Key Points of Infection Control in Dental Practices

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My Experience

Prevention of infection begins in ones mind and

the knowledge of the problem is the beginning of quality assurance

The Dental Practices - no Man's Land?

So far no surveillance of health care-acquired infections exists ®
no data about the actual infection risks

- **Only numerous data about contamination of dental units and handpieces**
- **One case report on letal *Legionella pneumonia* acquired in dental practices**

Ricci ML, Fontana S, Pinci F, et al. Pneumonia associated with a dental unit waterline. Lancet 2012, 379(9816): 684

- **Data about increased antibody titres against HCV, HBV and *Legionella* spp. especially at oral surgeons**

Klein et al. Occupational risks for hepatitis C virus infection among New York City dentists. Lancet. 1991;338:1539–1542

Ammon A, et al. 2000. Hepatitis B and C among Berlin dental personnel: incidence, risk factors, and effectiveness of barrier prevention measures. Epidemiol Infect 2000; 125: 407-13

Fotos PG, et al. Prevalence of Legionella-specific IgG and IgM antibody in a dental clinic population. J Dent Res 1985; 64: 1382-5

Reinthaler FF, et al. Serological examinations for antibodies against Legionella species in dental personnel. Dent Res 1988; 67: 942-3

Pankhurst CL, et al. Prevalence of legionella waterline contamination and Legionella pneumophila antibodies in general dental pratictioners in London and rural Northern Ireland. Br Dent J 2003; 195: 591-4

Results on Contamination of Water Systems in Dental Units

In 208 water samples

- ***9.1% L. pneumophila,* in 7.5% > 10^3 cfu/ml**
- **41.4% *P. aeruginosa,* in 36.3% > 10^3 cfu/ml**

Veronesi L, et al. Legionella contamination in the water system of hospital dental settings. Acta Biomed 2007;78: 117-22

In 101 air/water syringes

- **21.8% *L. pneumophila* (serogroup 1 and 3)**

Zanetti F, et al. Water characteristics associated with the occurrence of Legionella pneumophila in dental units

In 35 dental units (air/water syringes)

- **free-living amoebae up to 330/mL**
- **biofilms augment the number of free-living amoebae in dental unit waterlines**

Barbeau J, Buhler T. Biofilms augment the number of free-living amoebae in dental unit waterlines. Res Microbiol 2001; 152: 753–60

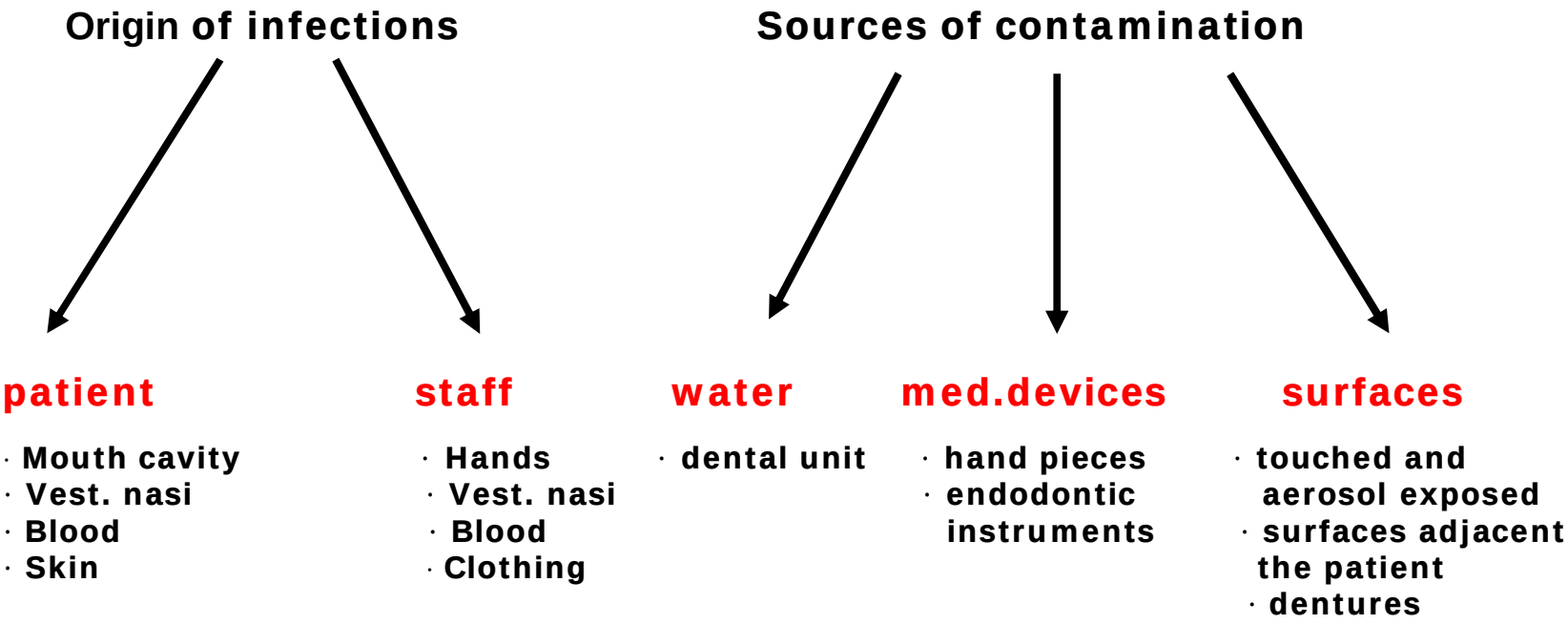
In 99 dental units (air/water syringes)

- **33% *Legionella*, predominantly *L. pneumophila* serogroups 2–14**

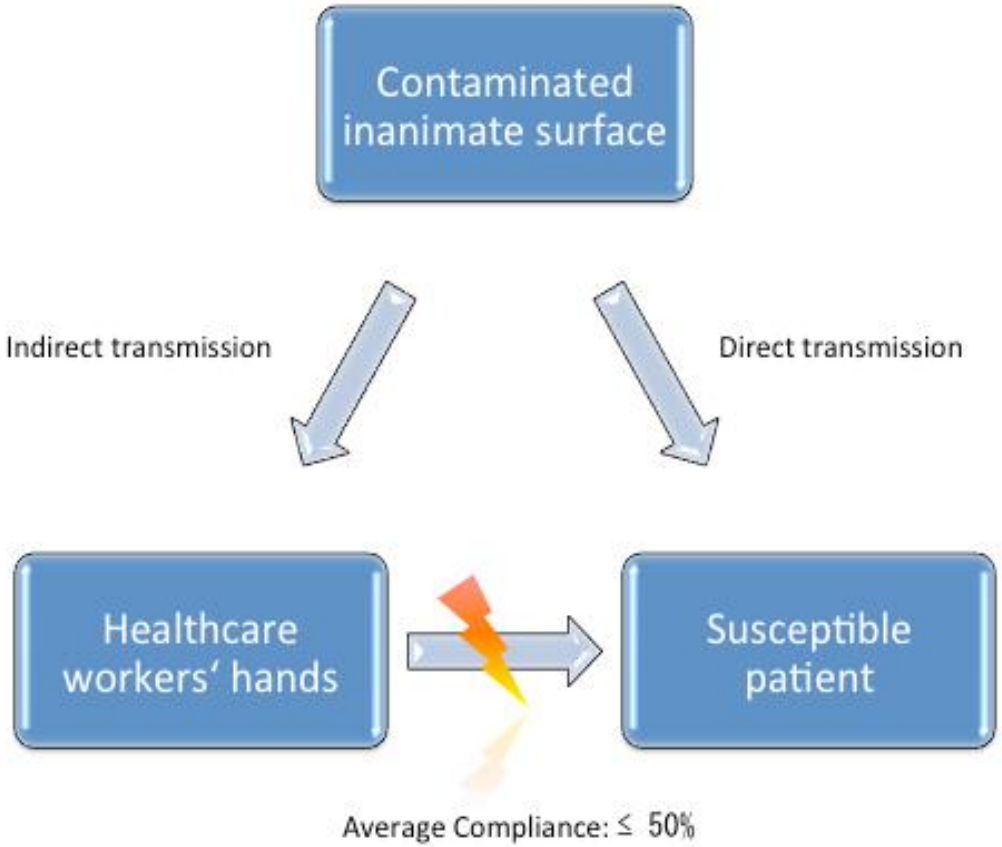
Singh T, Coogan MM. Isolation of pathogenic Legionella species and legionella-laden amoebae in dental unit waterlines. J Hosp Inf 2005; 61: 257–62

but
absence of evidence is not evidence of absence!

