A Comprehensive System for Washing, Pre-disinfecting and Sterilizing of Dental and Surgical Instruments

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Purpose: The purpose of this study was to test and describe in detail a newly developed comprehensive system for washing, pre-disinfecting and sterilizing of dental and surgical instruments.

Materials and Methods: The system consists of a combined washing and steam-operated pre-disinfection apparatus and newly developed trays, in which assorted instruments can be washed and disinfected without handling individual instruments. The system was subjected to a large number of tests.

Results: The cleaning efficiency of blood-soiled instruments was found to be excellent. The disinfection of dental instruments contaminated with bacteria, yeast and non-enveloped virus showed decimal reduction factors that were equivalent to sterilization. The trays had optimal sealing qualities. Their steam permeability was perfect even after prolonged use in N-, S- and B-type autoclaves. However, long-term tests in a clinic revealed shortcomings with regard to insufficient drying of instruments in the wash/disinfection apparatus. Furthermore, the mechanical stability of the polysulfonate tray covers needs to be improved. Occasionally, after extended use, the fit of the filters in metal trays became inadequate, in particular when trays were sterilized for 18 min at 134°C for a prolonged period of time.

Conclusion: In spite of the above-mentioned shortcomings, the system shows great labor and cost-saving potential, allowing a new approach to instrument recirculation and workflow in the dental office.

Key words: dental office hygiene, pre-disinfection of instruments, new dental trays

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For many years hygiene in the dental office was a neglected issue. In the 1980 s, the rapid pandemic spread of HIV infections made dentists increasingly aware of and receptive to improved dental office hygiene measures (Runnells, 1984; Bössmann, 1986, 1994). After some initial resistance, measures offering protection from occupational cross-infections, like barrier techniques or HBV-vaccination (Wisnom and Siegel, 2003), were increasingly implemented (Baumann, 1992; Burke et al, 1994; Gibson et al, 1995; Molinari, 2000; Kearns et al, 2001).

In the years that followed, efforts to improve infection control in dental offices focused on particular vulnerabilities like handpiece disinfection and/or sterilization (Lewis et al, 1992; Lewis and Arens, 1995; Lloyd et al, 1995). These issues and many other critical infection control precautions in the dental office became mandatory under the US Centers for Disease Control and Prevention (CDC) (Kohn et al, 2003). Undoubtedly, these infection control regulations and similar recommendations by European dental societies (Guggenheim and

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Wiehl, 1993; Wiehl and Guggenheim, 1993; Wiehl, 1996; Guggenheim et al, 1999) or regulatory authorities had an impact on hygiene in dental offices. Despite undoubted progress, there are clear limits to the efficiency of infection control that can be achieved by eliminating particularly vulnerable areas. The overall quality of infection control in the dental office largely depends on the office design. In particular, treatment and non-treatment areas, instrument recirculation centers and the technical laboratory should be effectively separated (Guggenheim and Wiehl, 1993). In addition, the historically deeply-rooted treatment concept of storing instruments sometimes wrapped, but mostly unwrapped, in drawers adjacent to the dental unit i.e. within the aerosol zone, continues to prevail worldwide. Appropriate dental office hygiene demands an alternative treatment concept. Following an initial examination, a precise treatment plan for the subsequent sessions is established. Sets of instruments needed for different treatments are combined in filter trays. These trays are then sterilized and stored in a clean, dry area far from the chair side in tray shelves, cabinets or drawers. Single, rarely used instruments are sterilized in see-through bags and complement these sets. Following appropriate surface disinfection of the dental units and surrounding areas, the trays needed for a particular treatment session are completed by disposables carried on a disinfected tray to the dental unit.

There are several reasons why this concept is not readily accepted by dentists. Large number of trays and a considerably larger number of individual instruments of all kinds are needed. In addition, the time required for instrument recirculation (pre-disinfection, washing, repacking and sterilization) makes this concept laborious and costly. These costs can only be fully passed on to the patient or his/her insurance in a few countries. Therefore it is clear, that a breakthrough in this new treatment and hygiene concept is only possible if costs are massively reduced.

