"What's New on Infection Control for Handpieces?"

Andrew Smith
Professor of Clinical Bacteriology
• Declarations of interest
• PhD studentships funding from W&H Ltd
• Lecture fees: Steris, Schulke & Mayr Ltd, BDA, Henry Schein
• Funding from W&H Ltd to attend OSAP 2015 meeting
Lecture Plan

- A little bit of handpiece history
- Some standards to guide us?
- Cleaning
  - Defining clean
  - What’s new?
- Sterilization
  - Defining sterile
  - What’s new?
The role of the handpiece

Handpiece types:

Dental turbine: e.g. used to drill tooth

Dental slow speed motor: e.g. used to polish teeth

Straight handpiece: e.g. used for oral surgery
• Handpieces weak link in the dental infection prevention chain
• Handpiece cleaning and sterilization challenging = access to internal components and lumens e.g., stainless steel, D=0.9 mm & L=83 mm, in air driven turbines
• Weight: 42 – 100g
• “The sterilization of the handpiece of the dental engine is beset by so many at least *a priori* difficulties that this detail of practice is too often and too generally ignored.”

• “This condition is not due to a paucity of recommendations. A survey of the literature which makes no claim for completeness yielded many suggestions”
• “Our experiences have thoroughly impressed us with the necessity of testing out the efficacy of any method of sterilization under the conditions followed in the individual office.”

• “Slight and even unrecognized departures from a described method may render such a modification useless.”
But when was this written?

The Sterilization of the Handpiece


(From the Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania, Philadelphia, Pa.)

Dental Cosmos Vol. Ixvi August 1924
• Moving on....

STERILIZATION OF DENTAL INSTRUMENTS

HENRY A. BARTELS, B.S., D.D.S.

Department of Oral Pathology, School of Dental and Oral Surgery, Columbia University, New York City

J DENT RES 1931; 11; 67
DOI: 10.1177/00220345310110011101
“A thorough knowledge of sterilization methods, their correct use and their limitations, is of inestimable value to the dental practitioner.”

“As the laity is becoming more familiar with the means of germ destruction, they are more apt to scrutinize the methods of sterilization employed by the dentist.”

“The employment of sterile instruments, as a means of preventing infections, has been advocated so frequently that no further discussion of this matter is required at this time.”
• **Summary**

• “12. An oil bath is an ideal agency for the sterilization of instruments, in which rusting and dulling of instruments are prevented.”

• “13. A steam sterilizer, to be run efficiently, must not be overpacked and must not contain entrapped air”
Cross-Infection Risks Associated with Current Procedures for Using High-Speed Dental Handpieces

DAVID L. LEWIS* AND ROBERT K. BOE

Faculty of Ecology, University of Georgia, Athens, Georgia 30602, 1 and 4721 Chamblee-Dunwoody Road, Building 400, Dunwoody, Georgia 30338

*Corresponding author.
Demonstrated aspiration of a coloured dye into the air turbine chambers

Recommended heat treatment of high speed Hp’s between each patient
Cross-contamination potential with dental equipment

DAVID L. LEWIS  MAX ARENS  STANTON S. APPLETON  KOICHI NAKASHIMA  JUNICHI RYU  ROBERT K. BOE  J. BENJAMIN PATRICK  DOUGLAS T. WATANABE  MANAJI SUZUKI

<table>
<thead>
<tr>
<th>TABLE I—DNA DETECTED IN EQUIPMENT WITH PATIENT SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

HIV a game changer
**Table I**—DNA detected in equipment with patient samples

<table>
<thead>
<tr>
<th>Sample</th>
<th>β-globin</th>
<th>HLA DQα</th>
<th>gag</th>
<th>pol</th>
<th>env</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient B (HIV-positive, symptom-free)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood</td>
<td>.</td>
<td>.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Inside prophy angle 9 (sealed)</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inside prophy angles 10, 11 (unsealed)</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prophy paste, angles 9–11</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inside high-speed handpiece</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
HIV a game changer

<table>
<thead>
<tr>
<th>Sample</th>
<th>Human DNA</th>
<th>HIV proviral DNA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β-globin</td>
<td>HLA DQα</td>
</tr>
<tr>
<td></td>
<td></td>
<td>gag</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>env</td>
</tr>
<tr>
<td><strong>Patient C (HIV-positive, AIDS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Inside prophy angle 12 (sealed)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Inside prophy angles 13–14 (unsealed)</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Prophy paste, angle 12</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Prophy paste, angle 13</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Prophy paste, angle 14 (plastic)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Inside high-speed handpiece</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Lewis et al 1992
Lab studies

Using lab model of herpes simplex virus infection
All handpieces fitted with anti-retraction valves,
It was not until the units were flushed internally and disinfected externally that the pathogens were eliminated.