Possible Sources for Infections in Dental Practices



Transmission Routes for Nosocomial Pathogens in Dental Practices



Pitfalls of Pathogens

- Persistence on inanimate surfaces
- Biofilm formation in dental units
- Development of resistance
- Invisible colonization from patients and staff

Persistence on Inanimate Surfaces

Bacterium	Range of survival
Acinetobacter spp.	3 days to 1 year
Enterococcus spp. incl. *VRE*	5 days to 30 months
E. coli	1.5 hours to 16 months
Klebsiella spp.	2 hours to > 30 months
Pseudomonas aeruginosa	6 hours up to 16 months
Serratia marcescens	3 days up to 2 months
MSSA, MRSA	7 days up to 1 year
Streptococcus pneumoniae	1 day up to 30 month

Kramer A, Assadian O. Survival of microorganisms on inanimate surfaces. In: Use of Biocidal Surfaces in Clinical Settings for the Reduction of Healthcare Acquired Infections. Springer: New York, in print

Legal Basis for Infection Control in Germany

- **German Infection Prevention Act**
  - → **Hygiene plan with SOPs for the dental practice**
  - → **link physician for infection control (40 hour curriculum)**
  - → **governmental monitoring of dental practitioners**
  - → **one specialist in the practice with special expertise for reprocessing (at present only recommendation)**
- **Medical Device Directive (European law)**
- **Guidelines of the Commission of Hospital Hygiene and Infection Control at the Robert Koch-Institute (mandatory since 2011)**

® **Guideline for Infection Control in Dentistry (1998, 2006)**

- **Drinking water regulation**
- **Accident Prevention Regulation Health Service**
- **Code of Social Law ® quality assurance**

Hygiene Status in German Dental Practices – results of questionnaires

Origin of the cited results

- Kramer A, Meyer G, Ertzinger S, Kietz K, Schrader O, Martiny H. Multicenter study on the realization of selected hygiene measures in 331 dental practices. Hyg Med 2008; 33 (3): 64–73 (Berlin, Magdebeurg, Greifswald: sample size 335)

- Meyer VP, Jatzwauk L.
  Management of hygiene in dental practices –results of a nationwide Online survey in Germany. IDZ Informat 2010, Issue 2 (Germany: sample size 500)

- Hübner NO, Handrup S, Meyer G, Kramer A. Impact of the "Guidelines for infection prevention in dentistry" (2006) by the Commission of Hospital Hygiene and Infection Prevention at the Robert Koch-Institute (KRINKO) on hygiene management in dental practices – analysis of a survey from 2009. GMS Krankenhaushyg Interdiszip 2012; 7(1):Doc14 (20120404) (Greifswald: sample size 35)

Realisation of Infection Anamnesis and Appointment System Considering the Infection Risk (n=400)

Item	Berlin (2002) [%]	Magdeburg (2002) [%]	Greifswald (2002) [%]	Greifswald (2009) [%]
Infection anamnesis	80	82	84	89
Appointment system for risk patients	34	36	43	90

Proportion of Vaccinated Staff

Vaccination	Berlin	Magdeburg	Greifswald	
	[%]			
	2002	2002	2002	2009
H. influenzae	10	4	4	4
Pertussis	1	56	56	57
Diphtherie	14	77	77	97
Tetanus	75	92	92	100
Hepatitis A	37	69	69	69
Hepatitis B	77	94	94	94
Rubella	20	40	40	no data
Chickenpox	5	28	28	34
Mumps	11	40	40	63
Measles	10	49	49	63
Poliomyelitis	61	77	77	no data
Viral influenza	71	72	42	34

Efficacy of Vaccination

- **Influenza Morbidity was sign. lower (p <0.001) despite higher viral loads in throat swabs in HCWs with contact to patients with flu (p = 0.035)**

  Chu TP, Li CC, Wang L, et al. A surveillance system to reduce transmission of pandemic H1N1 (2009) influenza in a 2600-bed medical center. PLoS One 2012, 7(3) e32731

- **Infectious childhood diseases are completely preventable as well as polio, tetanus, diphtheria**

- **HBV preventable apart from so-called non responder**

Conclusion

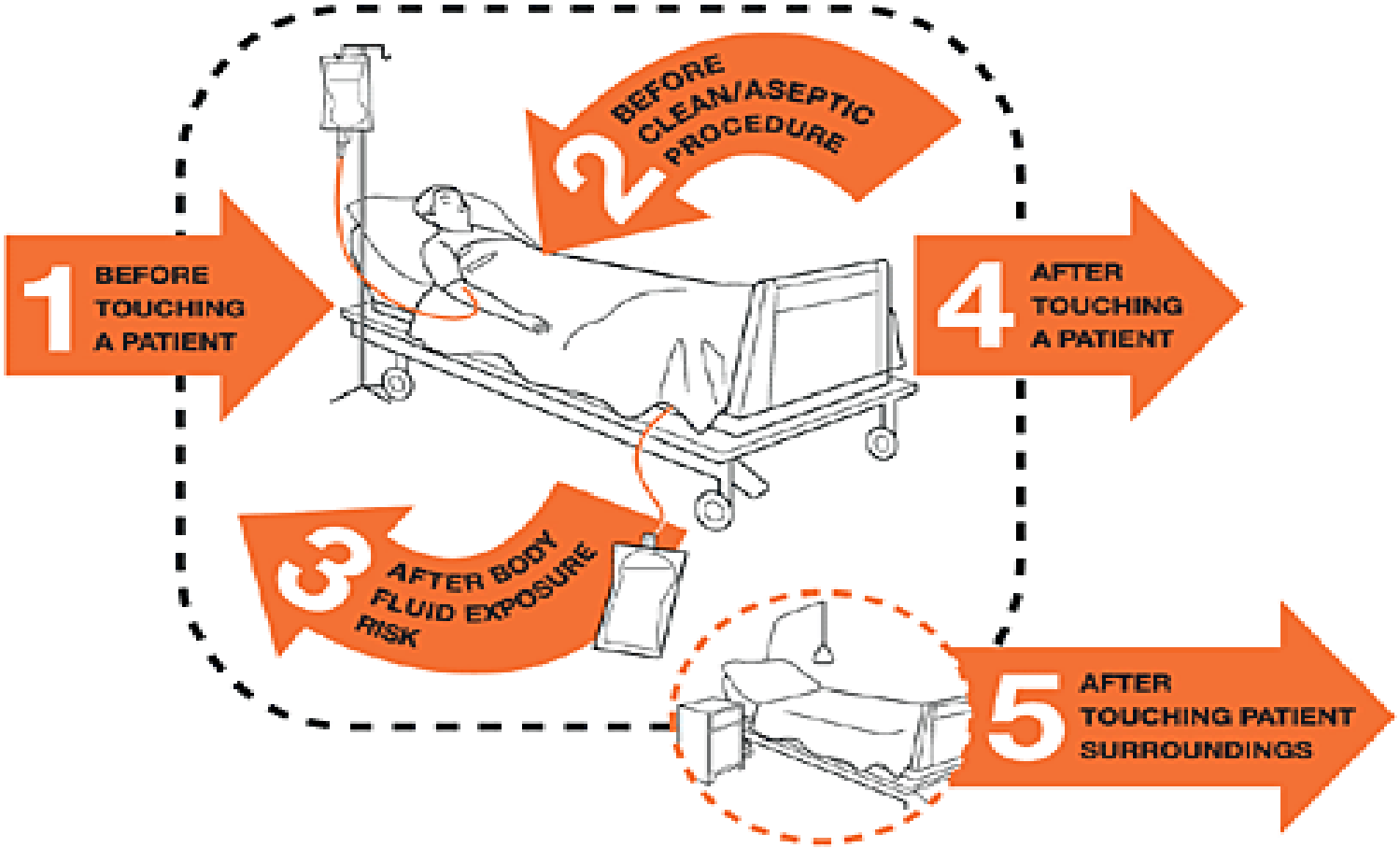
In order to realize the aim of > 90 % vaccination rate, education about risks for dentists and for their patients is needed!