The system described below is a comprehensive system for washing, pre-disinfecting and sterilizing of dental and surgical instruments in trays. It consists of a newly developed combined washing and steam operated pre-disinfection apparatus and of filter trays with perforated steel bodies and two identical filter covers. The principal innovations of the system include: major ergonomic advantages compared to pre-disinfection with thermo-disinfectors or immersion of instruments into liquid disinfectants; much shorter process cycle; assorted instruments in the body of the tray can be washed, pre-disinfected and controlled without handling each individual instrument; and, after cleaning and pre-disinfection, the trays with all instruments already in place can be prepared for sterilization in a matter of seconds by fitting the covers.

In this paper we present a short technical description of the Vapocid® V970 apparatus and the Vapocid® filter trays, followed by an evaluation of its washing and disinfection performance. The Vapocid® filter trays were tested with standardized heavy instrument loads for both tightness against particles and disinfection efficiency against bacteria and virus. The sterility of heavily contaminated instruments was investigated after sterilization in several currently used autoclave types. The Vapocid® trays and steam disinfector were in addition tested in the clinic for a prolonged period of time.

MATERIAL AND METHODS

Vapocid® V970: Technical Description and Function

The steam disinfection device supplied by OMB MEDITECH AG, Bütschwil, Switzerland, is shown in Fig 1. Subject to the unit being pre-heated for approximately 12–18 min, the apparatus washes and steam-disinfects dental instruments in Vapocid® trays in a programmed automated cycle that takes 13–15 min. It also allows washing/disinfecting of hoses from the dental unit to avoid biofilm formation in these tubes. The apparatus consists of the following main components: a synthetic housing accommodating a metal chamber equipped with a swivel door and integrated safety lock; a panel of touch buttons for operating the apparatus fitted below the door; an LCD display that provides information on the program status; an inlet for the rinse aid reservoir accommodated on the top of the housing with an emergency door opener on the right-hand side; and water in/outlets and power cord mounted on the rear of the unit. The chamber provides sufficient space on each of two levels for one large or two half-size European norm trays. The tray rack can be removed to accommodate larger items. Water for instrument cleaning and steam is distributed within the chamber by self-rotating arms with a series of cleaning nozzles. Further technical details are summarized in Table 1.

Table 1 Vapocid® V970 technical specifications*

Power requirements:	V	220 – 240
	hz	50 – 60
Wattage:	W	2000
Energy consumption/cycle:	kWh	0.2
Water consumption/cycle:	L	≈ 7
Water pressure, inlet:	bar	3 – 6
Water conductivity:	µS/cm	100 – 200
Overall dimensions:	mm	301 x 627 x 529
Operational weight:	kg	23

* 100 – 110 V version also available

Fig 1 Vapocid® V970 apparatus for washing and disinfecting dental instruments in Vapocid® tray bodies. A: front view, door closed. B: the open door allows a view of the chamber which has a capacity for two full-sized or four norm half-sized tray bodies.

Touching the off/on icon on the display starts a wash/disinfection cycle. During the pre-heating phase (12–18 min) the message <PREPARE> will display. The pre-heating phase is terminated when the display reads <READY TRAY>. The door is now opened and indicated on the display by <DOOR OPEN> and the Vapocid® trays without covers (Fig 2B) can be loaded. After shutting the door, the start icon needs to be touched and the cold-water wash lasting 2 min begins. The display indicates <WASH>. Steam is now flushed into the chamber. The display shows <STEAM>. During this phase, the door can no longer be opened and is safety locked. When the trays with inserted instruments have reached 99°C, a holding phase of 2 min follows. For safety and regulatory reasons, the holding time in Vapocid® V970 sold on the market was increased to 5 min. A wash/disinfection cycle will be completed in ~ 15 min. Then the chamber is cooled by ventilation indicated by the display message <COOLING>. The door opens automatically when the temperature falls below 50°C allowing the chamber to be unloaded at any time thereafter. The wastewater is pumped out of the chamber and the water reservoir is cleaned by water flushes. This phase of the cycle is noted on the display by <WAIT> and is terminated when the display shows <END>. Before a new cycle can be started, the stop/open icon must be touched, until <READY TRAY> is displayed.

