Ozonated Liquids in Dental Practice – A Review.
Author: Dr Julian Holmes, Lime Technologies Holdings Ltd, Clinical Director.

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Ozonated Liquids in Dental Practice – A Review

Part 6: Oral Hygiene & Infection Control.

Abstract: In Part 6 of Ozonated Liquids in Dental Practice, the uses of ozone are examined in the role of oral hygiene, both in the dental practice environment, and the use of ozonated water in the at-home setting. This is expanded to look at the role of ozone's uses in infection control at the end of this section.

Introduction.

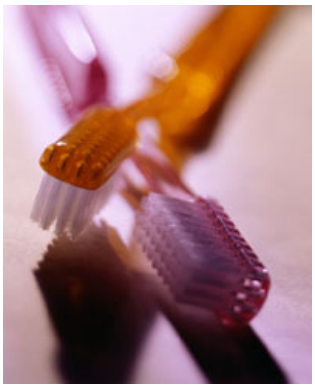

Fig 06.02

The use of ozonated fluids in dental and medical care is well referenced in the published research and literature. Most of this research comes from Russia and Cuba, where extensive research has been carried out over the last 50 years into the use of ozonated fluids for infection control and wound management.

Dental researchers have started to examine the effects of ozonated fluids in periodontal disease. Huth *et al* in two papers in 2006 and 2007 (*Huth et al 2006, Huth et al 2007*) examined the effect of ozone on periodontal tissues. The 2007 paper compared traditional periodontal anti-microbial products with the use of ozonated water. Both papers concluded that ozonated water has an excellent anti-microbial effect.

Huth *et al* (*Huth et al 2007*) in their later paper examined the effect of ozone on the influence on the host immune response. These researchers chose the NF-kappaB system, a paradigm for inflammation-associated signaling/transcription. Their results showed that that NF-kappaB activity in oral cells in periodontal ligament tissue from root surfaces of periodontally damaged teeth, was inhibited following incubation with ozonized medium. The Huth 2007 study establishes a condition under which aqueous ozone exerts inhibitory effects on the NF-kappaB system, suggesting that it has an anti-inflammatory capacity (*Huth et al 2007*). The use of ozonated water in dental ultrasonic systems, such as scalers, sonic preparation systems (KaVo

Sonic-Sys, KaVo GmbH, Germany) and air abraision systems would seem to be supported by Huth *et al* 2006 and Huth *et al* 2007.

There are many benefits to control oral hygiene and as a source of sterile water. However, patients should also be informed that there is an interaction of aqueous ozone with anti-microbials. This research has been published, illustrating the importance of potential interactions of dissolved ozone and prescribed anti-microbials. Patients who are taking a course of antibiotics may need to be informed that the use of ozonated water inactivates antibacterial agents (*Dodd et al 2006*) and in particular amoxicillin (*Andreozzi et al 2005*), progesterone (*Barron et al 2006*) and tetracycline (*Dalmázio et al 2007*). For concern to dentists is that ozone may inactivate the anti-microbial effects of triclosan (*Suarez et al 2007*).

A current topic of debate in dental material science and long term potential effects, are endocrine disruptors found in resin-based dental restorative materials. Deborde *et al* (*Deborde et al 2005*) showed endocrine disruptors were destroyed by ozonated water. This paper potentially points towards a pathway to remove these chemicals from the body system after placement of 'modern' tooth-coloured or 'white' fillings.

There is no doubt that oral hygiene forms the fundamental basis for the prevention of dental caries. Research suggests that the process of decay – decay in this context meaning the establishment of an acid-based niche environment where demineralisation exceeds remineralisation – starts in the microbiological coating over the surface of the tooth, called plaque. Plaque consists of food debris, bacteria normally present in the oral cavity and various proteins. Plaque needs to be disrupted and removed on a regular basis to prevent infection and damage.

There is evidence that dental disease is not only transmitted between patients from dental unit cross infection, but within the family environment too – from mother to child. Horizontal transmission also occurs in play-school years and between siblings. Children exchange sweets and explore each other. In the process, transmission of dental infections will take place.

At it's simplest, brushing is the main way to remove plaque: from the simple hand-brush (**Fig 06.01**), to electronic versions like the Sonic-Care (Phillips, Holland).

And then there are a host of mouth rinses (**Fig 06.03 & 06.04)** and floss types (**Fig 06.5 & 06.06)** that purport to aid the removal of the plaque layer.

Fig 06.03 & 06.04
Oral Hygiene Products – Mouth Rinses

Fig 06.05 & 06.06
Oral Hygiene Products – Flosses & Inter-Dental Brushes

However, the morphology and anatomy of teeth, especially molar teeth, make it difficult for the average patient to achieve good oral hygiene and care.

The photograph of the tooth brush bristles and the molar fissures (**Fig 06.07**), and the electron photograph of the same (**Fig 06.08**) make the point.

The bristles that make up a tooth brush are bigger than the fissures they are meant to clean, and oral hygiene – removal of plaque and impacted debris - in these areas is impossible.

