# Efficacy of Various Decontamination Methods and Sterilization on Contaminated and Inoculated Diamond-Coated Burs

***Nicole Wirth, Capt, USAF, DC***

***SURF Presentation***

# Co-Investigators

- Lori Henrichs, MS, MT
  - Medical Technologist, Microbiologist
  - 59th Medical Wing - Clinical Research Division
  - Joint Base San Antonio - Lackland TX
- Daniel Savett, DDS
  - Col, USAF, DC
  - Director, USAF Dental Research and Consultation Service (DRCS)
  - Institute of Surgical Research
  - JBSA, Fort Sam Houston, TX
  - Assistant Professor Uniformed Services University of the Health Sciences Postgraduate Dental College
- Wen Lien, DDS, MS
  - Col, USAF, DC
  - Director, Dental Materials Evaluation and Testing
  - USAF Dental Research and Consultation Service (DRCS)
  - Institute of Surgical Research
  - JBSA, Fort Sam Houston, TX
  - Associate Professor Uniformed Services University of the Health Sciences Postgraduate Dental College
- Michael Crabtree, DDS, MS
  - Col, USAF, DC
  - Director, Endodontics
  - Advanced Education in General Dentistry Residency
  - Air Force Postgraduate Dental School
  - Joint Base San Antonio - Lackland, TX
  - Associate Professor Uniformed Services University of the Health Sciences Postgraduate Dental College
- Kraig S. Vandewalle, DDS, MS
  - Col (ret), USAF, DC
  - Director of Dental Research
  - Advanced Education in General Dentistry Residency
  - Air Force Postgraduate Dental School
  - Joint Base San Antonio - Lackland, TX
  - Professor Uniformed Services University of the Health Sciences Postgraduate Dental College

Disclaimer: The views expressed are those of the authors and do not reflect the official views or policy of the Uniformed Services University, Department of Defense, or its Components. The authors do not have any financial interest in the companies whose materials are discussed in this manuscript.

# Outline

- Background
- Objective
- Materials and Methods
- Results
- Discussion
- Conclusions

# Background

- Dental burs are one of the most commonly used dental instruments within a dental clinic.
  - Carbide burs
  - Diamond burs

# Background

- A conventional “diamond bur”
  - A metal rod that is coated by galvanic deposition with diamond powder
  - The shape of the diamond granules = complex surface structure
    - Increased retention
      - Dental debris
      - Microorganisms
      - Other materials
    - More difficult to sterilize

# Background

- October 2002
  - Medical Device User Fee and Modernization Act of 2002 (MDUFMA)
  - Removed the previously premarket exemption for diamond-coated burs
  - Requires manufacturers to include validation data which includes cleaning and sterilization data
  - No manufacturers have submitted the required validation data

# Background

- Aasim et al. (2006)
  - Optimum time for ultrasonic cleaning = 5 to 10 minutes for endodontic files
- Perakaki et al. (2017)
  - Ultrasonic cleaner for 10 minutes > washer disinfector for endodontic files

# Background

- Kumar et al. (2015)
  - Autoclaving and glutaraldehyde resulted in complete sterilization of carbide burs
- Al-Jandan et al. (2016)
  - A high-pressure autoclaving session followed by a low-pressure steam autoclave session resulted in no bacterial growth on carbide dental burs
- Mathiranan et al. (2017)
  - Autoclave and hot air ovens = best method of carbide bur sterilization

# Background

- Limited research has been published on diamond burs:
  - Sajjanshetty et al. (2014)
    - No sterilization methods tested were absolutely efficacious
    - Only examined single methods of sterilization
  - Gul et al. (2018)
    - No pre-cleaning methods were effective

# Background

- Clean-A-Diamond (Premier) cleaning stone
  - Hand held autoclavable aluminum oxide cleaning stone
  - No research has been published

# Objective

- The objective of this study was to evaluate the effectiveness of various decontamination methods and subsequent sterilization on contaminated and inoculated diamond-coated burs.