Vapocid® trays: Technical Description and Function

The trays are shown in Fig 2. They are available in two sizes and two qualities. All trays have a perforated stainless steel tray body allowing flow through of water or steam and can be equipped with flexible plastic instrument holders (Fig 2B). After use at the chair side, the body of the tray with all instruments in place is washed/disinfected in a thermo-disinfector or in the Vapocid® V970. Thereafter, the tray is checked for completeness and cleanness of the instruments. The tray is then closed from the bottom and top by two identical pierced covers with holes and inlaid filter mats. The covers are available in two versions: polysulfonate or steel (Fig 2C). Both are equipped with filters with welded silicone seals. The more durable steel version has a steel plate filter holder that is fastened with a nut to the tray cover (Fig 2D); the polysulfonate cover has a groove, which fits to the silicone seal and is mounted with a screw. The filters are suitable for multiple use (see below). Polysulfonate covers are tightly locked to the body of the tray by two built-in slide locks (Fig 2F), whereas steel covers are clasped to the body of the tray by two steel sealing clips. The clips offer enough area to label the trays (Fig 2F).

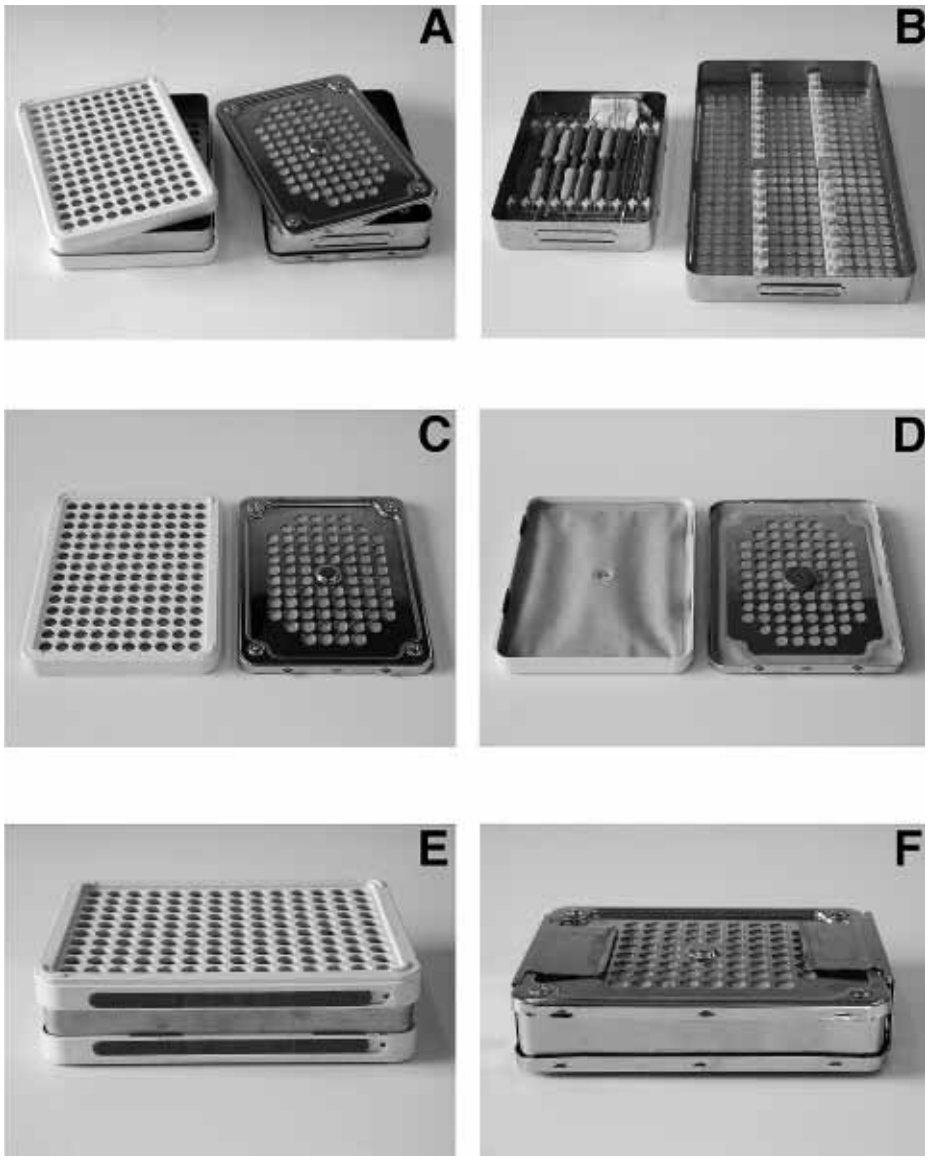

Fig 2 Vapocid® trays of all types: **Fig 2A** shows half-sized trays with polysulfonate and metal covers; **Fig 2B** a half tray body with instruments inserted into silicone holders and a full-sized tray equipped with instrument holders without instruments; **Fig 2C** shows both cover types; **Fig 2D** shows the reversed covers: polysulfonate cover with inserted filter without fixation screw (left); metal cover with filter and filter holding plate mounted (right); **Fig 2E** shows a polysulfonate half-sized tray with locked cover; **Fig 2F** shows a metal half-sized tray with cover locked by steel clips.

Evaluation of Vapocid® V970 Cleaning Efficiency

Various dental instruments were placed for a few minutes into a dish filled with hemolyzed human blood stemming from expired conserves. Thereafter the instruments were air-dried on a perforated metal plate for 60 min at room temperature and transferred to the bodies of four half trays. Fifteen assorted instruments (329 g) used for periodontal treatment were inserted into the trays' silicone holders or, alternatively, trays without holders were loaded with 500 g of various instruments. The trays were then placed on both levels inside the Vapocid® V970 chamber and subjected to two treatments: cold water rinse only, or complete cycle.