Hand Hygiene

Item	Berlin (2002)	Magde-burg (2002)	Greifswald (2002)	(2009)	Germany (2009, n= 500)
Disinfection before and after each treatment	20	34	50	89	76
Surgical hand disinfection	39	92	92	100	73
Gloves	75	59	61	85	87
No changing of gloves	68	35	31	49*	

*changing when visible soiling or damage and after treatment of risk patients

Conclusion: The 5 Moments of Hand Hygiene are also valid in Dental Practices



+ disinfection after removing gloves

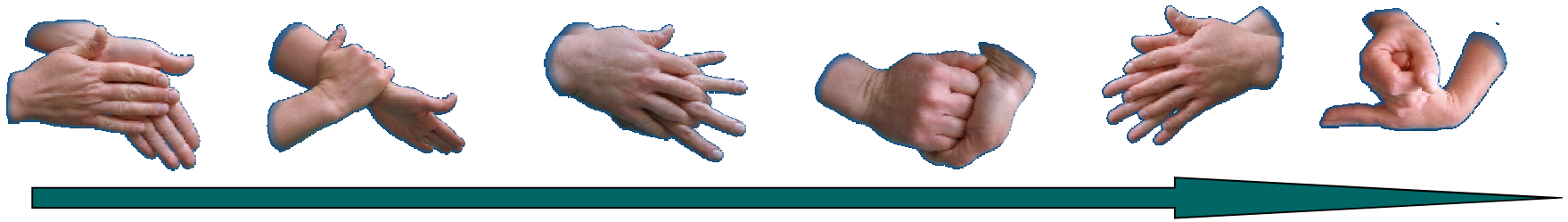
News in Surgical Hand Rub

- Exposure time 1.5 instead of 3 min
- Eschewal of handwashing as part of surgical hand rub, latest 10 min before intervention
- No use of iodophores because of toxic risks
- Skin protection does not influence the efficacy of hand rubs
- Dermal alcohol absorption is not critical
- Hübner NO, Kramer A. Effect of a 1 min hand wash on bactericidal efficacy of standard alcohols for surgical hand disinfection and on skin hydration. Int J Hyg Environ Health 2006; 208: 285-91.
- Hübner NO, Kramer A. Does a preceding hand wash and drying time after surgical hand disinfection influence the efficacy of a propanol-based hand rub? BMC Microbiol 2006;6: 57.
- Kramer A et al. Improving adherence to surgical hand preparation. J Hosp Inf 2008; 70 Suppl 1: 35-43
- Hübner NO, Kramer A. Determination of antiseptic efficacy of rubs on the forearm and consequences for surgical hand disinfection. J Hosp Inf 2011, 78(1): 11-5
- Kramer A et al. Quantity of ethanol absorption after excessive hand disinfection using three commercially available hand rubs is below toxic levels for humans. BMC Inf Dis 2007; 7: 117
- Below H, Kramer A. Dermal and pulmonary absorption of propan-1-ol and propan-2-ol from hand rubs. ICHE 2011.

Surgical hand rub - practise

After 10 s exposure, the efficacy on underarms is as effective as 15 s of skin antisepsis on the upper arm (proof according to the German test model)

modifyed technique of surgical hand disinfection
the procedure begins with application on both hands, thereafter directly two successive applications on lower arms, 10 s each, afterwards only rub-in technique: total disinfection time 1.5 min



Kramer, Hübner N, Below et al. Improving adherence to surgical hand preparation. J Hosp Infect 2008; 70 Suppl 1: 35-43

Hübner, Kellner, Kramer. Determination of antiseptic efficacy of rubs on the forearm and consequences for surgical hand disinfection. J Hosp Infect 2011,78: 11-5.

Conclusion

Optimization of compliance up to nearly 100%

- **Choice of well tolerable alcohol-based formulations with moistures, but without remanent additives**
- **comfortable dispensers – sensor and registration of usage**
- **Skin safety plan for protection and care**
- **Education, training and supervision**

Surface Disinfection after each Patient Treatment

Item	Berlin (2002)	Greifswald (2002)	Magdeburg (2002)
Hand contact surfaces	59	65	59
Dental prostheses	90	99	97
Tube opening of the suction system	37	28	15

Conclusion

In order to realize the aim of 100% disinfection of relevant surfaces

- **Choose well tolerable active agents without unpleasant odor; i.e. alcohols, oxidants, formic acid**
- **comfortable usage; i.e. wipe dispensing systems**
- **Education, training and supervision**

Protective Clothing

Item	Berlin (2002)	Magdeburg (2002)	Greifswald (2002)	Greifswald (2009)	Germany (2009)
Masks	39	56	39	85	87
Masks before oral surgery	54	88	70	100	no data
Protective goggles	64	60	63	85	64
Gloves for surface disinfection	68	82	88	no data	

Conclusion

- Information on the risks
- Supply of personal protective equipment
- Education and unexceptional realization

Antisepsis

Before	Berlin (2002)	Greifswald (2002)	Magdeburg (2002)
Periodontal therapy	23	77	79
Endodontic therapy	2	24	27
Tooth extraction	14	40	30
Oral surgery	24	75	79
Mucosal injection	2	18	20

Conclusion

- Information on the risks of failure of antisepsis
- Education and training
- In Germany there is a current change from chlorhexidine to octenidine because
  - identical efficacy but
  - no risk of side effects

Hübner NO, Siebert J, Kramer A. Octenidine dihydrochloride, a modern antiseptic for skin, mucous membranes and wounds. Skin Pharmacol Physiol 2010;23(5):244-58

Prevention of Endocarditis

Item	Berlin (2002)	Greifswald (2002)	Magdeburg (2002)
Antibiotic prophylaxis	92	87	73

Conclusion

- **Information on the risks and consequences including legal aspects**
- **Education and training**