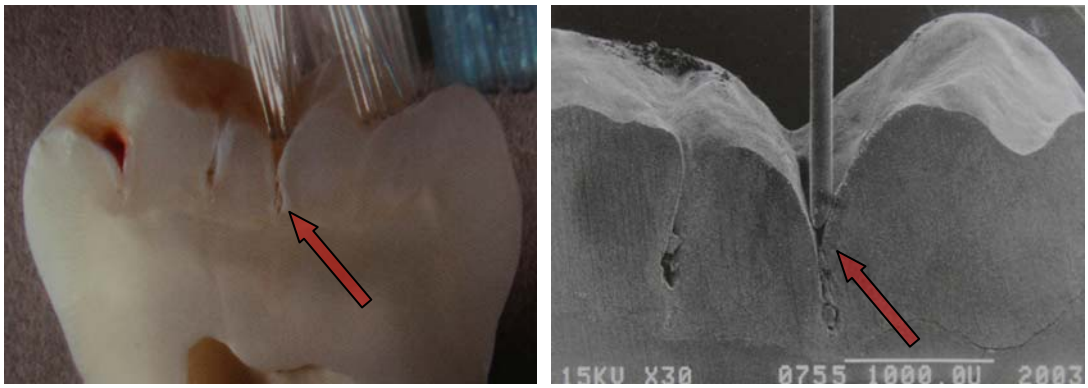

Fig 06.07 & 06.08
Fissure Size & Bristle Tip Size

Fig 06.07 & 06.08 showing the relative sizes of tooth brush bristles and molar fissures.

And it is not just tooth morphology that makes oral hygiene difficult. The position of teeth, crowding, and technical work can all impact into the ability to clean. There are also some people where they do not either want to understand, or cannot understand the importance of hygiene, as shown in **Fig 06.09** and **Fig 06.10**.

Fig 06.09 & 06.10
Poor Oral Hygiene around Teeth and Implant Heads

Ultimately, as a patient's oral hygiene and care becomes uncontrolled, the damage caused leads to infection of both hard and soft tissues.

This leads to periodontal disease and caries, with associated tooth support loss, and eventually the loss of teeth (**Figs 06.11, 06.12 and 06.13**).

Figs 06.11, 06.12 & 06.13
Oral Hygiene Failure

This disease process is usually accompanied by halitosis, and is sometime reflected in the patient's general care of themselves and others.

As materials have evolved, so have our understanding of the past problems with failure become clearer. New protocols and materials can help patients – especially those who are young, the aged and manually disadvantaged – to maintain a healthy oral environment.

Statistics show us that the percentage of elderly people is rapidly increasing in all countries. Many elderly patients have medical conditions that make dental treatment a challenge. Sudden muscle spasms and movements make the traditional drill & fill dental care a challenge in terms of avoiding tissue destruction, and maintaining soft tissue integrity.

And there seems to be an increase in the number of elderly patients with transmissible diseases that are impossible to remove from dental instrumentation with traditional sterilisation methods. In addition, restorative management of primary root caries lesions has therefore become challenging especially for the high percentage of the elderly population in special care units that are experiencing reduced financial support from health services.

Oral hygiene becomes of great importance if the dental profession can gain compliance, and if the patient can be convinced that it is in their own best interests, despite the time and small discomfort it may cause. The use of ozonated water and liquids has been shown to reduce the bio-biological loading in terms of unattached bacteria, micro-organisms in plaque found around and on tooth surfaces, and those found in periodontal pockets.

Where there is traumatic soft tissue injury resulting from accidental damage or traumatic injury, the soft tissue is quickly infected by the resident background microbiological flora. If ozonated water is used as an oral rinse not only will the potential for soft tissue infection be limited, but also the vitality of the tooth pulp could be maintained.

Clinical Case 06.01.

Fig 06.19 shows accidental trauma to the upper anterior teeth of this young boy. The trauma was caused by a simple swing in a play park.

Fig 06.19
Upper Arch Trauma

This sort of injury makes it difficult for the patient to use normal brushing. Treatment in the oral hygiene part of the overall plan is to accelerate the soft tissue healing and then restore the damaged teeth.

Use the Lime Technologies Home Water Sanitiser Unit (LT-HWU3) to make ozonated water to maintain oral hygiene.

Set the LT-HWU3 to the ’10-Minute’ setting to make 1 litre of ozonated water in your practice. Ozonated water can be used to rinse and wash the injured tissue, as well as maintain oral health.

Patients can use the LT-HWU3 unit at home to make ozonated water to brush with, sterilise their tooth brushes and use ozonated water as part of their hygiene cycle.

Clinical Case 06.02.

This young lady was involved in a road traffic accident. After 24hours in hospital for concussion, she attended for emergency dental treatment.

Fig 06.20
Upper Arch Trauma

Fig 06.20 shows fractures into pulpal tissue more than 48 hours old in both upper central teeth.

Fig 04.21 intra-oral x-ray, showing no deep root fractures of the central teeth or alveolar bone tissue.