To measure the cleaning efficiency, half of the treated instruments were inserted into a sterile 500 ml bottle and 25 ml of sterile saline was added. The bottle was then placed in a tilt position for 2.5 min into an ultrasonic bath. Next, the instruments were replaced by the other half of the instruments and the procedure was repeated. The washing solution was collected. With another 25 ml of saline the procedure was repeated. Both washings were then pooled (50 ml) and kept on ice. Blood-soiled instruments as well as clean instruments (blank) were used as controls. The washing solutions stemming from blood-soiled instruments were diluted serially (10^{-1} – 10^{-3}). The optical density of these dilutions was measured in a Hitachi

2000 photometer at 280 nm and used to establish calibration curves. The OD_{280} of the washing solution from treated instruments allowed for the blood remaining on the instruments to be expressed as a percentage of the blood detected on untreated blood-soiled instruments. These experiments were repeated four times.

Evaluation of Vapocid® V970 Disinfection Efficiency

a) against bacteria and yeast: *Staphylococcus aureus* OMZ 143, *Pseudomonas aeruginosa* OMZ 154 and *Candida albicans* OMZ 110 were used. All strains were grown in Difco Brain/Heart Infusion (237500, Becton Dickinson, Sparks MD, USA) with 5% horse serum. The cultures were incubated aerobically for 14 h at 37°C. The resulting suspensions were directly used to contaminate dental instruments. The load of instruments, distributed in four Vapocid® half-size trays, was identical to the one used for the determination of the washing efficiency. Instruments were covered with the microbial suspensions for 15 min and then transferred directly to the four Vapocid® half-size trays. After air-drying (45 min at room temperature), the assorted trays were either subjected to a full wash/disinfection cycle or used as untreated controls. Test instruments and controls were further treated as described for the blood-soiled instruments. The washing solution (50 ml) stemming from control instruments was subjected to a dilution series (10^{-2} – 10^{-4}) and plated on Plate Count Agar with the aid of a spiral dilutor. The washing solution of the Vapocid® V970 treated test instruments was centrifuged (20 min, 1520 x g). The supernatant was then decanted, the sediment re-suspended and vortexed in 0.5 ml sterile saline. Aliquots of 100 µl were plated on Plate Count Agar (Difco) using Drigalski spatula. Colony forming units (CFU) were counted after aerobic incubation for 48 h at 37°C.

b) against virus: As test virus we used a relatively heat resistant non-enveloped T4 phage (OMZ 1000). Bacteriophages were prepared from a lysate of *Escherichia coli* OMZ 735 on M1-soft agar. Plates preincubated with *E. coli* were inoculated with a T4 phage suspension ($\approx 10^{12}$ phages) during the log phase of bacterial growth. When maximum lysis was reached, phage buffer (Drews, 1968) was added and the soft agar layer was scraped off. Bacterial cells, cell remnants, and debris were removed by centrifugation (2600 x g, 15 min, 4°C). The supernatant was carefully decanted and used for a phage titration. Suspensions with a titer $> 10^{12}$ were obtained and stored at 4°C. For a prolonged storage in liquid nitrogen, glycerol was added at a final concentration of 15%.