# Null hypothesis

- There would be no difference between various decontamination methods and sterilization methods on: (1) microorganism elimination (2) debridement of a contaminated and inoculated course diamond burs.

# Materials and Methods

- 7 groups of 20 diamond burs (5847.31.016 FG Super Coarse Flat-End Cylinder Diamond, Brasseler)
- Sterilized extracted human molars
- Four microorganisms:
  - Enterococcus faecalis
  - Staphylococcus aureus
  - Pseudomonas aeruginosa
  - Geobacillus stearothermophilus

# Materials and Methods

- Bur contamination
  - Abrading extracted teeth for 30 seconds with a high-speed handpiece

# Materials and Methods

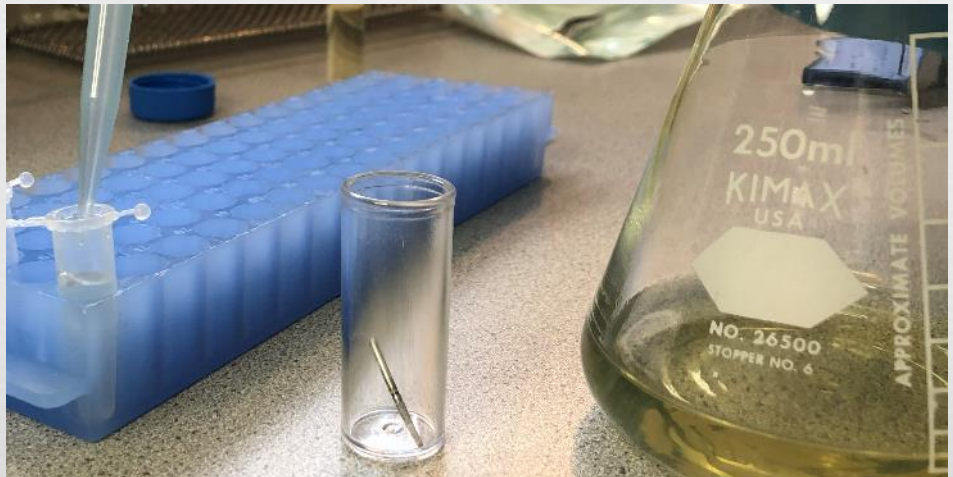
- Four microorganisms
  - Enterococcus faecalis (Gram + facultative anaerobe)
    - Commonly used bacteria in endodontic studies
  - Staphylococcus aureus (Gram + facultative anaerobe)
    - Common bacteria found in the oral cavity, EPA indicated to test disinfectants
  - Pseudomonas aeruginosa (Gram – aerobe)
    - EPA indicated to test disinfectants
  - Geobacillus stearothermophilus (Gram + facultative anaerobe spore)
    - Used as the biological indicator for autoclave sterilization testing