Fig 06.21
Upper Arch Trauma

Soft tissue injuries had begun to heal. These were treated with ozone and ozonated oils.

Of immediate concern was the infected exposed pulpal tissue of both central teeth. Both centrals were ozone treated for 10 x 60 seconds of ozone. The patient reported that the pain had ceased. No local anaesthetics were used in this procedure.

The published work of Professor V Bocci suggests that ozone controls pain and reduces swelling, eliminates any bacterial infection and assists oral hygiene, and stimulates tissue regeneration and repair, leading to managed healing. Use the LT-Ozonated Oil range. Irrigate the injured soft tissue with the appropriate ozonated oils.

Use the Lime Technologies Home Water Sanitiser Unit (LT-HWU3) to make ozonated water to maintain oral hygiene. Set the LT-HWU3 to the ’10-Minute’ setting to make ozonated water in your practice. Ozonated water can be used to rinse and wash the injured tissue, as well as maintain oral health.

Patients can use the LT-HWU3 unit at home to make ozonated water to brush with, sterilise their tooth brushes and use ozonated water as part of their hygiene cycle.

Clinical Case 06.03.

This young boy was involved in a swing accident. As he stood in front of a swing, the seat returned and struck him in the mid-face.

Fig 06.22 shows extensive external soft tissue damage where the impact of the swing fractured the front teeth, and the impact of the teeth into the labial soft tissue.

Fig 06.22
Upper Arch Trauma

Fig 06.23 shows the intra-oral tissue damage above the upper left central. The labial portion of upper right central was removed from the labial sulcus injury.

Fig 06.23
Upper Arch Trauma

fracture in the upper right central, #11.

Fig 06.24
Upper Arch Trauma

The use of ozone allowed the practitioner to alleviate pain and control anxiety.

The benefits of ozone have shown that an alternative pathway is available than traditional teaching and understanding of the dynamics or tissue healing and regeneration in dental tissues.

Where the dental restorative care is more complex, ozone and ozonated water offer a more predictable solution to on-going care.

Figs 06.25 and **Fig 06.26** show a periodontal case in transitional crown & bridge. The patient is given ozonated water and oil-gels to use as part of the restorative stages, to maintain tissue health, and regenerate bone around the splinted teeth.

Fig 06.25

Fig 06.26

Use the LT-Ozonated Oil range. Irrigate below the pontic areas, and around the bridge abutments with the appropriate ozonated oils.

Use the Lime Technologies Home Water Sanitiser Unit (LT-HWU3) to make ozonated water to maintain oral hygiene. Set the LT-HWU3 to the '10-Minute' setting to make ozonated water in your practice. Ozonated water can be used to rinse and wash the injured tissue, as well as maintain oral health.

Patients can use the LT-HWU3 unit at home to make ozonated water to brush with, sterilise their tooth brushes and use ozonated water as part of their hygiene cycle.

Fig 06.27 shows a periodontally compromised patient. The treatment plan is to place the patient into long-term transitional units to stabilise the case, and improve appearance & function.

Fig 06.27

Fig 06.28

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Fig 06.28 showing transitional units in place for long term stabilisation.

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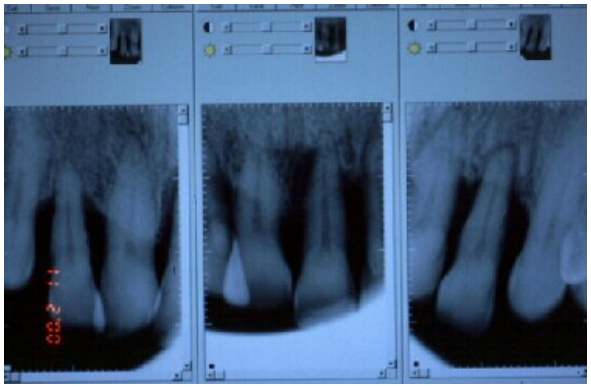

Fig 06.29

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Fig 06.30

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Fig 06.29 & Fig 06.30 shows a periodontally compromised patient was placed into long term transitional units to stabilise the case, and improve appearance & function. **Fig 06.29** shows the PA x-rays of this case pre-treatment. After full-case assessment, diagnostic wax-up, stent manufacture and discussion with the patient, all upper teeth were prepared for crown & bridge placement as shown in **Fig 06.30**. Upper right 3 & 2, upper left 2 were removed for bone grafting and implants. Oral hygiene maintenance is of vital importance, otherwise further bone height and associated soft tissue loss will result.

Use the LT-Ozonated Oil range. Irrigate the surgical areas with the appropriate ozonated oils.

Use the Lime Technologies Home Water Sanitiser Unit (LT-HWU3) to make ozonated water to maintain oral hygiene. Set the LT-HWU3 to the '10-Minute' setting to make ozonated water in your practice. Ozonated water can be used to rinse and wash the injured tissue, as well as maintain oral health.

