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Potential Dental Unit Water Lines Contaminants and Their Impacts: A Parasite Perspective

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ABSTRACT
Oral health is at risk due to systemic diseases transmitted to patients due to microbial contamination of the dental unit waterlines (DUWLs) with pathogenic microbes. So, there is concern about the levels of oral diseases associated with inappropriate and unhygienic oral care practices, the most important of which is the contamination of water with parasites. For provision of oral health care. Patients and dentists and dental team must be caution to avoid its potential risks to dentists and patients, and to monitor the quality of the dental units' water due to DUWLs provide a favourable environment for microbial proliferation and biofilm formation, and that water is consequently often contaminated with various microorganisms (bacteria, fungi, protozoa, viruses).
Keywords: *Microorganisms; Dental unit waterlines; Biofilm; Health; Parasites.*

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INTRODUCTION

Dental Unit Waterlines and Related Problems

The water being delivered through dental unit waterlines (DUWLs) during oral healthcare procedures is suddenly of public concern by the aftermath of the Florida HIV transmission case several years ago [1]. So, there is a growing interest in focusing on the risk of exposure to contaminated water in the dental office.

Moreover, some reports proved that their high levels of potentially pathogenic microorganisms in the dental treatment water [1-3], and Dental Unit Waterlines (DUWLs) provide a favourable environment for microbial proliferation and biofilm formation, consequently often contaminated with high densities of various microorganisms (bacteria, yeasts, fungi, viruses, protozoa, unicellular algae and nematodes), due to water stagnation in the narrow-bore dental unit waterline (DUWL) tubing's [4], which can develop individual and collective infections [5]. causing a health problem for dentists and patients, especially those who are immuno-compromised [1,6].According to Garg et al. [6]contaminated water may be ingested by patients or may contact mucosal and / or teeth continuity solutions. It provides direct access to connective tissue and turns possible absorption and reach of circulatory system. It can serve as a source of respiratory and ocular infection for patients and dentists.

MICROBIAL CONTAMINATION OF DUWLS AND BIOFILMS

Barbeau *et al.* [7], reported that the water systems of dental units is an aquatic ecosystem in which various opportunistic pathogens colonize the inner surface of the pipes, and DUWLs provide a suitable environment for microbial multiplication and the formation of biofilm which may be comprised of pathogens microorganisms, including bacteria, fungi and protozoa, often forming a protective layer of viscous substance (limo/mucus) that allows them to survive in adverse environments and in vade new locations [8,9], such as fungi and protozoa or bacteria [10].

Among the many microbes that were isolated from the dental water units (DUWLs) are *Achromobacter xyloxidans*, *Acinetobacter* spp., *Actinomyces* spp., *Alicaligenes dentrificans*, *Bacillus* spp., *Bacteroides* spp., *Caulobacter* spp., *Flavobacterium* spp., *Fusobacterium* spp., *Klebsiella pneumoniae*, *Lactobacillus* spp., *Legionellas* pp., *Micrococcuss* pp., *Moraxella* spp., *Mycobacterium avium*, *Nocardia* spp., *Pasteurella* spp., *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Burkholderiacepacia*, *Streptococcus* spp., *Staphylococcus aureus*, *Mycobacterium* spp., *Xanthomonas* spp., *Phoma*spp., *Penicillium* spp., *Cladosporium* spp., *Alternaria*spp. *Scopulariopsis* spp., *Acanthamoeba* spp., *Cryptosporidium* spp., *Microsporidium* spp. and *Giardia* pp. [4,11-13].

Legionella, *Pseudomonas* are potential pathogens are of particular concern because of their ability to cause pneumonia, and other respiratory infections. Also, *Candida* spp., can cause both superficial and systemic diseases due to their presence in dental unit water [12,14-16]. Therefore, caution must be exercised to avoid its potential risks to dentists and patients, and to monitor the quality of the dental units' water

Protozoans Found in Water Supplies

Previous reports have confirmed that there are many protozoa in dental water lines. Examples of important protozoans in dental waterlines are species of *Microsporidium*, *Giardia* and *Cryptosporidium* as showed in figure (1) [17-19]. Protozoa are unicellular organisms that are characterized by their locomotion, and exist in a variety of shapes and can live by themselves or as parasites [20-22].