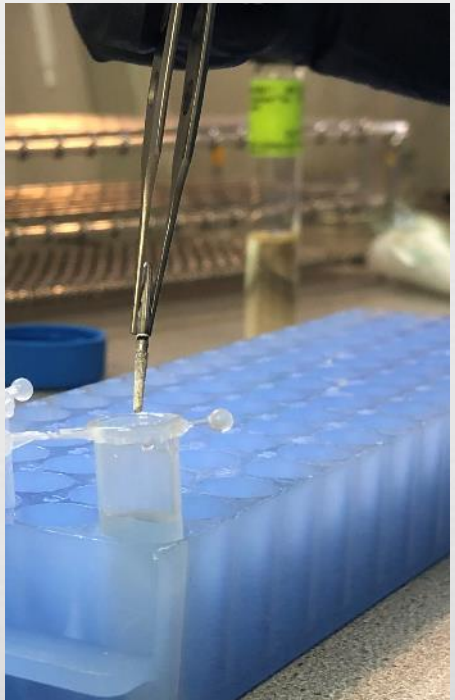
# Materials and Methods

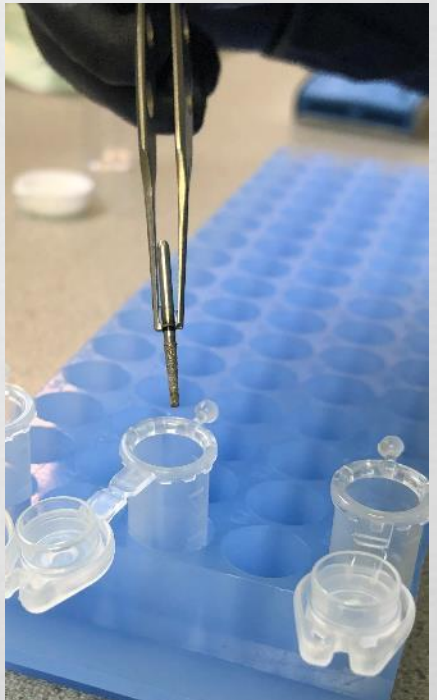
- Suspensions of the microorganisms were prepared by cultivating the organisms in Trypticase Soy Broth
- All incubated  at 35 +/- 2°C ambient air for 24 hours, except G. stearothermophilus which was incubated at 50 +/- 2°C ambient air for 24 hours

# Materials and Methods

- Inoculated by immersing them in 1 mL for 10 minutes in the inoculum suspensions
  - Represents the approximate amount of time the burs are in a patient's mouth
- Placed in a sterile container for 24 hours



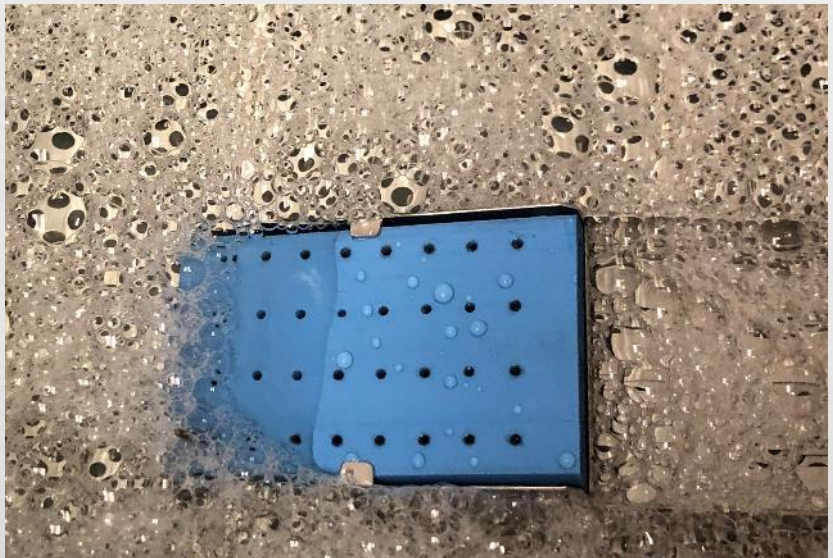
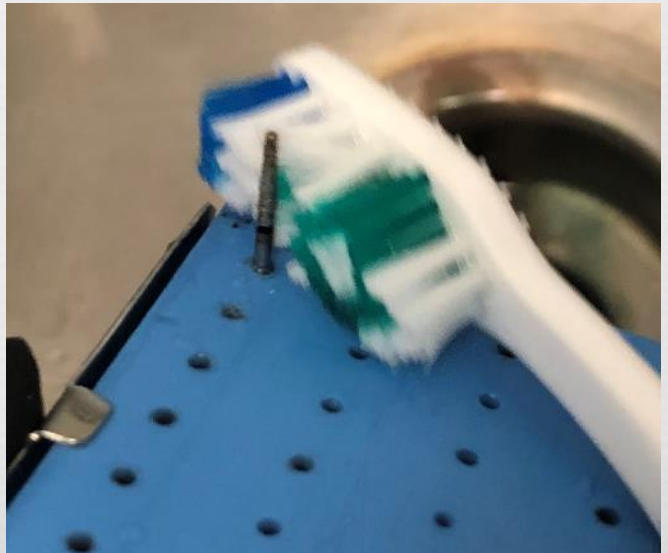