Patients can use the LT-HWU3 unit at home to make ozonated water to brush with, sterilise their tooth brushes and use ozonated water as part of their hygiene cycle.

Where splinting (**Fig 06.31**) has been carried out, use ozonated oils and water for oral hygiene

Fig 06.31

Infection Control: eg Oral Yeast and Fungal Infections.

Where full upper and/or lower dentures are worn (**Fig 06.32** & **Fig 06.33**) there is a risk in the elderly and immunocompromised that yeast infections, such as Candida, can invade both the supporting soft tissue, and denture acrylic.

There are number of pharmaceutical products that can be obtained as over-the-counter or prescription-only. These anti-fungal agents tend to be messy to apply, have a distinctly unpleasant taste, and compliance issues often result in poor treatment results. Hyphae invade into the denture acrylic and below the tissue mucosa, making it a difficult infection to eliminate.

The use of ozonated fluids has been extensively trialled in Cuba and Russia (*González et al 1989, Lemus et al 1995, Díaz et al 1997, Díaz et al 1998, Arteaga et al 2001, Díaz et al 2001, Sechi et al 2001*)

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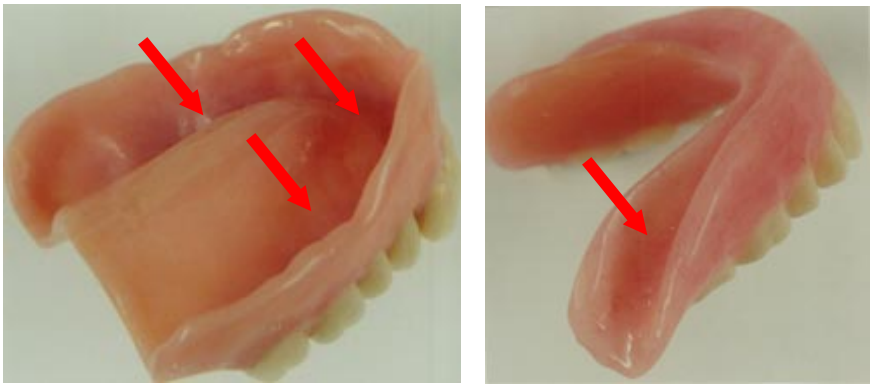

Fig 06.32 & 06.33
Upper & Lower Full Dentures

Micro-encapsulation of anti-fungal pharmaceuticals can help deal with denture sore-mouth, or denture stomatitis.

A simpler way to deal with this type of fungal infection is to use ozonated oils. The oils a simply dripped into the soft tissue bearing areas, illustrated by the red arrows in **Fig 06.32 & Fig 06.33.**

In the clinical example, (**Fig 06.34**) the patient presented with denture stomatitis in the upper arch (it is unusual to see fungal infection of the lower denture bearing area) which is shown by the red arrow.

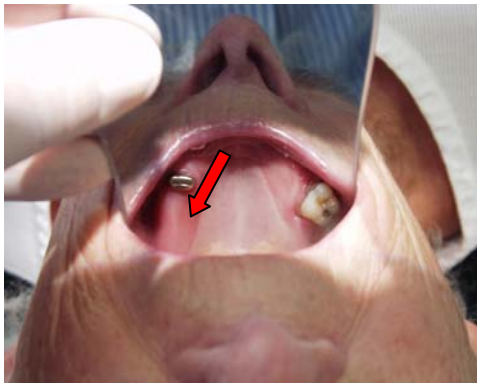

Fig 06.34
Denture Stomatitis

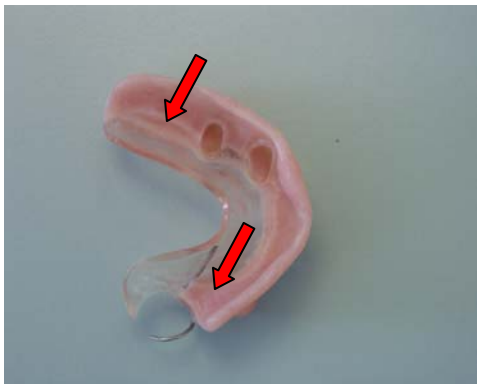

Fig 06.35
Denture Stomatitis

The patient was instructed thoroughly clean the denture, rinse and dry. Once clean, the patient was instructed to use ozonated sunflower oil, and drip this oil into the denture bearing area, as shown by **Fig 06.35**. The denture is inserted into the mouth and seated. This protocol is repeated 2x each day.

Within 24 hours, the redness had begun to resolve and by 48 hours there was no detectable stomatitis present. Swabs were taken at day-5 of treatment to confirm the elimination of the yeast. This echoed the results from Cuba. Notable was the disappearance of stains and discolouration – this is the bleaching effect of ozonated fluids.

Elective Surgery.

Where surgery is planned, there is more of an opportunity to use ozone during the entire treatment plan.

In the following case, surgery to correct snoring left the patient with sore fauces (**Fig 06.36**). These were ozone treated for 2x 60-second cycles on each area. Within 10 minutes after ozone application, the patient reported reduced pain, no discomfort on drinking or swallowing.