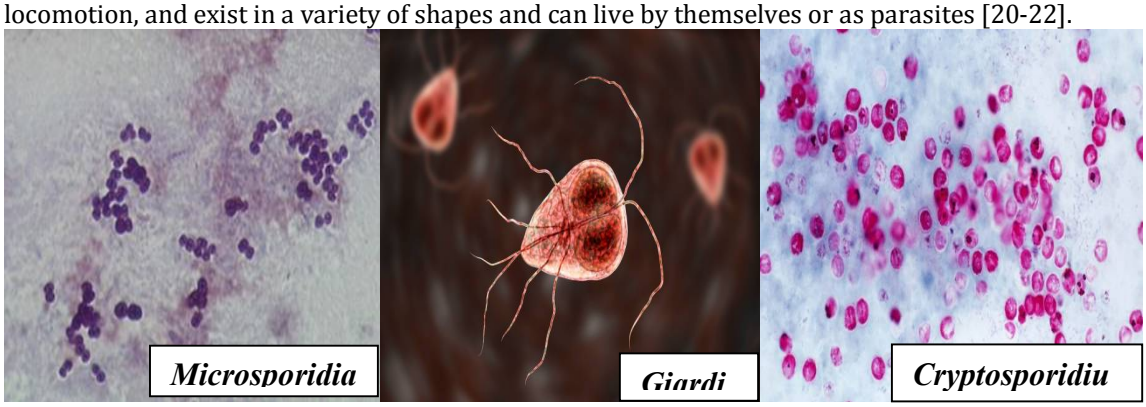

Fig. 1. Examples of important protozoans in dental waterlines.

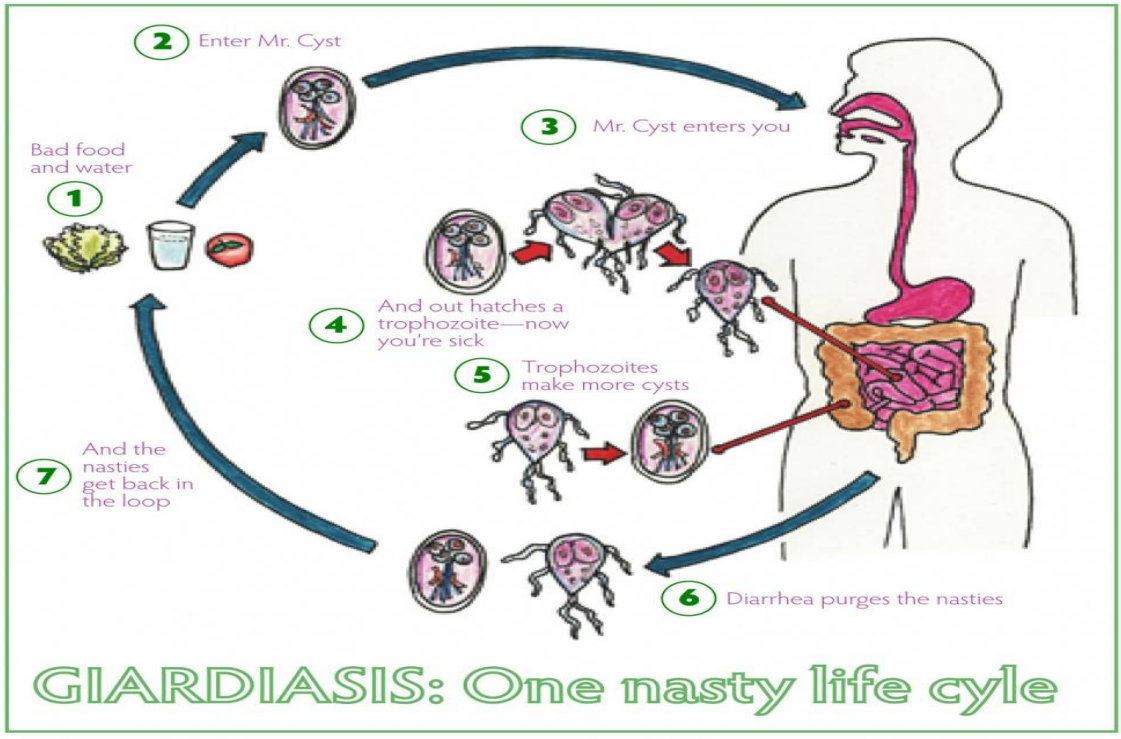

Fig. 2. The life cycle of *Giardia lamblia*.

Giardia lamblia is one of the most common causes of water borne disease in humans and causes a diarrheal disease known as giardiasis. The life cycle of *Giardia lamblia* is showed in figure (2) [23]. The

most important characteristic of *Giardia* is that it is resistant to treatment methods due to its entry into a cystic state and also because it is protected by an outer shell that protects it from difficult environmental influences and keeps it alive for long periods [20-22].