Dental instruments were contaminated with phages as described for microorganisms. After airdrying, the instruments were again distributed among four trays and subjected to a wash/disinfection cycle or used as untreated controls. Test instruments and controls were then washed as mentioned above. The washing solution (50 ml) from control instruments was diluted serially with phage buffer and from the dilutions, 10^{-5} and 10^{-6}, 0.1 ml was pipetted into small plastic tubes. From the washing solution of test instruments, five times 1 ml were transferred into sterile tubes. All tubes were incubated with 0.1 ml of a culture of *E. coli*, pre-incubated in M1-broth for 4 h and M1D soft agar (3–4 ml, 45°C). The tubes were vortexed and their content poured over a solid M1D agar layer in Petri dishes. The plates were incubated for 48 h at 37°C. Plates with distinctly separated virus plaques (Fig 3) were selected and counted. Results from quadruple experiments are expressed as plaque forming units (PFU) per ml of washing solution.

Further Investigations with Vapocid® Trays

Sealing qualities: Vapocid® half-size trays with polysulfonate (N = 3) or metal (N = 3) covers were placed in large plastic bags containing 1 kg of finely ground wheat flour with a particle size of ~ 5 – 10 µm. The content of the bag was thoroughly shaken for 2 min. The trays were removed from the bag and adherent flour was removed by knocking the trays repeatedly on a table surface. Remaining flour particles were removed with compressed air before the inside of the trays was inspected macroscopically for penetration of flour particles.

To test the permeability of the mounted filters for bacteria and bacterial spores, polysulfonate and metal half-size trays with the previously described instrument load were sterilized at 134°C for 10 min in a N-type autoclave (Tuttnauer 2540E) and then finely sprayed of the topside of the tray covers with 1.5 ml of *S. aureus* OMZ 143 (2.7×10^8 bacteria/ml) or *Bacillus stearothermophilus* OMZ 992 spores suspension (3.0×10^9 spores/ml). The contaminated trays were dried in a laminar flow bench

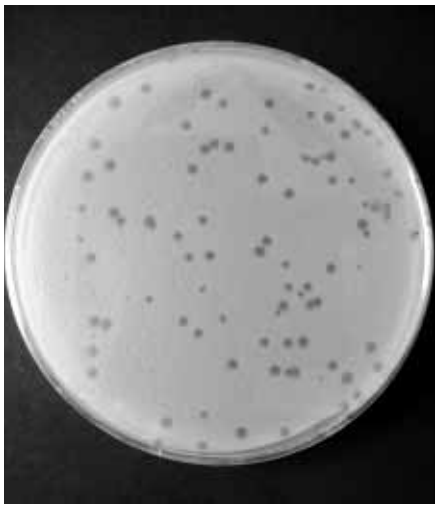

Fig 3 A culture plate densely seeded with *E. coli* showing virus plaques caused by lysis of bacteria. Such plates were seen when incubated with washings of T4 contaminated, not disinfected instruments. The number of plaque forming units (PFU) was counted.

for 30 min. Thereafter, the instruments were removed with sterile forceps and further processed as previously indicated. The number of bacteria or spores that had penetrated through the filter was determined from the washing solutions as described above and expressed as CFU/ml.