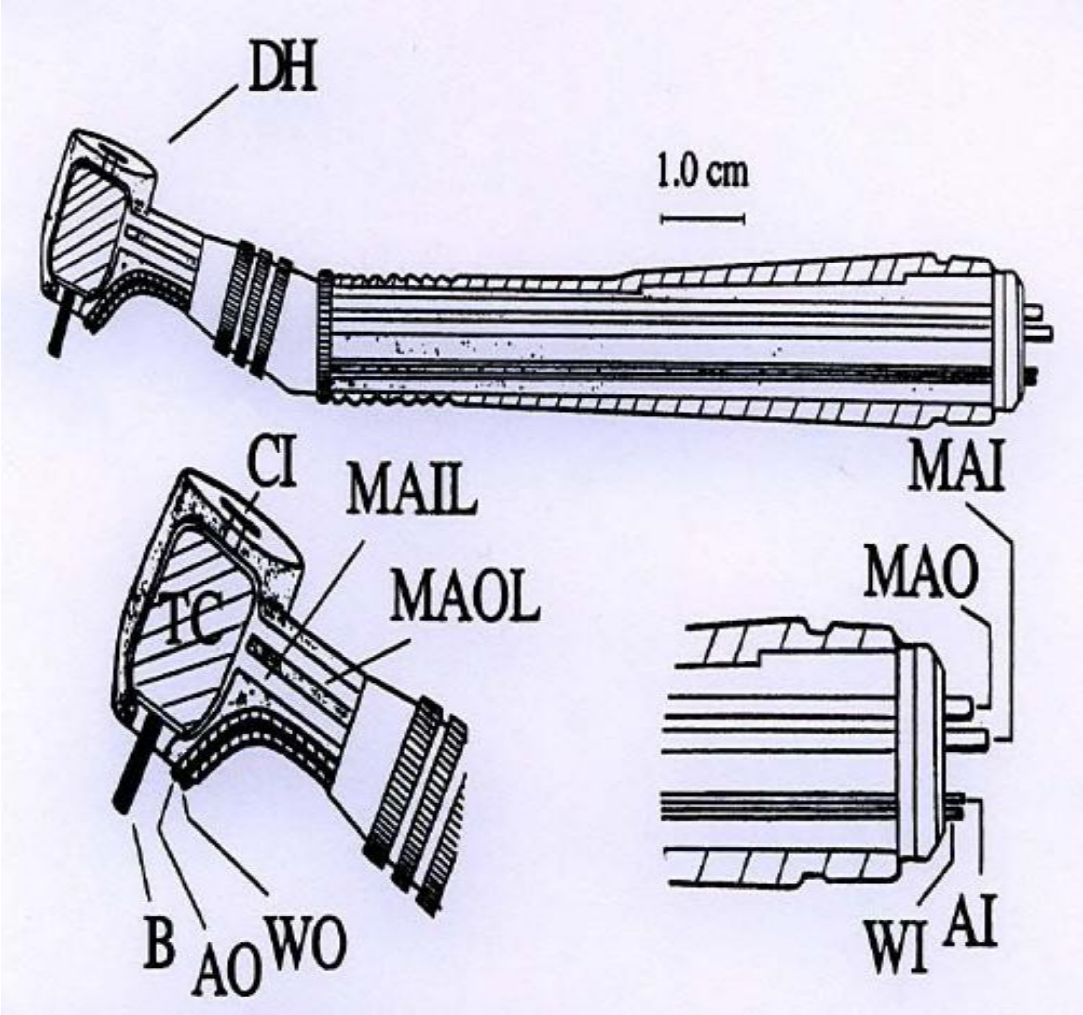
Reprocessing of Medical Devices

Reprocessing of	Berlin (2002)	Magdeburg (2002)	Greifswald (2002)	(2009)	Germany (2009)
Handpieces after each patient	26	8	10	43	89
Handpieces at the end of working day	94	96	94	99	no data
Endodontic instruments	99	100	100	100	
No control of sterilisation	13	5	2	20	

Reprocessing of Medical Devices

Item	Greifswald (2009)	Germany (2009)
Classification of medical devices	89	87
SOP for reprocessing of handpieces	94	89

Cross-Infection Risk by Handpieces



Drilling (25 x 1 s) at tooth surface cause contamination (dye tracers, HBV DNA, proviral HIV DNA) of the air / water hoses of handpieces independent of reflux blocking ventil

Lewis DI, Boe RK. Cross-infection risks associated with current procedures for using high-speed dental handpieces. J Clin Microbiol 1992; 30: 401–6

Lewis DI, et al. Cross-contamination potential with dental equipment. Lancet 1992; 340: 1252–4

Serious Deficiencies in Reprocessing of Medical Devices (Data of Greifswald 2009)

- No willingness to participate in further training in this complex field: 23 %
- No taking a course for reprocessing of medical devices: 23 %
- No person designated who is responsible for reprocessing: 20 %
- No validation of sterilizers: 20 %
- No chemical indicator for the batch control: 23 %
- No use of helix test (PCD): 32 %
- No knowledge, which type of sterilizer in the practice: 17 %
- Use of type N sterilizer, which is obsolete for semicritical medical devices B: 6 %
- Only manual reprocessing: 34 %, thereoff 6 % without final sterilization
- No ultrasonic bath: 37 %
- No new suction cannula after every treatment: 3 %

Conclusion

- **Basis for reprocessing is the classification of medical devices in non-critical, semi-critical A/B and critical A/B/C**

  - **non critical** → cleaning (C) → disinfection(D)
  - **semi-critical** → (A) C + D
    → (B) precleaning (P) immediately after use, C → D, preferably mechanically inclusive lumen
  - **critical** → (A) optionally P → C → D → steam sterilization
    → (B) P → generally mechanically C + D → steam sterilization

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    sterilization assistant or education in instrument´s reprocessing in dental practices

Conclusion

- **Validated reprocessing of dental instruments is a fully controllable risk.**
- **Efficient cleaning of instruments contaminated with blood, secretion, or remnants of tissue is a critical pre-requisite for the following disinfection or sterilization. The recommended standard is the use of machine-based processes.**
- **The whole reprocessing process has to be defined in a SOP.**
- **Appropriate education and training is essential for performing the professional reprocessing process based on an educational curriculum**

Additional Classification by Risk of vCJD or CJD

I. Disease or suspected vCJD
II. Disease or suspected CJD
III. Related with CJD-patients (except it was a familial genetic unbiassed detected)
IV. Receiver of human growth hormone (non-recombinant) and of corneal or dura mater transplants
V. Patients with unexplained, rapidly progressive disease of the CNS (with and without dementia), without suspected CJD
VI. All other patients

Root canal instruments are highly critical

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At each reprocessing two for prion decontamination effective methods:

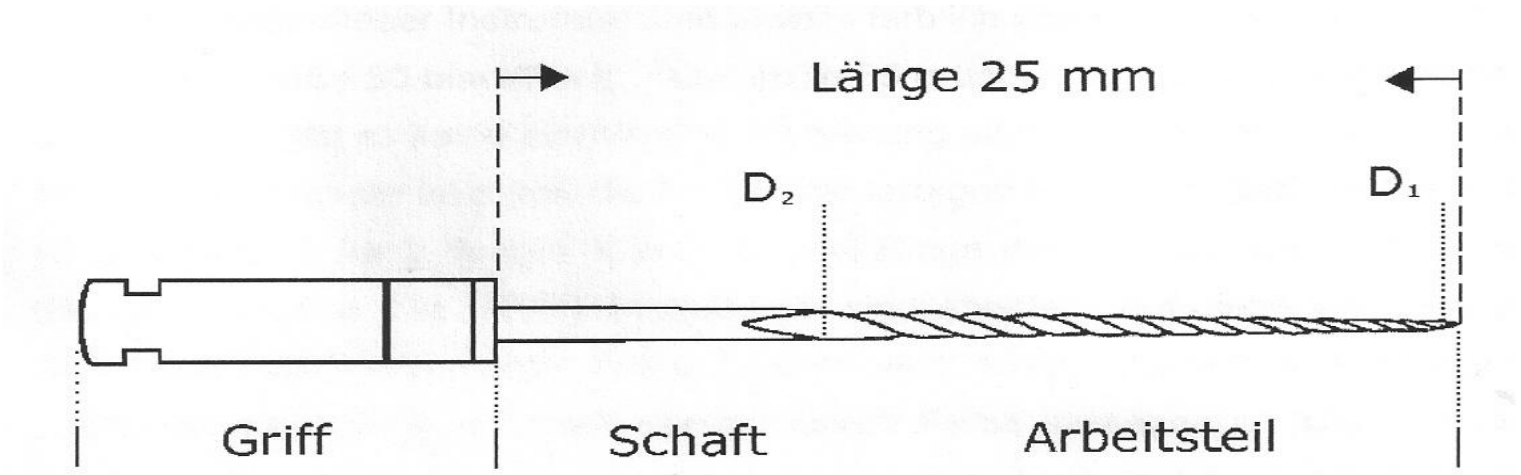
- **Pre-cleaning, thereafter not fixing alkaline cleaning (pH≥ 10 for 10 min)**
- **mechanical chemo-thermal disinfection**
- **sterilization 134 ° C for 5 min; if alkaline cleaning not possible, 134 ° C for 18 min**

or alternatively use of GdSCN and final sterilization

Study of Influence of GdSCN on the Torsional and Bending Stiffness of Root Instruments

Method

- **Root canal file EasyShape 25 and 35 mm (Brasseler GmbH, Lemgo, Germany), declared for eigth times reprocessing (steam sterilization)**



Study of Influence of GdSCN on the Torsional and Bending Stiffness of Root Instruments moment

3 groups

- **A: Immersion of files (each n = 18) in 6 mol GdnSCN solution for 15 minutes in 8 sequential cycles; after each exposition rinsing with sterile Aqua dest. and 5 min drying**
- **B: once immersion in 6 mol GdnSCN for 12 h (to simulate wrong usage)**
- **C: untreated control (n = 12)**

Measured parameter

- **Bending stiffness: Type DRL-I-0,05 (ETH-Messtechnik GmbH Gschwend, Germany)**
- **Torsional moment and torsional angle: Motor Cap type MC5G and Sensor MT-TS 50 Ncm „P“, software CapGraph (Mecmesin GmbH, Schwenningen, Germany)**

All methods in accordance with DIN EN ISO 3630-1

Results

File	Group	Bending stiffness	Torsional moment	Torsional angle
25mm	A vs. C	n.s.	n.s.	n.s.
	B vs. C	p = 0,0490	p < 0,0001	n.s.
35mm	A vs. C	n.s.	n.s.	n.s.
	B vs. C	n.s.	n.s.	n.s.

A: 6 mol GdnSCN for 15 minutes in 8 cycles
B: once in 6 mol GdnSCN for 12 h
C: control

Conclusion

- 6 mol GdSCN is compatibel for the tested root instruments
- A complete destruction of prions is reachable with 4 mol GdSCN in 1 hour or 6 mol GdSCN in 15 minutes – this possibility of prion inactivation is cost efficient and easily performed in the dental practice

Our manuscript is prepared for J endodontics

Water Safety - Cooling of Handpieces for Surgical Intervention

Water	Berlin (2002)	Greifswald (2002)	Magdeburg (2002)
Sterile cooling medium insted water from the water supply	46	26	25

Water Safety in Dental Units in Greifswald 2009

Applied protection measures

- **100%: Flushing the water systems for 2 minutes after every treatment and at the beginning of the work day**
- **6%: once a year water sample of the dental unit for microbiologically control**

Microbiological quality of water

- **29% average of 550 total cfu/ml (threshold 100 cfu/ml)**
- **11% *P. aeruginosa* between 180 and 200 cfu/100 ml (threshold 0 cfu/100 ml)**
- ***No Legionella* ssp. was detected**

Conclusion

Legal situation

- **Currently, quality of water of dental units is not covered by specific regulations in the EU**
- **In Germany drinking water quality is required and at least once a year microbiological control ® <100 total cfu / ml; < 1 cfu *E. coli* or *Coliforme* / 100 ml; < 100 cfu *Legionella* spp. / 100 ml**
- **In the US only testing for aerobic heterotrophic bacteria is recommended**

Recommendation justified by own experiences

<100 total cfu / ml, < 1 cfu *E. coli* or *Coliforme* / 100 ml;

< 1 cfu *Legionella* spp. / 100 ml; < 1 cfu *P. aeruginosa* / 100 ml

Dyck A, Exner M, Kramer A. Experimental based experiences with the introduction of a water safety plan for a multi-located university clinic and its efficacy according to WHO recommendations. BMC Public Health 2007, 7:3

Because no correlation between the count of aerobic heterotrophic bacteria and the presence of *Legionella* spp. or *P. aeruginosa,* special diagnostic is essential to control the water of dental units

Bristela M et al. Testing for aerobic heterotrophic bacteria allows no prediction of contamination with potentially pathogenic bacteria in the output water of dental chair units. GMS Hyg Inf Contr Interdiszip 2012; 7(1):Doc12 (20120404)

Efficacy of Decontamination in Dental Units

Trial 1: Intensification of the purge program of the dental unit

- **Situation: 22 contaminated dental units in a dental clinic with aerobic heterotrophic bacteria up to 3.830 cfu / ml and with molds up to 1000 cfu / ml**
- **The manufacturer's recommended program for cleaning and intensive decontamination was intensified by shortened intervals over a 2-week period: For Sirona units, the automatic purge program instead of once a day was run every morning and evening for 20 min each time, and the intensive decontamination instead of once a month every two weeks; this schedule has been maintained since then. For KaVo units, cleaning with hydroclean function was carried out for 2.5 min every morning and evening. The automatic intensive decontamination was run daily instead of weekly.**
- **A maintenance log book was introduced, in which the purge was confirmed by the operator's signature.**
- **Within 5 weeks, all previously contaminated units were decontaminated.**

Kramer A, Assadian O, Bachfeld D, Meyer G. Purge- and intensive-purge decontamination of dental units contaminated with biofilm. GMS Hyg Inf Contr Interdiszip 2012; 7(1):Doc11 (20120404)

Efficacy of Decontamination in Dental Units

Trial 2: Use of the PotoClean® Technology, based on anodic oxidation of NaCl in water ® active agents sodium hypochlorite 0.02%, ozone 0.009%, hydrogen peroxide 0.00005%, oxygen 0.0013%

- **Situation:**
  - **two 15 years old contaminated dental units: 310 cfu aerobic heterotrophic bacteria + 30 cfu molds/ml**
  - **one 5 years old contaminated dental unit: 300 cfu molds/ml**