Fig 06.36

It is worth while noting that ozone has been used in dental surgery since 1932, when a Swiss dentist, Dr E Fisch used ozone in his dental practice to control and manage infection. What modern research is showing is that this 'old' technology has a very important role to play in medical and dental treatment with the advent of multiple resistant micro-organisms to traditional and routine pharmacology and anti-microbials.

Key Points: The key-points discussed in this section are.

The use of ozone in surgery dates back to 1932 with Dr E Fisch.

The ultimate goal is to create and maintain a healthy smile that the patient can maintain themselves with ease. Oral hygiene is a commitment to compliance for a predictable outcome.

Ozone has a role in oral hygiene – from routine brushing, to controlling oral hygiene after surgery or extensive treatment that may challenge hygiene compliance. The published research shows ozone eliminates bacterial, fungal and viral based infections, as well as eliminating the spread of disease by spores.

As dental care becomes more complex, and as the patient ages, ozone helps to maintain a healthy oral environment. Ozone is the ideal treatment when integrated into routine dental practice and surgery. Ozone increases the predictability of the final result.

Use the LT-Ozonated Oil range. Irrigate around the implant head and under the bar, and soft tissues with the appropriate ozonated oils.

Use the Lime Technologies Water Sanitiser Unit to make ozonated water to maintain oral hygiene. The Patient can use the Lime Technologies Water Sanitiser at home to continue the treatment and oral hygiene control. Set the Water Sanitiser Unit to the '10-Minute' setting to make ozonated water at home and in your practice.

Ozonated Oils and Oil-Gels: General Points & Instructions.

This range of ozonated oils is made to strict manufacturing standards with medical grade oxygen. This oxygen is 99% pure, and is passed into a converter to form ozone. Ozone is then combined with pure vegetable oils and extracts. Each batch of manufactured oils is tested to ensure effectiveness.

Storage. Please refrigerate or keep in a cool, dark place. Do not freeze. Replace the container lid when not in use.

Spillage. Clean up oil spills and dispose of carefully. The oils are non-toxic.

Container Disposal. Dispose of the containers with care and consideration to your environment. Use a recycling centre if possible.

Inflammability. This product is not inflammable under normal conditions and use. Do not expose to heat sources.

Directions for use. These products should not be swallowed in large quantities and are not intended for internal use unless specified below. However, they are not toxic, and if swallowed, there are no special precautions that should be taken. If in doubt, consult your usual doctor.

Treatment Duration. For areas of infection, the treatment time is from 2-3 weeks. For the treatment of skin surface ulcers, the treatment time for small areas is 3-4 weeks, for large ulcers, from 3 to 4 months. Healing time is dependant on the age of the patient, the medical status of the patient, and the size of the lesion being treated. If in any doubt, contact Dr Julian Holmes at julian@limetechnologies.net or your own medical practitioner who you normally consult with. Further information is available from the Internet and World Wide Web on www.limetechnologies.net.

Presentation. Ozonated oils are pure plant extracts, through which pure oxygen and ozone are passed. The plant extracts undergo a chemical reaction to form a thick, viscous oil, or in some cases, a petroleum jelly like product. The final products contain ozonides. These ozonoids have a pharmaceutical activity similar to ozone gas, but at a reduced activity level. These products are bactericidal, fungicidal, and veridical. The oils are chosen for their innate healing properties, and the ozonides enhance this effect.

Ozonated Oils and Oil-Gels: Medical Usage.

Skin Surface Abrasions and Cuts: Clean the affected skin surface with cooled boiled or sterile water. It is important if possible to remove all foreign bodies from the skin surface, such as gravel, small stones, sand, and dirt. Dry and apply a thin layer of the ozonated oil over the affected skin surface. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. There is no need to cover unless protection from further trauma is required, or work place health and safety regulations require wound coverage.

Skin Ulceration: Clean the ulcer site and surrounding area with cooled boiled or sterile water. Dry to a damp surface if possible and apply a thin layer of the ozonated oil over the ulcer site and surrounding skin edge. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected area. There is no need to cover unless protection from further trauma is required, or work place health and safety regulations require wound coverage.

Nail Infections: Clean the nail and surrounding finger/toe skin surface with cooled boiled or sterile water. Dry and apply a thin layer of the ozonated oil over the nail and surrounding skin surface. If possible, work the oil/oil-gel below the nail and into the creases on either side of the nail. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected area.

On fingers, a finger cot, or gloves will help keep the oil/oil-gel in the correct place, and prevent touched areas being left with an oil film.

On toes, there is no need to cover unless protection from further trauma is required, or work place health and safety regulations require treatment area coverage.

Skin Penetrations: eg Thorns /Splinters If possible clean your hands and the affected skin surface with cooled boiled or sterile water. Remove all parts of the thorn or splinters if possible. Dry and apply a thin layer of the ozonated oil over the affected skin surface. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. Cover with a dressing if possible. Seek medical help if parts remain embedded below the skin surface.