The penetration of T4 (OMZ 1000) virus particles was assessed in empty pre-sterilized (134°C, 10 min) filter trays. For these experiments, Vapocid® metal half- and full-size trays were used. In addition, a large Ergosafe filter tray (Martin Medizin Technik, Tuttlingen, Germany) was subjected to the same test protocol for control purposes. In a laminar flow bench the trays were opened with sterile gloves. Open sterile 59 cm^2 Petri dishes filled with 20 ml phage buffer were placed in the trays, which were then closed immediately. Two Petri dishes were placed in the Vapocid® full tray, one each in the Ergosafe tray and in the Vapocid® half-size tray. The surface of the closed trays was then contaminated with a phage suspension (5 x 10^{10}/ml) with 50 short thrusts from a spraying bottle. The trays were carefully opened and the Petri dishes closed. As control, a Petri dish outside the tray was sprayed. The phage titer in all phage buffer solutions in the Petri dishes was determined as described above. Experiments were all repeated in quadruplicate.

Steam permeability: Steam permeability of all types of Vapocid® trays was tested in N-, S-, and B-type autoclaves. The trays were loaded with dental instruments as described. Bioindicators (Attest® 1266P, 3M, Rüschlikon, Switzerland) and chemoindicators (Comply SteriGage 1243 B, 3M, Rüschlikon, Switzerland) were placed in the center of trays. The following autoclaves were used: Type N: Tuttnauer 2540E (Tuttnauer Europe, Breda, The Netherlands); Type S: Safetyklav pro (Arstechnika KG, Bretten, Germany); Type B: Harvey Sterile PV (Unident, Geneva, Switzerland). Details of the programs run with these autoclaves are provided in the result section. All tests were carried out in triplicate.

Steam Permeability of filters after repeated processing in the Vapocid® V970: The filters in the tray covers are reusable as long as not mechanically damaged. It was, therefore, of interest to investigate whether they could be washed and disinfected with the Vapocid® V970. Tray covers of two half-size and two full-size trays with inserted filters were subjected to 50 Vapocid® V970 cycles, then mounted on tray bodies and locked. Equipped with a SteriGage-chemoindicator the trays were then autoclaved using a N-type autoclave (Aquarius, Unident, Geneva, Switzerland) with the program "wrapped" (12 min, 134°C). The experiment was carried out twice with triplicates using half-size and full-size polysulfonate trays.

Form stability: The form stability of the polysulfonate covers for two full-size and four half-size Vapocid® trays was assessed after 236 autoclaving cycles using a N-type autoclave (Aquarius, Unident, Geneva) at 135°C for 5 min.

Experience in the clinic: Two Vapocid® V970 and approximately 75 full-size and 75 half-size trays with polysulfonate or metal covers each were tested in the Clinic for Geriatric and Special Care Dentistry at the Center for Dental and Oral Medicine and Cranio-Maxillofacial Surgery, University of Zurich, for more than a year. As the capacity of the Vapocid® V970 washers/disinfectors was insufficient for this large clinic, the trays were in part also subjected to a pre-disinfection in a thermo-disinfector (Miele G7735CD, Miele AG, Spreitenbach, Switzerland).

RESULTS

Vapocid® V970 Cleaning Efficiency

The results are compiled in Table 2. The data show that the cleaning efficiency was remarkable considering the extreme blood-soiling of dental instru-

Table 2 Vapocid® V970 cleaning efficiency of blood soiled instruments

Sample		OD 280 nm $\bar{x} \pm$ SD	Remaining blood % $\bar{x} \pm$ SD	Cleaning efficiency
Blood soiled control, untreated, tested in 3 dilutions	10^{-1}	2.564 ± 0.016		
	10^{-2}	0.432 ± 0.039	100%	0%
	10^{-3}	0.041 ± 0.006		
Clean instruments (blank)		0.126 ± 0.003		
Blood soiled instruments, washed only		0.682 ± 0.225	2.303 ± 1.086*	97%
Blood soiled instruments, washed and disinfected		0.207 ± 0.111	0.047 ± 0.081*	99.9%

* Corrected for blank value

Table 3 Vapocid® disinfection efficiency with instruments contaminated with bacteria or *C. albicans* (N = 4)

Microorganism	Control instruments CFU	Test instruments CFU	Decimal reduction factor
S. aureus	$1.2 \times 10^9 \pm 1.1 \times 10^9$	1.00 E0*	9
Ps. aeruginosa	$4.1 \times 10^9 \pm 1.3 \times 10^9$	1.00 E0*	9
C. albicans	$3.7 \times 10^7 \pm 0.5 \times 10^7$	1.00 E0*	7

* Detection limit

ments. It was also evident, that the cleaning process released some 220 nm absorbing material from clean (blank), not blood soiled instruments. We corrected the absorption from soiled instruments by these values.