| Group | Contamination | Decontamination Method | Sterilization Method |
|---|---|---|---|
| 1 Positive Control | Tooth debris & bacteria | None | None |
| 2 Negative Control | Tooth debris only | Burs were divided into 4 groups of five burs, each undergoing one of the decontamination and sterilization methods noted in Groups 4-7 | Steam – one cycle of steam sterilization[#] |
| 3 Directly from the package | None | None | None |
| 4 Manual Cleaning (Brasseler IFU) | Tooth debris & bacteria | One minute rinse under cool running water<br>10-Minute immersion in a neutral-pH cleaning solution*<br>One minute brush in solution<br>One minute rinse under warm water until visibly clean | Steam – one cycle of steam sterilization[#] |
| 5 Clean-A-Diamond stone & manual cleaning (Brasseler IFU) | Tooth debris & bacteria | 2 seconds of debridement with the Clean-A-Diamond stone[+]<br>One minute rinse under cool running water<br>10-Minute immersion in a neutral-pH cleaning solution*<br>One minute brush in solution<br>One minute rinse under warm water until visibly clean | Steam – one cycle of steam sterilization[#] |
| 6 Ultrasonic Cleaning (Brasseler IFU) | Tooth debris & bacteria | 15-minute sonication in an ultrasonic unit[^] | Steam – one cycle of steam sterilization[#] |
| 7 Clean-A-Diamond stone/ Ultrasonic cleaning (Brasseler IFU) | Tooth debris & bacteria | 2 seconds of debridement with the Clean-A-Diamond stone[+]<br>15-minute sonication in an ultrasonic unit[^] | Steam – one cycle of steam sterilization[#] |

*Dawn Ultra, Proctor & Gamble, Cincinnati, OH; [^]1000 Pro-Sonic, Sultan Healthcare, York, PA; [#]Amsco 400; [+]Mini Square, Premier, Plymouth Meeting, PA

# Materials and Methods

- Group 4
  - One minute rinse under cool running water
  - 10-Minute immersion in a neutral-pH cleaning solution
  - One minute brush in solution
  - One minute rinse under warm water until visibly clean


# Materials and Methods

- Group 5
  - 2 seconds of debridement with the Clean-A-Diamond stone+
  - One minute rinse under cool running water
  - 10-Minute immersion in a neutral-pH cleaning solution*
  - One minute brush in solution
  - One minute rinse under warm water until visibly clean

# Materials and Methods

- Group 6
  - 15-minute sonication in an ultrasonic unit

# Materials and Methods

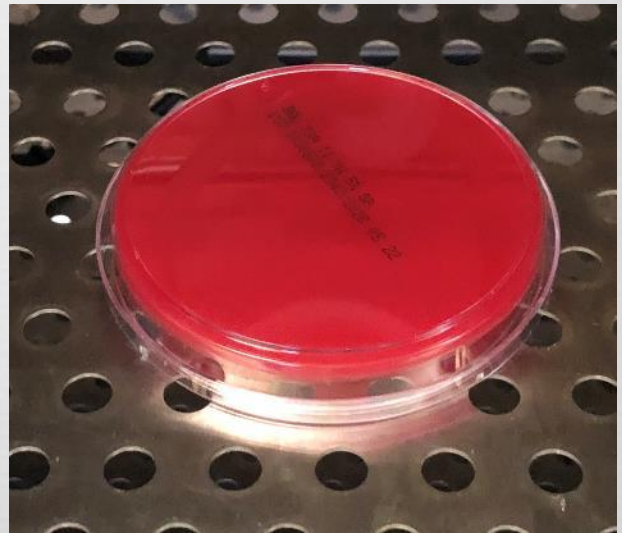
- Group 7
  - 2 seconds of debridement with the Clean-A-Diamond stone+
  - 15-minute sonication in an ultrasonic unit