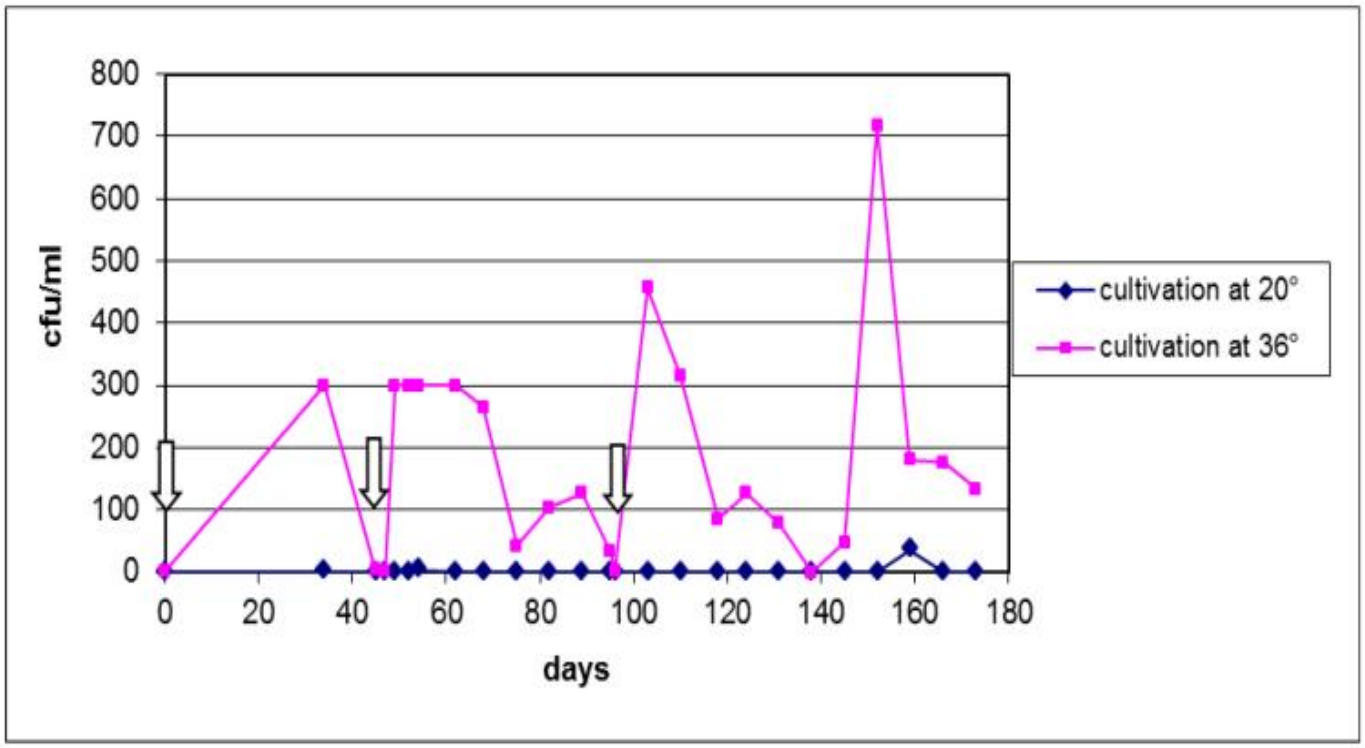
- **Initially shock decontamination (20 mg Cl/ml for 2 hours), repeat after 2 and 4 month, in the remaining time continous dosing of 1 mg Cl/L**

Trial 2: Efficacy Against Mold in the 5 Years-old Dental Units

- **Already after the first shock decontamination no bacterial contamination of the water was detectable in any of the samples followed by its continued use at the concentration of 0.1 mg Cl/L**

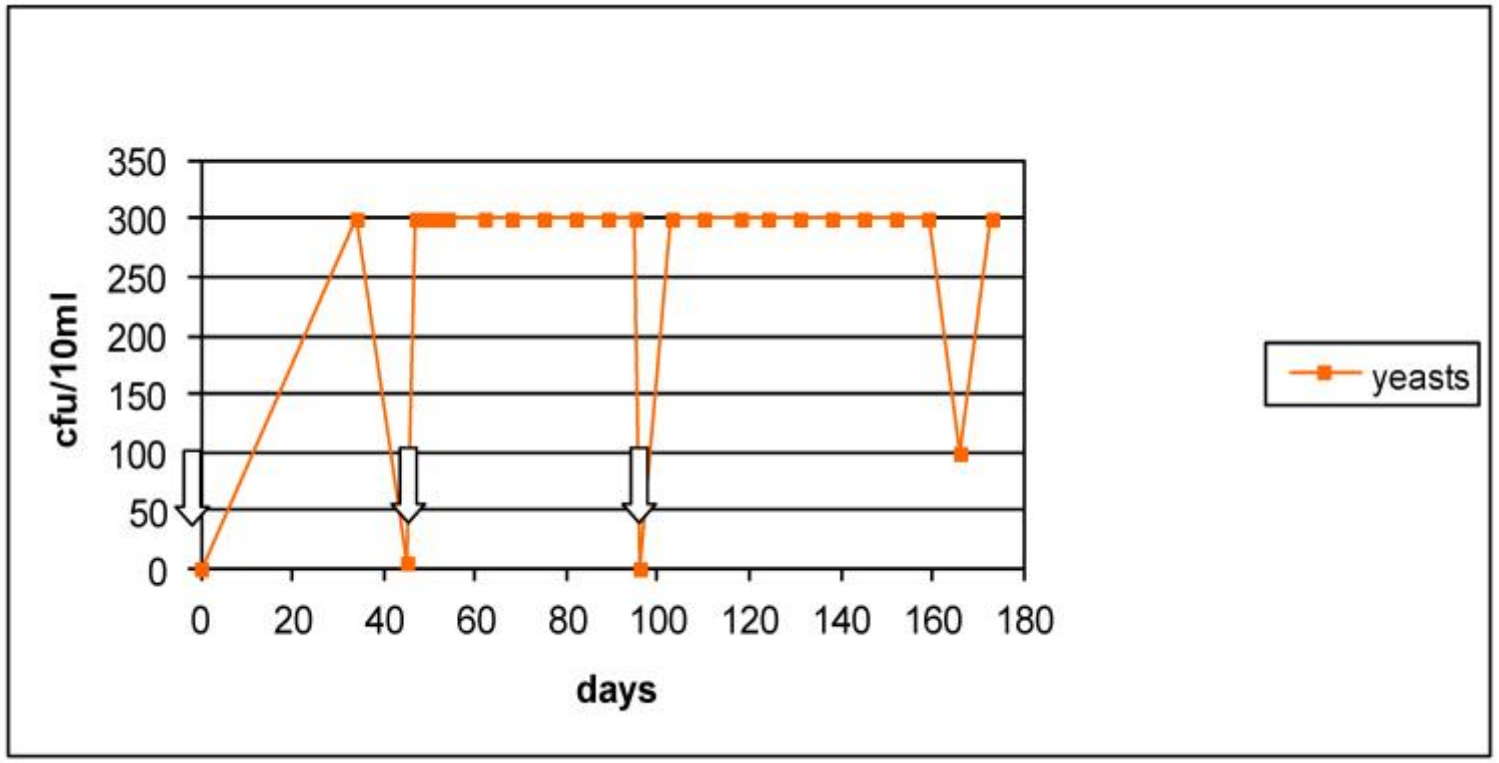
Fischer S, Meyer G, Kramer A. Economic comparison of conventional maintenance and electrochemical oxidation to warrant water safety in dental unit water lines. GMS Hyg Inf Contr Interdiscip 2012; 7(1):Doc08 (20120404)