Epstein et al., 1995
Handpieces a cleaning and sterilization problem

(M Zimmermann)
Anti-retraction valves?

Failure of anti-retraction valves and the procedure for between patient flushing: a rationale for chemical control of dental unit waterline contamination.

Montebugnoli L, Dolci G, Spratt DA, Puttaiah R.

You do not have access to the content that you requested. Please review your options for gaining access at the bottom of the page.

Efficacy of anti-retraction devices in preventing bacterial contamination of dental unit water lines

Francesca Berluti, Luca Testarelli, Francesco Vaia, Massimo De Luca, Giovanni Dolci
Tel.: +39-3381504134.
Brief report

Microbial contamination of used dental handpieces

Gordon Smith BSc Hons, MRes, PhD, Andrew Smith BDS, FDS RCS, FRCPath, PhD *
CDC guidance

• For processing any dental device that can be removed from the dental unit air or waterlines, neither surface disinfection nor immersion in chemical germicides is an acceptable method.

• Ethylene oxide gas cannot adequately sterilize internal components of handpieces (250,275).
<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Dental instrument or item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>Penetrates soft tissue, contacts bone, enters into or contacts the bloodstream or other normally sterile tissue.</td>
<td>Surgical instruments, periodontal scalers, scalpel blades, surgical dental burs</td>
</tr>
<tr>
<td>Semicritical</td>
<td>Contacts mucous membranes or nonintact skin; will not penetrate soft tissue, contact bone, enter into or contact the bloodstream or other normally sterile tissue.</td>
<td>Dental mouth mirror, amalgam condenser, reusable dental impression trays, dental handpieces*</td>
</tr>
<tr>
<td>Noncritical</td>
<td>Contacts intact skin.</td>
<td>Radiograph head/cone, blood pressure cuff, facebow, pulse oximeter</td>
</tr>
</tbody>
</table>

* Although dental handpieces are considered a semicritical item, they should always be heat-sterilized between uses and not high-level disinfected (246). See Dental Handpieces and Other Devices Attached to Air or Waterlines for detailed information.
Although no epidemiologic evidence implicates these instruments in disease transmission (353), studies of high-speed handpieces using dye expulsion have confirmed the potential for retracting oral fluids into internal compartments of the device (354–358).
This determination indicates that retained patient material can be expelled intraorally during subsequent uses. Studies using laboratory models also indicate the possibility for retention of viral DNA and viable virus inside both high-speed handpieces and prophylaxis angles (356,357,359).
Heat methods can sterilize dental handpieces and other intraoral devices attached to air or waterlines (246, 275, 356, 357, 360).
IX. Special Considerations
A. Dental Handpieces and Other Devices Attached to Air and Waterlines
1. Clean and heat-sterilize handpieces and other intraoral instruments that can be removed from the air and waterlines of dental units between patients (IB, IC) (2,246,275,356,357,360,407).
Manufacturer’s instructions for cleaning, lubrication, and sterilization should be followed closely to ensure both the effectiveness of the process and the longevity of handpieces.
HPS guidelines

- No specific guidance on dental handpieces
- See CDO letter
- Revised Glennie framework
In some instances, the decontamination process may not generate full sterilization, for example in the reprocessing of dental handpieces; however, the guidance will nevertheless seek to raise standards and minimise infection risk. – CDO for England (Barry Cockcroft)
Handpiece cleaning - The effective cleaning of handpieces in accordance with manufacturers’ guidance. Dedicated cleaning equipment is available and may be of value. However, validation in this area is difficult, and the advice of manufacturers/suppliers should be sought.
• Considerations for cleaning handpieces
• Check DHP compatibility with AWD’s
• In the absence of an AWD - use of a dedicated handpiece-cleaning machine may be considered.
• AWD’s may remove DHP lubricant – therefore need for relubrication
Some AWD’s have a handpiece irrigation system require that a special filter be fitted to protect the internal mechanism of the handpiece from extraneous debris during the operating cycle.