# Materials and Methods

- The diamond burs were immersed in 1 mL of sterile saline and vortex mixed (Fisher Heavy Duty Vortex Mixer) for 2 minutes

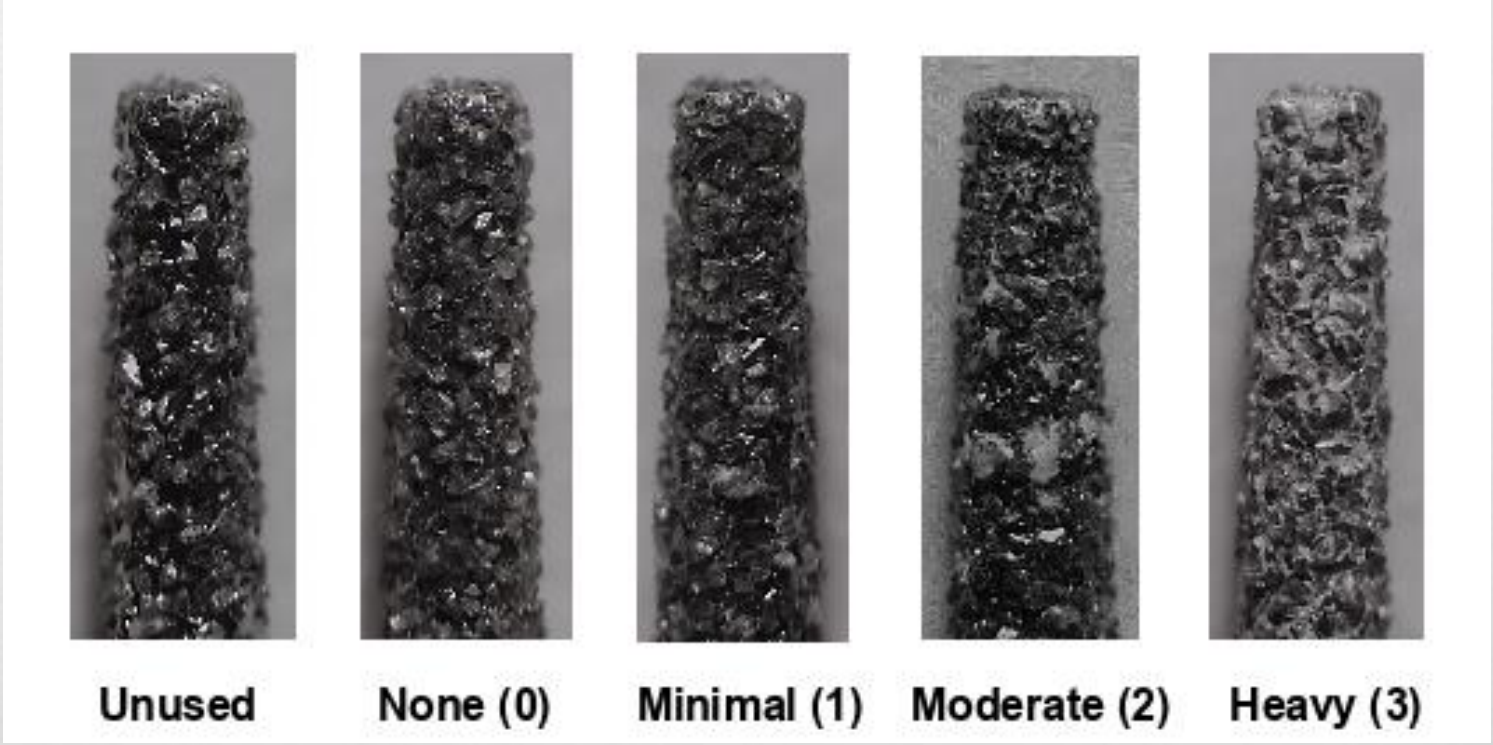

# Materials and Methods

- Saline was serially diluted and plated on TSA II for E. Faecalis, S. aureus, P. aeruginosam and G. stearothermophilus
- All plates were incubated at 35 +/- 2°C ambient air for 24 hours, except for G. stearothermophilus which was incubated at 50 +/- 2°C ambient air for 24 hours



