IN BRIEF

- Dental unit water supplies become heavily contaminated with micro-organisms.
- The number can exceed the European standards for potable water.
- Super-oxidised water was used in a concentrated form to purge biofilm from dental units.
- Super-oxidised water was then used in a 5% (v/v) concentration as a maintenance dose to prevent recolonisation of the units.
- The combination of a purge and a maintenance dose of super-oxidised water reduced the micro-organisms to zero.

# An investigation of the efficacy of super–oxidised (Optident/Sterilox) water for the disinfection of dental unit water lines

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**Aims** To determine the efficacy of super-oxidised water (Optident/Sterilox) in the decontamination of dental unit water lines.
**Methods** Dental units (10) were first purged with concentrated super-oxidised water. After purging, a 5% (v/v) super-oxidised water was used as a maintenance dose. Samples for microbiology were taken after 0,1,2,3,4,5,6,7 d, and each week for a further 13 weeks.
**Results** After purging, 5% (v/v) super-oxidised water was successful in reducing the microbial counts to zero, although in three of the units some bacteria were intermittently isolated in the first week of treatment.
**Conclusions** Super-oxidised water was successful in the removal of bacteria from dental unit water supplies. Complete removal required the treatment with a purge phase of concentrated disinfectant and a maintenance phase of at least two weeks.

## INTRODUCTION

Dental unit water lines become contaminated both from the inlet water supplies and by back-siphonage through the turbines and three-in-one syringe.[1,2] The micro-organisms which contaminate the water lines are mainly bacteria, which form tenacious biofilms on the walls of the tubing in the unit.[3,4] The biofilms release bacteria into the unit water, which can contaminate patients.[5] The bacteria present in the contaminated water lines can cause opportunistic infections and include *Pseudomonads*, *Legionella* and *Mycobacteria* spp.[6] The bacterial counts can be as high $1.6 \times 10^5$ cfu $ml^{-1}$.[7] These high counts are in excess of the European Union guidelines, which specify that drinking water should be supplied at <100 cfu $ml^{-1}$ at 22°C and <20 cfu $ml^{-1}$ at 37°C.[8]

This investigation describes the use of super-oxidised water for the disinfection of dental unit water supplies. Super-oxidised water is a solution of sodium chloride, which has been electrolysed by passage over titanium electrodes at 9 amp. The product that is produced has a pH of 5.0–6.5, an oxidation potential of >950 mv and is mainly hypochlorous acid at a concentration of approximately 144 mg $L^{-1}$.[9] Super-oxidised water has high cidal activity against a range of bacteria including *Legionella* and *Mycobacteria* spp.[10] It has already been tested in a laboratory model of dental unit water systems and found to be effective.[11]

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## METHOD

### Disinfectant

The unit for the generation of the super-oxidised water (Optident/Sterilox) was supplied by Optident (Ilkley, Yorkshire). The unit consisted of a generator attached to a saline solution reservoir. On demand, the saline solution was passed through the generator producing concentrated super-oxidised water.

### Units and disinfection protocol

Ten Adec Cascade units were used in the trial with independent reservoirs (Adec, Nuneaton, UK). The units had not been used for operative work in the three weeks preceding the trial. The units were used for clinical work after disinfection when the recoverable colony counts fell below 100 cfu $ml^{-1}$. The unit reservoirs were filled with concentrated super-oxidised water and approximately 100 ml was evacuated from each outlet to ensure that the tubing was filled with disinfectant. The concentrated super-oxidised water was left in place for 4 h to purge the system of biofilms. After 4 h the reservoir was disconnected, emptied and refilled with a 5% (v/v) solution of super-oxidised water, approximately 100 ml was then evacuated from each outlet. Fresh 5% (v/v) super-oxidised water was then used each working day (Monday to Friday) during the trial. At the weekends 5% (v/v) diluted super-oxidised water was left in the unit.