Skin Wounds: If possible clean your hands and the affected skin surface with cooled boiled or sterile water. Remove all parts of the thorn or splinters if possible. Dry and apply a thin layer of the ozonated oil over the affected skin surface. Seek medical help if necessary. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. Cover with a dressing if possible. Seek medical help if necessary.

Skin Infections:

1. Bacterial: eg Acne Clean the affected skin surface with cooled boiled, sterile water or skin cleanser. Dry and apply a thin layer of the ozonated oil over the affected skin surface. Seek medical help if necessary. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. There is no need to cover with a dressing.

2. Fungal: eg Athlete's Foot Clean the affected skin surface with cooled boiled or sterile water. Dry and apply a thin layer of the ozonated oil over the affected skin surface and between the toes. Seek medical help if necessary. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. Wear open shoes to allow the foot to remain dry.

Change socks every day and wash following manufacturer's instructions.

3. Viral: eg Shingles, Lip Herpes Clean the affected skin or lip surface with cooled boiled or sterile water. Dry and apply a thin layer of the ozonated oil over the affected skin surface. Seek medical help if necessary. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. There is no need to cover unless protection from further trauma is required, or work place health and safety regulations require wound coverage.

Superficial Burns: Clean the affected skin surface with cooled boiled or sterile water.

Dry and apply a thin layer of the ozonated oil over the affected skin surface. Seek medical help urgently. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. Cover with a dressing if possible. Seek medical help urgently if the burn is extensive.

Deep Burns: Clean the affected skin surface with cooled boiled or sterile water if possible. Dry and apply a thin layer of the ozonated oil over the affected skin surface. Cover with a dressing if possible. Seek medical help urgently.

Trauma Injuries: Clean the affected skin surface with cooled boiled or sterile water if possible. Dry and apply a thin layer of the ozonated oil over the affected area. Cover with a field dressing if possible. Seek medical help urgently.

Surgery Sites / Surgical Suture Lines: Clean the suture line with cooled boiled or sterile water. Dry and apply a thin layer of the ozonated oil over the affected skin surface. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. There is no need to cover unless protection from further trauma is required, or work place health and safety regulations require wound coverage.

Insect Bites & Stings: Clean the affected skin surface with cooled boiled or sterile water. Make sure any residual sting or insect parts are removed from the bite/sting area. Dry and apply a thin layer of the ozonated oil over the bite or sting surface. Seek medical help if necessary. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. There is no need to cover unless protection from further trauma is required, or work place health and safety regulations require wound coverage.

Ozonated Oils and Oil-Gels: Directions for use – Dental.

These products are shipped to the UK, Europe, the USA, Africa, Japan, New Zealand, Australia and Lebanon. The oils have been used for periodontal and surgery healing work. The ozonated oils can eliminate and prevent infection, resolve pain within about 30 minutes, and they promote accelerated healing.

Dental Caries: Ozonated oils play ***NO*** part in the treatment of caries. The ozonoid oil product is not sufficiently active enough to destroy deep micro-biological niches and biomolecules that lead to demineralisation in enamel, nor deep micro-biological niches in dentine tooth structure. Ozonated oils may help to reduce pain and infection is gross caries with pulpal exposure, but this has not been tested or reported. *The oil-base will interfere with dentine and enamel bonding systems.*

Ozone gas delivered from the LT-CMU3 Unit or a similar ozone generating device that has CE and MD Marks, are the only ozone units that should be used in these cases. The CE and MD Marks are part of a world-wide mark of Quality Assurance.

Gum Tissue Infections:

1. Bacterial: Clean the affected area with cooled boiled or sterile water or hydrogen peroxide mouth rinse. Apply a thin layer of the ozonated oil over the affected skin surface. Seek dental help if necessary. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. There is no need to cover with a dressing.

Dry Socket: Dry socket is a superficial bone and soft tissue infection, usually following the removal of a tooth or teeth (especially 8's) but this can occur in any site in the mouth after surgery. It is painful, and can take a long period of time to settle and heal with routine antibiotics.

To treat with ozone oils, clean the affected area with cooled boiled or sterile water or hydrogen peroxide mouth rinse.

A small syringe with a blunt end, for example the Ultradent 1.2ml syringe with a fine acid etchant delivery tip, is filled with ozonated oil. The syringe tip is introduced into the dry socket to its full depth if possible, and the oil is expelled into the socket as the syringe tip is withdrawn.

The patient should be sent home with a supply of the oil, syringes, delivery tips, and instructions, and instructed in oral hygiene care, and the case reassessed at regular time intervals.

Periapical Sinus: After the nerve tissue is irreparably damaged by trauma or caries, it will die. If this goes undetected, an area of infection at the tip of the root will develop. The drainage pathway is towards the buccal plates and sulcus. Treatment should be combined with RCT (Root Canal Therapy).

During RCT, the sinus can be irrigated with ozonated oils. A small syringe with a blunt end, for example the Ultradent 1.2ml syringe with a fine acid etchant delivery tip, is filled with ozonated oil. The syringe tip is introduced into the sinus to its full depth, and the oil is expelled into the sinus as the syringe tip is withdrawn.