# Materials and Methods

- The bur heads from Groups 4 – 7 were then examined under a light microscope at 10x and rated based on remaining enamel and dentinal debris:
  - None (0)
  - Minimal (1)
  - Moderate (2)
  - Heavy (3)



# Statistical Analysis

- After incubation, the number of colony forming units (CFUs) on the plates were counted and CFU/mL recovered were calculated.
- The mean CFU/mL and standard deviation was determined per group.
- The remaining tooth debris data was analyzed with the Kruskall Wallis test (alpha = 0.05).
  - Mann Whitney U test was used for comparisons between groups.
  - The alpha value was adjusted to 0.008 with a Bonferroni correction

# Results

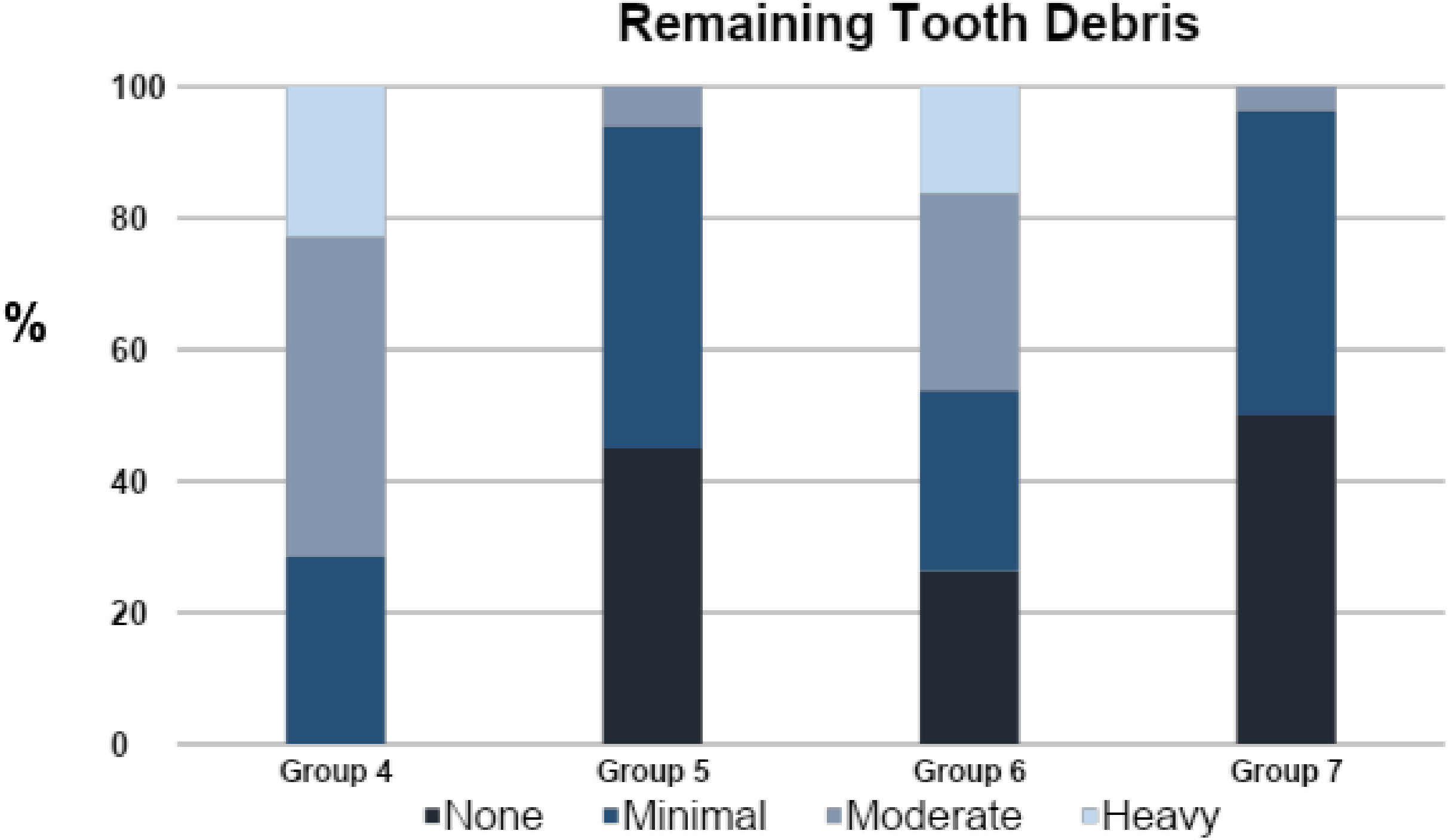
- Positive control (Group 1) resulted in bacterial growth
- No CFU/mL or no growth was found for all treatment and for all bacterial types.