There are machines that both clean and sterilize dental handpieces. At present it is not possible to validate the cleaning cycle of these devices using accepted criteria. However, due to the use of a vacuum sterilization cycle (Type S) there is an advantage of this process over using a Type N sterilizer.
• Handpiece Sterilization

• Where this is established, sterilization using a type B or type S sterilizer is likely to be useful, although it should be accepted that it is unlikely that sterility will be achieved – whatever sterilizer is used – due to the presence of lubricating materials.
• Handpiece Sterilization

Pre-wrap instruments only where this is recommended by the manufacturer and where the sterilizer is vacuum-assisted. The sterilizer should be validated for the intended load and is likely to be of type B or S. The use of a type N sterilizer is not appropriate for wrapped instruments.
• Handpiece Sterilization

Pre-wrap instruments only where this is recommended by the manufacturer and where the sterilizer is vacuum-assisted. The sterilizer should be validated for the intended load and is likely to be of type B or S. The use of a type N sterilizer is not appropriate for wrapped instruments.
Recommendations for the requirements to reprocess medical devices, published in 2012 by the Robert Koch-Institut (RKI) in cooperation with the Bundesinstitut für Arzneimittel und Medizinprodukte (BfArM), dental handpieces were described as “semicritical/critical A” (assessment, treatment) or “semicritical/critical B” (invasive treatment, operation, endoscopy).

• RKI says that >100 micrograms of protein is a concerning. So, Up to 100 micrograms there's no need to worry.
BDA & ADA advice

- To be added

BDA

ADA
Survey of the decontamination and maintenance of dental handpieces in general dental practice

G. W. G. Smith,¹ A. J. Smith,² S. Creanor,³ D. Hurrell,⁴ J. Bagg⁵ and D. F. Lappin⁶

Key findings
Defining Clean


cleaning = removal of contamination from an item to the extent necessary for its further processing and its intended subsequent use.

Cleaning efficacy test – 1

See ISO/TS 15885-5
• **Defining Clean**

• Cleaning efficacy test – 1 ISO/TS 15885-5

• Annex N (UK) Fully load the WD with the inoculated load items in accordance with the manufacturer’s instructions. Run an operating cycle. On completion of the cycle, remove the load items from the WD and subject them to careful visual examination or residual soil.

• Acceptance criteria: For the cleaning process to be regarded as satisfactory, there shall be no visible residual soil present on the load.
• **Defining Clean (ISO 15883-1)**
• Cleaning efficacy test – 2
• The WD shall be tested using actual loads contaminated by normal use.
• Visually assess the cleanliness of the processed items
• When the items are visually clean, one of the methods given in Annex C shall be used to detect the presence of residual proteinaceous contamination.
• Defining Clean (ISO 15883-1)
• Cleaning efficacy test Annex C
• Ninhydrin method
• Biuret method

An apple green colour indicates a protein free sample.

• OPA method
• When tested in accordance with C.2.3, the extinction value shall be < 0.020.
• **Defining Clean (ISO 15883-5)**
• Annex S (USA)
• for testing the efficacy of a cleaning process for reusable medical instruments artificially contaminated with mixtures of microorganisms and simulated organic soil.
• This method quantifies the removal of the spores, not the reduction of organic soil, as a means of determining the efficacy of a cleaning process.
• **Defining Clean (ISO 15883-5)**
• **Annex S (USA)**

  However, because published experimental results are scarce and the exact reduction would depend upon the precise experimental conditions, the test method does not specify rigid acceptance criteria.
Dental handpiece contamination: a proteomics and surface analysis approach

Andrew Smith\textsuperscript{a*}, Gordon Smith\textsuperscript{a}, David F. Lappin\textsuperscript{a}, Helen C. Baxter\textsuperscript{b}, Anita Jones\textsuperscript{b} and Robert L. Baxter\textsuperscript{b}

\textsuperscript{a}Institute of Infection and Immunity, College of Medical, Veterinary \& Life Sciences, Glasgow Dental Hospital \& School, University of Glasgow, Glasgow, UK; \textsuperscript{b}School of Chemistry, The University of Edinburgh, Edinburgh, UK
Handpiece cleaning at GDH

Protein concentration (µg/instrument)

Used Turbine (n=30)
Decon Turbine (n=20)
Used Spray Channel (n=30)
Decon Spray Channel (n=20)
Used Surgical Gear (n=25)
Decon Surgical Gear (n=10)