Vapocid® V970 Disinfection Efficiency

It appears from the data compiled in Table 3 that the disinfection performance of the wash/disinfection cycle against vegetative cells of bacteria or yeasts was excellent and reached the exigency of a sterilization process. Even with very high microbial loads, decimal reduction factors > 7 were reached with all species tested. However, cross infections in dentistry are more likely to be caused by virus than by bacteria or fungi. Enveloped virus have a lower thermo resistance than non-enveloped virus. Therefore, we choose a T4 bacteriophage for these experiments. The control instruments showed a mean contamination of $1.3 \times 10^9 \pm 0.1 \times 10^9$ (N = 4). After being subjected to a wash/disinfection cycle, only two sets showed a very low remaining contamination (1.1 ± 0.14) indicating decimal reduction factor of ≥ 8.0. That again fulfills the efficiency criteria even of a sterilization process.

Vapocid® Tray Sealing Qualities

The flour test revealed that all Vapocid® trays tested were absolutely tight for flour particles (5 – 10 µm). Neither *B. stearothermophilus* nor *S. aureus* colonies were detected in cultures of washings of sterile instruments after heavily spraying the topside of all types of Vapocid® trays with suspensions of spores or bacteria. This shows that the filter were not permeable for particles > ~ 0.5 µm.

In contrast, filters were not absolutely leak-proof for virus. In order to rule out that this was a particular weakness of the Vapocid® tray filters, the most perfect but also expensive tray system on the market (Ergosafe) was used as control. The results

Table 4 Penetration of virus (T4 phage) into Vapocid® trays

	Control no Filter	Full-size tray		Half-size tray	Ergosafe tray
		Left side	Right side		
Filter surface cm^2	0	69	69	66	33
PFU/cm^2	4.68 ± 1.52 (10^7)	2.81 ± 9.09 (10^2)	2.61 ± 1.52 (10^2)	2.93 ± 2.22 (10^2)	17.9 ± 8.19 (10^1)

are summarized in Table 4. It is evident that under an extremely high challenge the filter trays were not absolutely leak-proof for virus, although the number of PFU was greatly reduced in comparison to the control. The luxury Ergosafe tray performed only marginally better than the Vapocid® tray, the difference being statistically not significant.

Steam Permeability

The steam permeability of all types of trays tested in N-, S-, and B-type autoclaves (Guggenheim et al, 1999) of different manufacturers was excellent. The bio- and chemoindicators placed within the trays that were heavily loaded with instruments indicated sterility after application of all programmed sterilization cycles. Although there are minor differences between the programmed sterilization conditions in the autoclaves of the different manufacturers, the following conditions were investigated: fast sterilization for unwrapped instruments 3 – 5 min 134 – 135°C; sterilization for wrapped instruments 20 – 30 min 121°C; and prion denaturating program 18 – 20 min 134 – 135°C. In addition (and not mentioned in the section Materials and Methods) even simulating worst case scenarios using the process challenge control device (PCD II, 3M) equipped with the SteriGage integrating indicators showed sterility within the Vapocid® trays.

Steam Permeability after Repeated Processing in the Vapocid® V970

These experiments showed, that 50 wash/disinfection cycles did not alter the steam permeability through Vapocid® tray covers. The color changes of all 24 SteriGage integrating indicators showed acceptance of the sterilization process.

Form Stability

Based on a macroscopic inspection the form stability of the polysulfonate covers was maintained after 236 sterilization cycles (12 min, 134°C).