The case should be reassessed at regular time intervals.

2. Fungal: eg Denture Sore Mouth: Clean the affected gum tissue surface with cooled boiled or sterile water or hydrogen peroxide mouth rinse. Clean the denture with soap and water, rinse, and dry. Apply a thin layer of the ozonated oil over the fitting surface (the surface that touches the gum tissue) of the denture and replace. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface.

3. Viral: eg Lip Herpes

Clean the affected skin surface with cooled boiled or sterile water or hydrogen peroxide.
Apply a thin layer of the ozonated oil over the affected lip surface. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface.

Mouth & Tongue Ulceration: Clean the affected skin surface with cooled boiled or sterile water or hydrogen peroxide mouth rinse. Apply a thin layer of the ozonated oil over the ulcer site and surrounding skin edge. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected area.

Aphthous Ulcers: Either ozone gas from the LT-CMU3 unit can be delivered onto the ulcer surface, or ozonised oils can be placed onto the ulcer surface directly. Clean the affected skin surface with cooled boiled or sterile water or hydrogen peroxide mouth rinse. Apply a thin layer of the ozonated oil over the affected skin surface. Seek medical help urgently. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface.

Superficial Burns: Clean the affected skin surface with cooled boiled or sterile water or hydrogen peroxide mouth rinse. Apply a thin layer of the ozonated oil over the affected skin surface. Seek medical help urgently. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface.

Periodontal Pockets: These oils should be used in conjunction with thorough scale and debris prophylaxis. They are ***NOT*** an alternative to routine professional oral hygiene care. All periodontal pockets should be charted and measurements noted. Points of bleeding and pocket depth should be recorded. After professional prophylaxis, a small syringe with a blunt end, for

example the Ultradent 1.2ml syringe with a fine acid etchant delivery tip, is filled with ozonated oil.

The syringe tip is introduced into the periodontal pocket to its full depth, and the oil is expelled into the pocket as the syringe tip is withdrawn. At no time should the oil be injected into the soft tissue. The aim is to fill the pocket with the ozone oil or gel as an adjunct to debris removal. The patient should be instructed in oral hygiene care, and the case reassessed at regular time intervals. Ozonated oil can be re-applied at 1 week intervals in all cases, or in severe cases, more frequently.

Root Canal Therapy: Ozone, ozonated water and ozonised oils can be used during root canal therapy to clean and sterilise the canal systems. Once access has been created, and the canal system opened, ozone gas delivered by the LT-CMU3 unit is used to sterilise the canal system. 120 – 240 seconds of ozone should be used. If RCT is being staged over more than one visit, a small syringe with a blunt end, for example the Ultradent 1.2ml syringe with a fine acid etchant delivery tip, is filled with ozonated oil.

The syringe tip is introduced into each canal and the oil is expelled into the canal as the syringe tip is withdrawn. The access is then sealed. At recall, no more than 5-7 days after the previous appointment, the canals are opened, re-cleaned and if suitable, filled.

Surgery Sites / Surgical Suture Lines: Clean the suture line with cooled boiled or sterile water, or hydrogen peroxide solution. Apply a thin layer of the ozonated oil over the affected skin surface with a suitable instrument, such as a 'Micro-Brush'. The patient should be instructed to re-apply every 3-4 hours after re-cleaning the affected surface. There is no need to cover, such as with a perio-pack, unless protection from further trauma is required.

The Use of Ozone to Sterilise and Clean Air Supplies.

Ozone has been used to clean and sanitise air for over 100 years. The first reports of a public system come from the London Underground in the United Kingdom. Here, the subterranean portions of the railway network were supplied with fresh air that had been ozone treated (*Betjeman 1972*). It is known that usage of ozone-oxygen mixture is effective to eliminate pyogenic flora, tuberculosis agent, diphtheria and gas gangrene (*Apsatarov 1994, Vasil'ev & Markov 1992*) for example. The high performance of an ozone-oxygen mixture and its effect on Mycobacteria Tuberculosis has been published in the late 1990's (Priymak et al 1991, Belyanin et al, 1997).

One published study from the USA illustrated how ozone-treated air could control cross-infection amongst school children and their teachers. Published in 'Report to National Warm Air, Heating and Ventilating Association', James Steward, MD, the Director of Hygiene & E. S. Hallett, Chief Engineer, Board of Education, St. Louis examined the effect of ozone to control cross infection in air-born diseases.

During the influenza epidemic in St. Louis, the most critical and advanced cases were transferred to an open air school, which made for high percentage of mortality. In one particular ward, experiments were made with ozonized air on cases approaching or at the crises period of the diseases where patients were able to inhale at all, they were at once relieved and successfully carried through the crisis point.