### Microbiology

The turbine, slow-speed, three-in-one syringe and cup-filler outlets were sampled after 0,1,2,3,4,5,6,7 days and then weekly for a further 13 weeks. The water samples were collected aseptically in a sterile bottle containing 0.1 g of sodium thiosulphate to neutralise any residual disinfectant. The methods used for microbiological analysis were those used by Walker *et al.*[6,11] Briefly this consisted of first filtering the water through an 0.2 µM filter (Techware, Poole, UK) to recover viable micro-organisms. The filters were then vortexed in 10 ml phosphate buffered saline for

**Table 1 The average CFU form the turbine outlets for the first two weeks of disinfection (the range is shown in parenthesis; 0 = initial sample).**

| No. of days treatment | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 14 |
|---|---|---|---|---|---|---|---|---|---|
| Total CFU recovered (range) | 320,000 (280,000–410,000) | 60 (20–70) | 8 (0–10) | 2* (0–20) | 0 | 0 | 0 | 9** (35–50) | 0 |

*One unit had 20 CFU/ml recovered after 3 days, the other 9 units were sterile
**Two units had 35 and 50 CFU/ml recovered after 7 days, the other 8 were sterile

10 min to recover the waterborne micro-organisms. The recovered counts of micro-organisms were done by making decimal dilutions of the water samples with sterile phosphate buffered saline, plating onto R2A agar and incubating for 7 d at 37°C.[6,11] The number of colony forming units of micro-organisms $ml^{-1}$ (CFU $ml^{-1}$) was calculated from these dilutions. A number of selective media were also used for the detection of oral streptococci, *Actinomyces* spp, oral anaerobes, *Enterobacteria, Pseudomonads*, Candida, Legionella and *Mycobacterium* spp; these were as described by Walker *et al.*[6,11] Identification to species level was done by growth on selective agar and then the methods of Walker *et al.*[6,11]

## RESULTS

Table 1 shows the number of colony forming units recovered from the first two weeks of the trial; after this period no further bacteria were recovered. The CFU from the turbine outlets are shown for convenience, as these were consistently the highest found. Initially, the predominant bacteria were diphtheroids (which were not identified) and Pseudomonads, with no other micro-organisms grown on the selective media. After 7 d no further bacteria were recovered from the units. Clinical work was recommenced on the units 11 days after the start of the trial. One unit had counts of 20 CFU $ml^{-1}$ after 3 d and two had counts of 35 and 50 CFU $ml^{-1}$ after 7 d; these counts contained no significant pathogens.

## DISCUSSION

The methodology used in this study is that described by Walker and colleagues.[6,11,12] Both selective and non-selective culture media were used to ensure that known pathogens and vegetative bacteria would be recovered. The bacterial counts at 37°C were used as a measure of the total micro-organisms present. A 14 week trial was chosen to assess any effects of the disinfectant on the units.

The units were initially heavily colonised with bacteria and presumably biofilm was present which kept the counts high. The high counts obtained from these units were the reason for their withdrawal from clinical use. After treatment with super-oxidised water the number of bacteria fell to zero until the end of the 14-week trial period. Three units did however have counts ranging from 24 – 36 CFU $ml^{-1}$ in the first week of the trial. The reason for this is not known, but one explanation could be the release of bacteria from residual biofilm.

The super-oxidised water reduced the bacterial counts in the effluent water to zero after one week, which compares well to other disinfectant systems used for this purpose.[13] No deleterious effects were found from the use of the disinfectant on the units during the 14-week period. After this trial the units in Liverpool Dental Hospital have had six months of exposure to the super oxidised water, no effects have been found on the tubing, or the units themselves. Clearly, only further long-term use of super oxidised water will establish its effect on dental units. It is unlikely that super oxidised water will have any harmful effects on operators by inhalation or prolonged contact. Extensive studies by Sterilox (Sterilox Technologies International Ltd, Abingdon, UK) using standard international tests of exposure and toxicology have failed to show any harmful effects (Sterilox, data on file). This disinfectant is now used to treat endoscopes in a large number of primary care trusts in the UK and hospitals in the USA. Super oxidised water has also been shown to be an effective cleaning agent in root canal therapy.[14]

This form of disinfectant and other systems can reduce the bacterial counts to well within the parameters for potable water by the European Union.[8] At least two effective disinfection systems are now available for the disinfection of dental unit water systems,[13] the continued use of untreated dental unit water containing bacterial counts greater than that recommended by the EU[8] is difficult to justify on professional, moral or ethical grounds.

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