Part Sampled
Lumens contaminated with human blood and enterococci
“The sole use of the device for the reprocessing of strongly contaminated contra-angles cannot be recommended.”
Automated Thermal Reprocessing of Dental Turbines and Hand- and Angelpieces

Contaminated with enterococcus and BSA
Microbial reduction of 9 log achieved = disinfection
The cleaning process reduced protein contamination
to less than 100ug per instrument
Thoughts on handpiece cleaners

- Stand alone handpiece lubrication devices help maintain function of handpieces & in some cases contributes to cleaning.
- More published data required
- Handpiece adaptors in AWD’s needs published data
• What’s new in cleaning assessment technologies
G-Box - inside chamber

Cooled CCD Camera

Optimum Emission filters

Lamps – White light
Mercury 338nm

Platform
with sheet of black paper
Typical BSA protein standard calibrant

RFU

$y = 4E+07x + 209210$

$R^2 = 0.9912$
But what does sterile (instrument) mean???
• **Sterile** = "free from micro-organisms"

• An absolute concept

• Instruments are either sterile or they are not!

• Irrespective of the amount of bacteria at the operating site

• How is freedom achieved?
• **Product control**

• Test to see if your instrument is sterile

• **Difficulties:**
  • Cultural
  • Technical
  • Statistical
Process control

• Note the parameters of a lethal agent that are required to kill bacteria – time, temperature, pressure etc
The proportion of the microbial population killed per unit time (1 minute) is constant
<table>
<thead>
<tr>
<th>Minute</th>
<th>Orgs at start of new min</th>
<th>N killed</th>
<th>N left</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000,000 ( (10^6) )</td>
<td>900,000 ( (90%) )</td>
<td>100,000 ( (10^5) )</td>
</tr>
<tr>
<td>2</td>
<td>100,000 ( (10^5) )</td>
<td>90,000 ( (90%) )</td>
<td>10,000 ( (10^4) )</td>
</tr>
<tr>
<td>3</td>
<td>100,000 ( (10^4) )</td>
<td>9,000 ( (90%) )</td>
<td>1,000 ( (10^3) )</td>
</tr>
<tr>
<td>4</td>
<td>1,000 ( (10^3) )</td>
<td>900 ( (90%) )</td>
<td>100 ( (10^2) )</td>
</tr>
<tr>
<td>5</td>
<td>100 ( (10^2) )</td>
<td>90 ( (90%) )</td>
<td>100 ( (10^1) )</td>
</tr>
<tr>
<td>6</td>
<td>10 ( (10^1) )</td>
<td>9 ( (90%) )</td>
<td>1 ( (10^0) )</td>
</tr>
</tbody>
</table>
• The time taken to kill 90% or 1 log is the D-value
Number of bacteria

D-value at 121°C

10 fold reduction

D=1 min
<table>
<thead>
<tr>
<th>Minute</th>
<th>Orgs at start of new min</th>
<th>N killed</th>
<th>N left</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000,000 (10^6)</td>
<td>900,000 (90%)</td>
<td>100,000 (10^5)</td>
</tr>
<tr>
<td>2</td>
<td>100,000 (10^5)</td>
<td>90,000 (90%)</td>
<td>10,000 (10^4)</td>
</tr>
<tr>
<td>3</td>
<td>100,000 (10^4)</td>
<td>9,000 (90%)</td>
<td>1,000 (10^3)</td>
</tr>
<tr>
<td>4</td>
<td>1,000 (10^3)</td>
<td>900 (90%)</td>
<td>100 (10^2)</td>
</tr>
<tr>
<td>5</td>
<td>100 (10^2)</td>
<td>90 (90%)</td>
<td>100 (10^1)</td>
</tr>
<tr>
<td>6</td>
<td>10 (10^1)</td>
<td>9 (90%)</td>
<td>1 (10^0)</td>
</tr>
</tbody>
</table>
Hypothetical D values of different microbes at 134°C
(spores and prions take longer to kill)
D-values @ 121° C for some microbes exposed to saturated steam

<table>
<thead>
<tr>
<th>Microbe</th>
<th>D value @ 121°C</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. botulinum</em></td>
<td>12.24 seconds</td>
</tr>
<tr>
<td><em>Clostridium sporogenes</em></td>
<td>48-84</td>
</tr>
<tr>
<td>Spores of <em>Geobacillus stearothermophilus</em></td>
<td>120</td>
</tr>
<tr>
<td><em>Bacillus cereus</em></td>
<td>0.42</td>
</tr>
</tbody>
</table>
Is this sterile?