Clinical Experiences

Over 75 polysulfonate trays and metal trays have been used daily for more than a year in the clinic for Geriatric and Special Care Dentistry. This clinic is equipped with 14 dental units. The overall performance of the polysulfonate trays was good. However, the built-in side locks had to be handled with care. If too much force was applied when closing the tray, the sliding lock bar and its clamp on the cover often broke. Covers and bars had to be replaced more frequently than acceptable. The full metal version of the tray showed no problems whatsoever. This more luxurious and costly tray performed convincingly over an extended test period. From January 2003 we switched to autoclaving at 134°C for 18 min. With prolonged use, the filters revealed slight distortions and occasionally the welded silicone seal lost its perfect sealing qualities. Since then, the filters had to be changed more frequently. Due to the relatively small volume of the chamber of the Vapocid® V970, the steam disinfector is not designed for a large clinic and even two machines could only handle a small number of trays. Therefore the bulk of the trays and instruments were cleaned and disinfected using a Miele G7735CD thermo-disinfector. Overall, the technical performance of the Vapocid® V970 was good, but the instruments in the tray bodies were still wet after completion of the wash/disinfection cycle. Because instruments should be perfectly dry before autoclaving, it is vital that the drying performance of the apparatus is increased.

DISCUSSION

In recent years, the need for improved hygiene in the dental office to avoid cross-contaminations has found increasing acceptance (Molinari, 2000). After a phase of resistance, barrier techniques (gloves and masks) or the disinfection/sterilization of rotation instruments – to give two examples – have been widely implemented in industrialized countries. These and other isolated improvements have certainly led to safer dental treatment for the patient as well as the dental team. However, the greatest hygiene deficiencies in the dental office has not been eliminated – namely the storage of packed, and especially unpacked, instruments in drawers in the aerosol zone around the dental unit.

The necessary major step forward in office hygiene can only be achieved by a change of the prevailing treatment concept. This requires a number of sets of instruments in filter trays covering all routine treatments within a dental office. Rarely used additional instruments are packed separately in see-through bags. After use, instruments should be pre-disinfected, washed, repacked, sterilized and stored in an instrument recirculation center separated from the treatment area (Runnells, 1984; Guggenheim and Wiehl, 1993). This means that the dentist can no longer equip himself during treatment with instruments needed from drawers. Each treatment session must be planned well ahead and the necessary instrument trays, additional packed single instruments and disposables must be placed in the operatory following the surface disinfection of the dental unit (Wiehl and Guggenheim, 1993). A procedure where instruments are pre-disinfected and washed singly either in disinfection baths or in thermo-disinfectors is not practicable. To re-sort instruments in trays is too time-consuming and therefore too costly.

The Vapocid® tray allows washing and pre-disinfection of assorted instruments in the tray body. Prior to sterilization, the instruments may be easily controlled for cleanliness and occasionally sharpened or oiled. With its fast washing and disinfection cycle, the Vapocid® V970 reduces the number of trays and instruments needed in a dental office. Therefore, it has a clear advantage over thermo-disinfectors that have a larger capacity. However, the full exploitation of this capacity requires these units to be completely filled with additional trays and instruments. These are the only circumstances in which the water and energy consumption of the larger units is comparable with the Vapocid® V970, which has the additional advantage of not burdening the environment with chemicals. The efficiency of both washing and disinfection in the Vapocid® V970 was excellent. However, during use in the clinic it became evident that the apparatus needs to be improved due to insufficient drying of instruments.

The Vapocid® trays were subjected to an extensive test program. The trays fulfill the demands of a modern tray, i.e. steam permeability and sealing qualities in addition to easy handling properties. The observation that under extreme conditions filter trays have only a limited barrier function for virus was unexpected, but should have been anticipated in retrospect. It justifies the need to store sterilized instruments in filter trays or sealed see-through bags in a dry area (preferably in lockers or drawers) away from the clinic area.

In spite of this positive rating, the prolonged use of the trays in the clinic has shown that certain improvements are required. The mechanical stability of the polysulfonate covers of the trays was insufficient. If handled without care, the closing sliders or their fixation to the cover showed an unacceptable breakage rate. In metal tray covers, distortions of the filters leading occasionally to an insufficient fit of the silicone-welded seals was observed on prolonged usage of the trays, in particular when sterilized at 134°C for 18 min. According to the manufacturer, most of these shortcomings have meanwhile been eliminated. It may, therefore, be concluded that the new comprehensive system for washing, pre-disinfecting and sterilizing of dental and surgical instruments has a significant advantage over existing procedures. The unit allows safe and fast instrument recirculation. Furthermore, the system is economical, which makes a new dental treatment concept practicable. This implies a major step forward in overall dental office hygiene.

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