Two schools were then used for an experiment, one with ozonated air and another with ordinary

air. Both schools contained approximately the same number of rooms. The following cases of sickness were observed and tabulated:

Infection Type	Ozone-Treated Air	Untreated Air
Tonsillitis	13	57
Sore Throat	24	60
Colds	46	64
Headache	9	66
Stomach ache	0	25
Earache	1	15
Toothache	0	20
Indigestion	0	9
Fever	1	49
The Grippe	0	6
Pneumonia	0	4

Table 6.01: Infection Control & Air Sanitisation with Ozone

Comparing the total days absent they found that in the school where ozonated air was used, the school children were absent, due to the foregoing cases of sickness, 475 school days, while in the school where ordinary air was circulated by means of the ventilating system, the school children were absent a total of 1,098 school days.

Steward and Hallett concluded; ‘Thousands of lives would be saved every year if homes and schools were equipped with apparatus for the circulation of ozone. Injected with the air of the building to the extent of one part of ozone to one million parts of air, it effects approximately 100% purification. In five years that ozone has been used in the Public Schools of St. Louis, tuberculosis cases have been reduced by 50%, and in addition, other diseases have been materially reduced.’

The use of Ozone for Sterilisation.

Ozone is a powerful germicidal as was first indicated by Frohlick. Its high germicidal activity is has been shown to be due to its oxidizing power. Ozone is extensively used for the sterilization of public water supplies, for the treatment of wounds in hospitals, and for various purposes of sterilization and preservation in agricultural industries.

Some sterilization is effected by ozonation of air, since a marked reduction is obtained in the bacterial count of the air which has actually passed through the ozone generator and subsequent action of the generated ozone on the ambient surrounding air.

Ozone Concentration mg./1 hr	Time of ozonation Minutes	Bacterial count after 36 hrs. incubation	Mortification Percent colonies
174.3	0	Ca 2-3000	00
174.3	2	60	98
174.3	8	15	99.5

Table 6.02: Action of Ozone on Surface Cultures - E. coli

Ozone Concentration mg./1 hr	Time of ozonation Minutes	Bacterial count after 36 hrs. incubation	Mortification Percent colonies
174.3	0	1126	00
174.3	2	0	98.1
174.3	8	0	100

Table 6.03: Action of Ozone on Surface Cultures - Bacilli Diphtheria

Ozone Concentration mg./1 hr	Time of ozonation Minutes	Bacterial count after 36 hrs. incubation	Mortification Percent colonies
174.3	0	840	98
174.3	2	0	100

Table 6.04: Action of Ozone on Surface Cultures, Staphylococcus

Ozone Concentration mg./1 hr	Time of ozonation Minutes	Bacterial count after 36 hrs .incubation	Mortification Percent colonies
174.3	0	Ca 2000	0
174.3	2	Sterile	100

Table 6.05: Action of Ozone on Surface Cultures- Streptococcus

These tables illustrate the oxidative power of ozone on bacterial colonies grown macroscopically and dried on a soil medium.

The first table shows a kill rate of 98% and 99% of the bacteria E coli within two minutes and this confirms previous results of Dr Heise. It also illustrates the swift nature of the action of ozone, showing rapid oxidation of the bacterial colonies six hours after the vaccination.

In this study, other plates inoculated with dysentery, streptococcus, staphylococcus, ozonated 3-4 hours after vaccination were found to be sterile after two minutes of ozone treatment. These observations are confirmed by the later studies by the Belfast Ozone Research Group.

The author concluded that '*According to the results of these experiments as shown in these tables, the disinfectory germical action of Ozone must be considered as most excellent and superior to other methods*'.

A study in 2002 showed that ozone prevents the spread of infective spores. In 2004, Young and Setlow (*Young and Setlow 2004*) determined that ozone does not kill spores by DNA damage. Rather, ozone seems to render the spores defective in germination, perhaps because of damage to the spore's inner membrane. Spores are exceptionally resistant to cleaning and sterilisation methods. This paper illustrated the power of ozone to eliminate the most resistant infective bodies.

Gaseous ozone has long been observed to remove unwanted odours from air and fabrics, without damaging fabrics, for example, in home and hospitality settings. The paper by Destaillats *et al* in 2006 (*Destaillats et al 2006*) examined the chemical pathways of how ozone removes nicotine desorption from surfaces.

Units Available for Air Sterilisation from Lime Technologies Holdings Limited.

Fig 6.37. The LT-RAS3 from Lime Technologies Holdings Ltd

The LT-RAS3 unit is a self-contained air steriliser unit. The LT-RAS3 can be wall mounted, placed on a table or shelf top.

It is supplied complete with an auto-sensing 110-240 VAC Mains Power Supply Unit that supplies 12 VDC to the unit.

Two timers make the setting up of the LT-RAS3 simple. One timer controls the time on, and the second, the time off.

Periodic servicing by the customer is required to keep the ozone generator free from dust and debris build-up.

It costs 275.00 Euros direct from Lime Technologies Limited, www.limetechnologies.net

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Figures 06.01 to 06.36, © Dr Julian Holmes, 2008. Tables 6.01 – 6.05 © Kleinmann H, ????

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