Number of bacteria vs. Time (mins)

The graph shows the decline in the number of bacteria over time. The y-axis represents the number of bacteria on a logarithmic scale, while the x-axis represents time in minutes. The data points indicate a consistent decrease in bacterial count, suggesting that the sample may be becoming sterile.
A graph showing the number of bacteria over time. The x-axis represents time in minutes (0 to 12), and the y-axis represents the number of bacteria, ranging from 0.000001 to 1,000,000. The graph demonstrates a logarithmic decrease in bacterial count with time, approaching 0.000001 at 12 minutes, indicating the sample is sterile.
<table>
<thead>
<tr>
<th>Minute</th>
<th>Orgs at start of new min</th>
<th>N killed</th>
<th>N left</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1 (10^0)</td>
<td>0.9 (90%)</td>
<td>0.1 (10^-1)</td>
</tr>
<tr>
<td>8</td>
<td>0.1(10^-1)</td>
<td>0.09 (90%)</td>
<td>0.01 (10^-2)</td>
</tr>
<tr>
<td>9</td>
<td>0.01(10^-2)</td>
<td>0.009 (90%)</td>
<td>0.001 (10^-3)</td>
</tr>
<tr>
<td>10</td>
<td>0.001 (10^-3)</td>
<td>0.0009 (90%)</td>
<td>0.0001 (10^-4)</td>
</tr>
<tr>
<td>11</td>
<td>0.0001(10^-4)</td>
<td>0.00009 (90%)</td>
<td>0.00001 (10^-5)</td>
</tr>
<tr>
<td>12</td>
<td>0.00001 (10^-5)</td>
<td>0.000009 (90%)</td>
<td>0.000001 (10^-6)</td>
</tr>
</tbody>
</table>
• An instrument is sterile if the probability that there are viable microbes on the instrument is equal to or less than 1 in a million \(10^{-6}\) by a validated process.
But what about handpieces & trapped air?
Poached egg vs Oeuf en cocotte

For sterilization the same lethal effect

Steam = 3 mins

Dry Heat = 6,000 mins
INTRAVENOUS INFUSION OF CONTAMINATED DEXTROSE SOLUTION
The Devonport Incident

P. D. MEERS M. W. CALDER
Public Health Laboratory, Greenbank Hospital, Plymouth, Devon

M. M. MAZHAR G. M. LAWRIE *
Plymouth General Hospital, Plymouth, Devon

Sterilisation of Batch D1192/C
Air and steam do not mix

Steam enters from both sides
Air gets trapped inside
Although air may reach 134°C –
Behaves as hot air & takes longer to sterilize
Steam sterilization

Dry saturated steam
In direct contact with the load
134°C for 3 mins @ 2.25 bar gauge
Effect of steam sterilization inside the turbine chambers of dental turbines

Hans-Kristian Andersen, MD,\textsuperscript{a} Nils-Erik Fiehn,\textsuperscript{b} and Tove Larsen,\textsuperscript{b} Copenhagen, Denmark
DANISH MEDICINES AGENCY AND UNIVERSITY OF COPENHAGEN

Table I. Effect of non-vacuum and vacuum autoclaves on endospores of \textit{B stearothermophilus} inside turbine chambers of HTs

<table>
<thead>
<tr>
<th>Autoclave</th>
<th>(n^*)</th>
<th>Growth$^\dagger$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karoclave (NV)</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Sterimaster (NV)</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Validator (NV)</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Odontoclave (NV)</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Selectomat (V)</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

\textit{NV}, Non-vacuum autoclave; \textit{V}, vacuum autoclave.

$^*$Total number of observations.