Trial 2: Efficacy Against Bacteria in the 15 Years-old Dental Units



white arrows = shock decontamination

Trial 2 : Efficacy Against Molds in the 15 Years-Old Dental Units



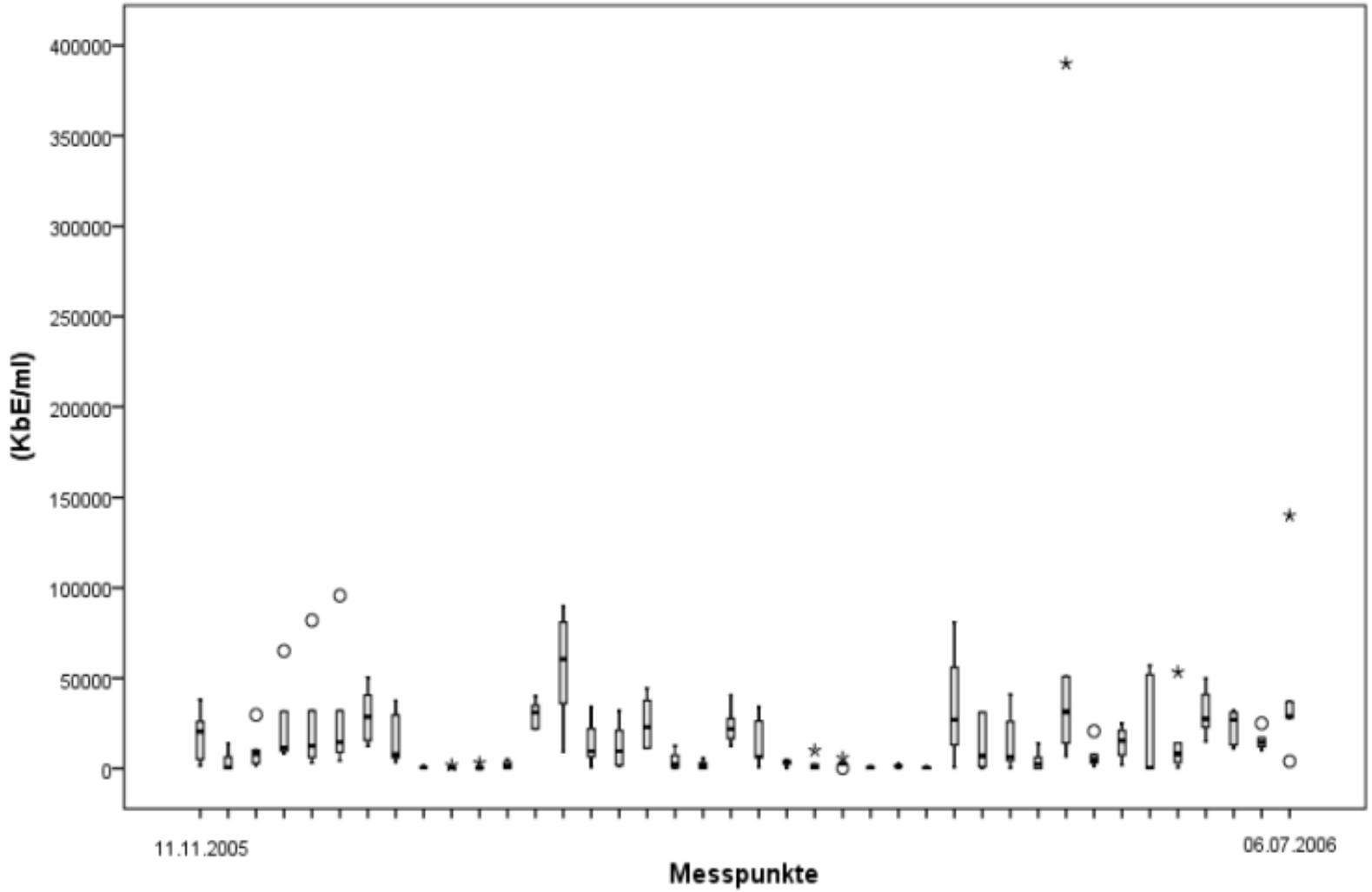
In the turbines of the older design with intensive biofilm formation, the PotoClean® technology was not effective

Efficacy of Decontamination in Dental Units

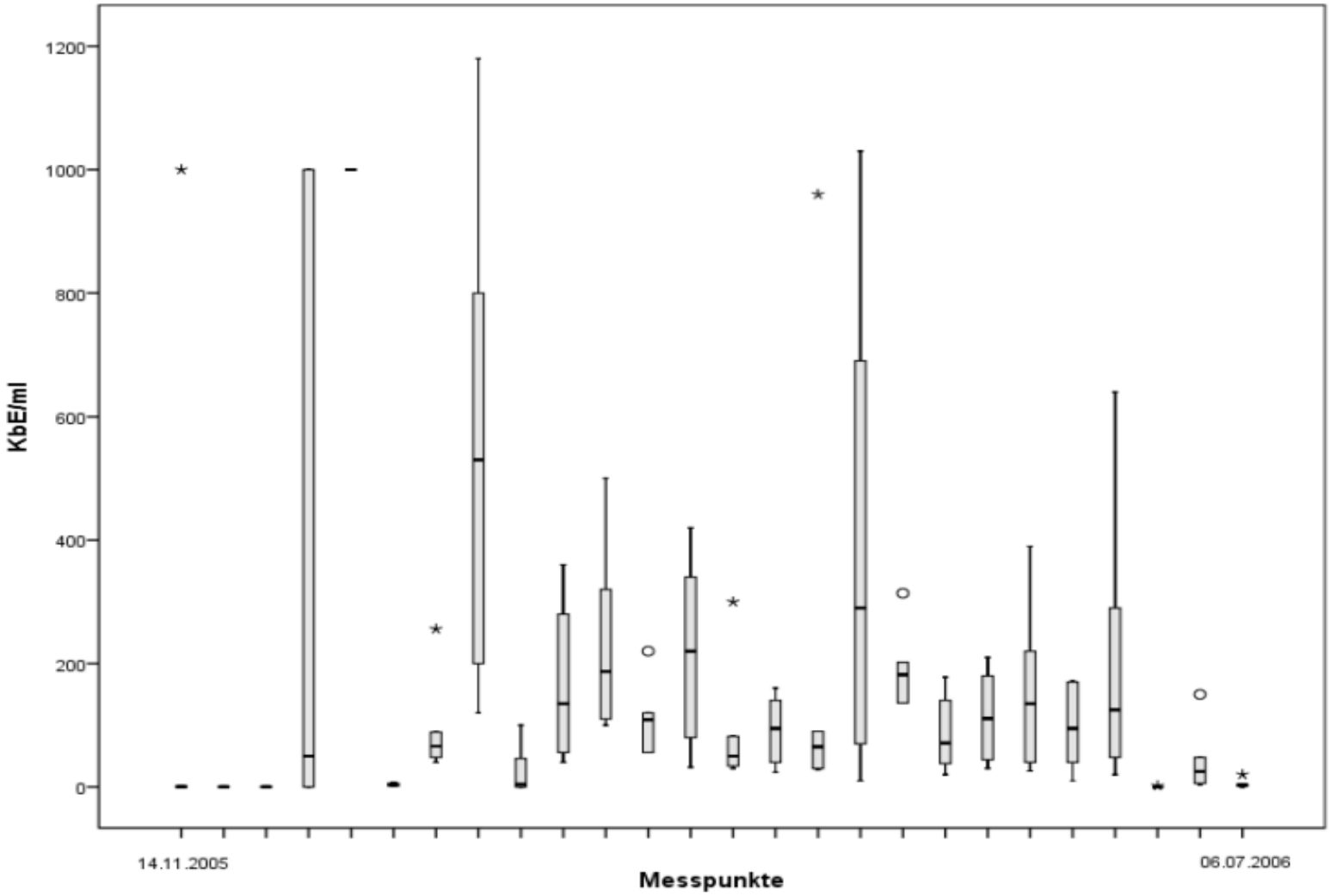
Trial 3: Use of the ActiDes-Blue Technology, Based on anodic oxidation of NaCl ® active agents hypochloric acid, sodium hypochlorite + further radicals (no detailed declaration)