# Results

| Treatment Groups | CFU/mL (range) | | | |
|---|---|---|---|---|
| | Enterococcus faecalis | Staphyloccus aureus | Pseudomonas aeruginosa | Geobacillus stearothermophilus |
| Group 1 | $1.2\text{-}5.3 \times 10^5$ | $1.1\text{-}7.9 \times 10^5$ | $1.2\text{-}6.7 \times 10^6$ | $1.0\text{-}1.6 \times 10^5$ |
| Group 2 | No growth | No growth | No growth | No growth |
| Group 3 | No growth | No growth | No growth | No growth |
| Group 4 | No growth | No growth | No growth | No growth |
| Group 5 | No growth | No growth | No growth | No growth |
| Group 6 | No growth | No growth | No growth | No growth |
| Group 7 | No growth | No growth | No growth | No growth |

# Results

- For the remaining tooth debris, the results of the Kruskall-Wallis test found a significant difference between groups (p=0.0001)
- The Mann-Whitney U test, found significant difference between all the groups except Group 5 and Group 7 (p=0.086)
  - Group 4 = significantly *more* debris than all other groups
  - Group 6 = significantly *less* debris than Group 4, but significantly *more* debris than Groups 5 and 7
  - Group 7 = *lowest level of debris*, but not significantly less than Group 5


Remaining Tooth Debris
100
80
60
40
20
0
%
Group 4
Group 5
Group 6
Group 7
None
Minimal
Moderate
Heavy

# Discussion

1st Null Hypotheses: There would be no difference between various decontamination and sterilization methods in microorganism elimination

Not rejected

# Discussion

2nd Null Hypotheses: There would be no difference between various decontamination and sterilization methods in debridement of a contaminated and inoculated course diamond-coated bur.

Rejected

# Discussion

- Based on our results, conventional multi-use diamond burs can be re-used and sterilized successfully.
- The increased cost and dental waste created through the one-time use of multi-use diamond burs may be unwarranted.

# Discussion

- Recommendation: That practitioners use the protocol (Group 5 or 7)
  - 2-second debridement with Clean-A-Diamond stone
  - 15 min. ultrasonic cleaning
  - 1 cycle of steam sterilization
  - Results in a sterile bur with the least amount of dentinal debris on the reused bur
- Adjuncts to steam sterilization, like the use of an ultrasonic washer and Clean-A-Diamond can result in…
  - Less dentinal debris

# Conclusions

- The contaminated and inoculated diamond-coated burs tested in this study may be successfully sterilized to eliminate the tested bacteria.

# Questions???