$^\dagger$Number of observations with growth.
Impact of an Oil-Based Lubricant on the Effectiveness of the Sterilization Processes

William A. Rutala, PhD, MPH;
Maria F. Gergen, MT(ASCP);
David J. Weber, MD, MPH

## Table 1. Impact of Hydraulic Fluid on the Effectiveness of Steam Sterilization and Ethylene Oxide Sterilization

<table>
<thead>
<tr>
<th>Organism, method of sterilization</th>
<th>Mean inoculum, cfu per instrument</th>
<th>No. of tests</th>
<th>Proportion of cultures with positive result&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Geobacillus stearothermophilus</em> spores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam (sterilization pouch)</td>
<td>$1.51 \times 10^5$</td>
<td>7</td>
<td>0/31</td>
</tr>
<tr>
<td>Steam (wrapped open tray)</td>
<td>$2.91 \times 10^5$</td>
<td>2</td>
<td>0/10</td>
</tr>
<tr>
<td>MRSA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam</td>
<td>$2.24 \times 10^6$</td>
<td>4</td>
<td>0/8</td>
</tr>
<tr>
<td>Ethylene oxide</td>
<td>$2.25 \times 10^6$</td>
<td>3</td>
<td>0/6</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam</td>
<td>$3.50 \times 10^6$</td>
<td>3</td>
<td>0/6</td>
</tr>
<tr>
<td><em>Bacillus atrophaeus</em> spores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene oxide (sterilization pouch)</td>
<td>$2.34 \times 10^5$</td>
<td>1</td>
<td>0/10</td>
</tr>
<tr>
<td>Ethylene oxide (wrapped open tray)</td>
<td>$2.34 \times 10^5$</td>
<td>1</td>
<td>0/5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>21</td>
<td>0/76</td>
</tr>
</tbody>
</table>

<sup>a</sup> Proportion of cultures with positive result = No. of positive cultures / no. of inoculated instruments tested.

**Note.** Items inoculated before sterilization included stainless steel knife handles (steam sterilization) and plastic syringe barrels (ethylene oxide sterilization). MRSA, methicillin-resistant *Staphylococcus aureus.*
• Data logger investigations
  - Temperature sensors
    (Teflon, d=2 mm, approx. L=30 cm, accuracy ± 0.05° C)
    - Air channel d=2.3 mm, L=80 mm
  - Pressure sensors (accuracy 0.25%)
Thermometrics

Drive air channel
D=2.3 mm,
L=80 mm,
V=332 ml
Methods V
Results (to date) summary

<table>
<thead>
<tr>
<th>3 sets of 3 different handpieces per cycle</th>
<th>Manuf A Model 1 (N=1)</th>
<th>Manuf A Model 2 (N=1)</th>
<th>Manuf B model 1 (N=1)</th>
<th>Manuf C Model 1 (N=1)</th>
<th>Manuf D Model 1 (N=1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cycle time</td>
<td>18 – 25 min</td>
<td>17 min</td>
<td>16 – 19 min</td>
<td>35 – 55 min</td>
<td>17 min</td>
</tr>
<tr>
<td>Holding time at 134°C</td>
<td>3.5 – 5 min</td>
<td>3 – 3.5 min</td>
<td>3.5 – 4 min</td>
<td>3.5 min</td>
<td>4 min</td>
</tr>
<tr>
<td>Temp lag of handpiece to chamber at 134°C</td>
<td>28 – 141 sec (small load)</td>
<td>68 – 139 sec (small load)</td>
<td>38 – N/A sec (small load)</td>
<td>0 – 1 sec (small load)</td>
<td>50 – 142 sec (small load)</td>
</tr>
<tr>
<td>BI fail</td>
<td>7/54</td>
<td>11/54</td>
<td>10/54</td>
<td>1/54</td>
<td>1/54</td>
</tr>
<tr>
<td>Cl fail</td>
<td>6/54</td>
<td>7/54</td>
<td>9/54</td>
<td>0/54</td>
<td>0/54</td>
</tr>
</tbody>
</table>
• Consequences of DHP decontamination failure
Hepatitis B virus transmissions associated with a portable dental clinic, West Virginia, 2009
Rachel A. Radcliffe, Danae Bixler, Anne

Patients to sue HIV-risk dentist: More than 100 patients of 'dirty' millionaire surgeon could receive payouts of up to £20,000

- Desmond D'Mello has been suspended amid claims he flouted safety rules
An implant periapical lesion leading to acute osteomyelitis with isolation of *Staphylococcus aureus*

S. Rokadiya¹ and N. J. Malden²

Fig. 2. Twenty-eight days post placement, radiolucency indicating osteolysis apicodistally to the implant which was still showing good mechanical retention
Summary

• DHP’s increasingly used for more invasive interventions
• DHP’s frequently become contaminated with patient derived material
• DHP’s difficult to clean
• DHP’s difficult for steam to gain access
• DHP’s are a weak link in the infection prevention chain in the dental office