- **6 dental units: up to 110 cfu *L. pneumophila* / 100 ml; up to 10 cfu *P. aeruginosa* / 100 ml**
- **shock decontamination 7 and 11 month after the start of decontamination, in the remaining time continous dosing**
- **Results: Elimination of *L. pneumophila* after 3 weeks, but sometimes 1-2 cfu of *P. aeruginosa***

Trial 3: Efficacy (box plots) Against Bacteria



Trial 3: Efficacy (box plots) Against Molds



Trial 3: Conclusion

As the sanitation was not successful, use of the CARELA® HYDRO-DES technology:

- **First alkaline pre-cleaning for bacterial slime breaking for 1 hour (pH 11)**
- **Thereafter filling with a two component agent, H_2O_2 with addition of sodium hydrogen sulphate and sulphuric acid in aqueous solution (0.1%) for 1 hour**
- **Afterwards the dental unit was flushing with tap water until the indicator showed no more rests of active substances**
- **Result: Complete decontamination for 14 days without further purge of the dental units**

Kramer A, Lemanski S, Demond K, Assadian O. Comparison of the ActiDes-Blue and CARELA HYDRO-DES technology for the sanitation of contaminated cooling water systems in dental units. GMS Hyg Inf Contr Interdiscip 2012; 7(1):Doc09 (20120404)

Costs of Hygiene in Dental Practices - Results of the First Two Realistic Analysis in Germany

2010: Analysis in a dental clinic with 10 work separate Places

- **Material costs for hygiene: reprocessing (capital allowance of washer disinfectors and sterilization technique, consumption of water and energy, water treatment for sterilization), disinfection of surfaces, antisepsis, clothing, certification and audit: 6672 €/year**
- **Personal costs for hygiene including vaccination: 6153 €/year**
- **Sum: 12.825 €/year**

2013 thesis accepted, work was performed in my institute

Costs of Hygiene in Dental Practices – 2nd study

2006-1010: Analysis in a group practice with 2 work places

Year	Personal costs (€)	Material cost (€)	Sum (€)	Increase
2006*	9.039	10.366	19.406	
2007	10.128	12.478	22.606	15,7%
2008	9.965	13.840	23.805	6,2%
2009	10.409	14.754	25.163	5,5%
2010	11.372	15.873	27.245	8,3%

***after Publishing of the new Guideline for Dental Hygiene of the Robert Koch-Institute 2006**

2013 thesis accepted, work was performed in my institute

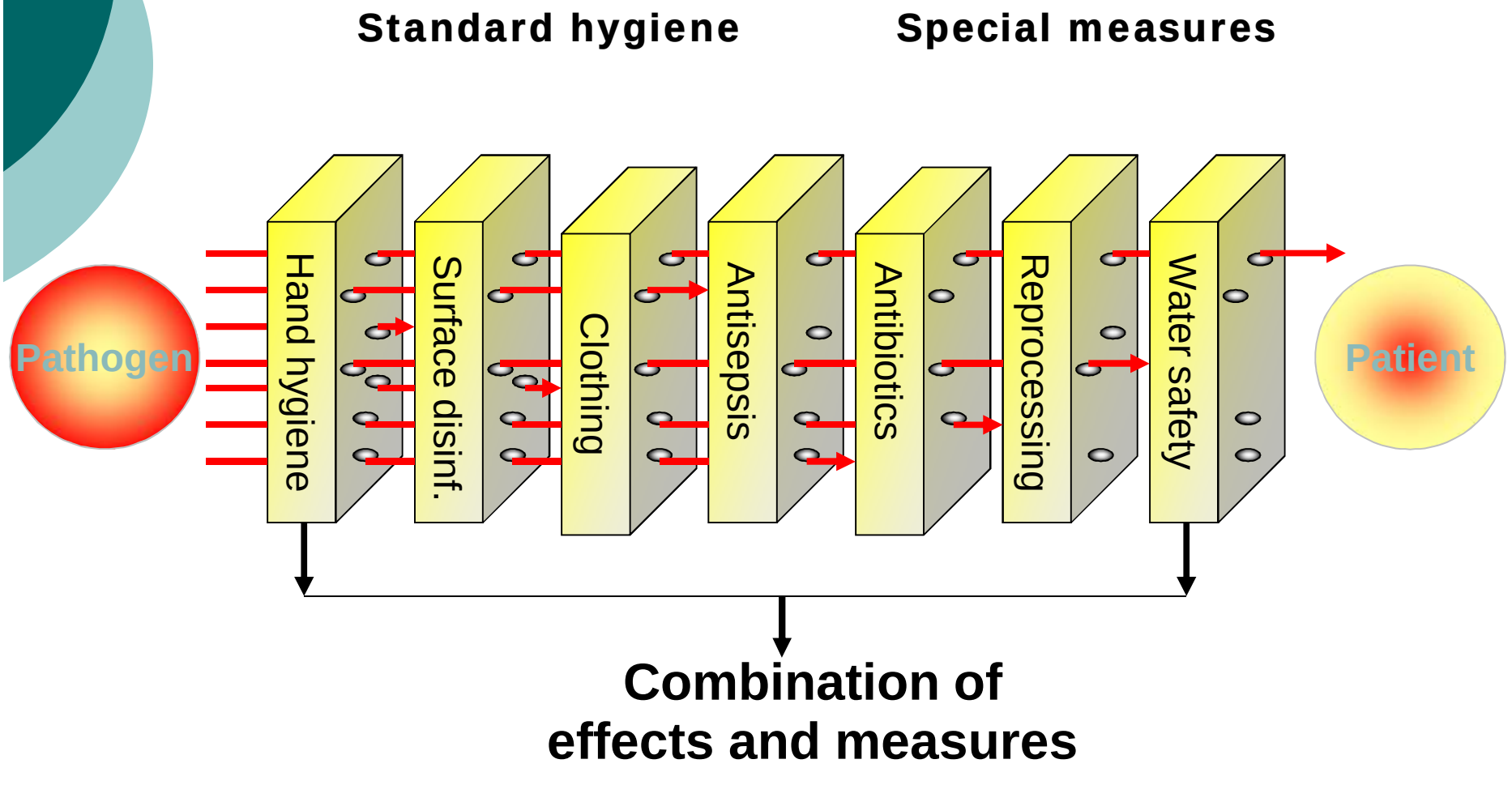
Future Challenges

- Initiation of studies to estimate the infection risks in dental practices
- Ensuring the validation of the whole reprocessing process
- Considering the rising costs in the financial regulation of dental practices (increasing of points for patient´s treatment as negotiation result between Physicians' association and the ensurance)
- Continuous education and training for staff of dental practices

European or WFHSS uniform regulations for

- water safety in dental units
- yearly government supervision on the base of a uniform checklist
- educational curriculum + training for reprocessing of medical devices

The Bundle Strategy (the “Anti-Cheese-hole approach”) guarantees the highest safety



Every Dentist Must Possess The Conviction of the Necessity of the Infection Control in Dental Practices Like Wildfire Capture