resist disinfectants under off-label conditions. It is reasonable to think that the high surface contamination observed on CCSs is due to poor products and operational errors under off-label conditions, i.e. when the dispersion and quantity of the disinfectant on the material, and the contact time is less than the manufacturer’s instructions.

Conclusion

Today, remaining competitive in the dental market is increasingly challenging. An aesthetically “beautiful” structure is attractive, but a structure that is cross-infection “secure” is a decisive factor for the patient. Any dental structure must be “safe and organised” to meet legislative, occupational and insurance obligations. In addition, there is the emerging problem linked to “quality imposed” by insurance companies that offer cover plans for dental treatment of patients against contractual reimbursements to dentists which are often “penalising” and decreasing. It is important to note that today, in the USA, refunds to accredited facilities are already reduced for preventable adverse events due to insufficient standard precautions.

Because dental professionals are responsible for product selection and use, they should carefully supervise and delegate the purchase to competent personnel, who can rationally compare surface disinfectants for medical devices based on cost. In general, manual work is indispensable, detailed, and human-influenced. Therefore, it is a priority to find solutions (ease of operation, dismountable parts, use of barriers, disinfectants with fast contact times, self-cleaning and antimicrobial surfaces) to reduce costs, and then the visual inspection is essential. Hydrogen peroxide-based disinfectants do not appear to have the characteristics to justify their higher cost; moreover, the occupational problems linked to the use of surface disinfectants of medical devices based on Quats and alcohols appear to be unjustified. Surfaces and disinfectants based on graphene oxide are being developed because of their antibacterial, low cost and bio- and eco-toxicity action.

Different types of controls (microbiological testing of viable microorganisms, ATP, fluorescents) with non-pathogenic markers of infectious agents were used to test the effectiveness of surface disinfection, but are not widespread in use and the results are not interchangeably applicable. Automatic touchless systems (UV, H₂O₂ aerosolisation) are effective and practical, but not a substitute for manual procedures. The operating room remains impractical during both treatments and,
in the case of H$_2$O$_2$ aerosolisation, until occupational exposure limit is reached (H$_2$O$_2$ = 1 ppm) after forced ventilation.$^{59,60}$

Given the importance of human factors and training, helpful solutions could include additives which make the homogeneous dispersion of disinfectant temporarily visible on surfaces,$^{61}$ specific operational guidelines applicable to the complexities of the dental environment, and, above all, careful supervision by institutions for the identification of products that are not certified and/or do not comply with European Directives and the FDA on the market.$^{53}$
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The opinions expressed in this article/clinical case are those of Dr. Livia Barenghi. Kerr Dental is a medical device manufacturer and does not dispense medical advice. Clinicians should use their own professional judgment in treating their patients.