Hassan et al. [24] isolated *Cryptosporidium* spp. from water samples taken from dental irrigation machines. *Cryptosporidium parvum* parasite cause a diarrheal disease as well-known as Cryptosporidiosis, and very resistant to chlorine disinfection due to the outer shell that allows it to survive in adverse conditions for long time [20-22], and transmitted by direct person-to-person contact, or ingestion of contaminated water [25], and is known to be resistant to antiparasitic drugs. Documented reports indicated that controlling infection transmitted by contaminated water is difficult for its oocysts ability to survive and its resistance to treatments [26,27]. Figure 3 showed the life cycle of Cryptosporidium [28]. What increases the danger of free-living amoebae is that they serve as a reservoir for other pathogenic organisms that cause many diseases, for example *Legionella* spp. and *Pseudomonas* spp. [29-35]. Some studies have found *Legionella* contamination and amoebae of DUWLs [36-38], and the more is the DUWLs contained higher concentrations of living microorganisms than at the input water supply. This confirming the role of the DUWLs in increasing microbial contamination such as *Legionella* contamination and amoebae of DUWLs [37,38].

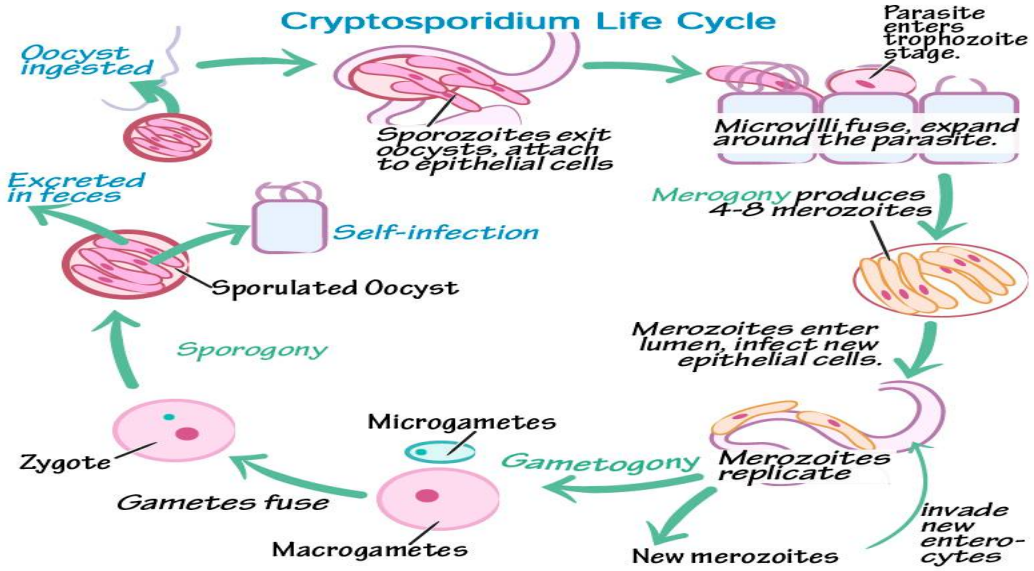

Fig. 3. The life cycle of *Cryptosporidium*.

***Acanthamoeba* Spp.**

Acanthamoeba species are of global interest as a result of the dangerous pathogenic species (Figure 4) [39], that cause many diseases to humans, including; the insidious, chronic and mostly fatal disease granulomatous amoebic encephalitis (GAE) as showed in figure (5) [40], particularly in patients with HIV/AIDS or who are chronically ill, diabetic, immune-compromised, have undergone organ transplantation or are otherwise debilitated with no recent history of exposure to recreational fresh water [40,41] and *Acanthamoeba* keratitis (figure 6) [40] causes a vision-threatening disease [42].

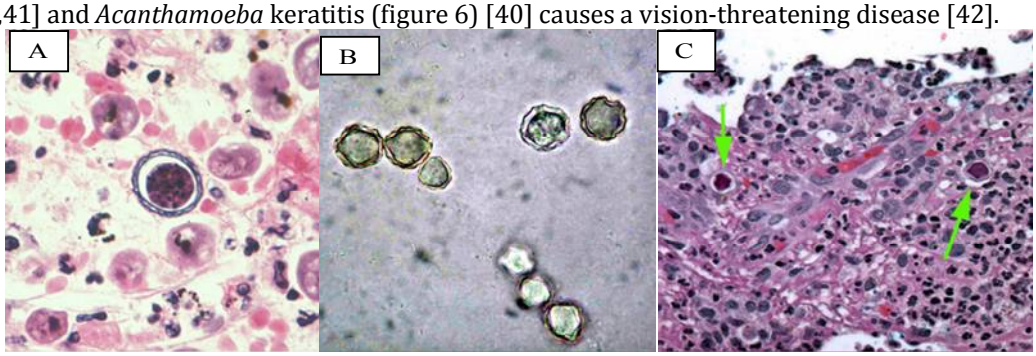

Fig. 4. Several species of *Acanthamoeba* A. Cyst of *Acanthamoeba* sp. from brain tissue; B: Cysts of *Acanthamoeba* spp. in culture; C: Cysts of *Acanthamoeba* sp. (green arrows) in tissue.

Fig. 5. Granulomatous amoebic encephalitis (GAE).

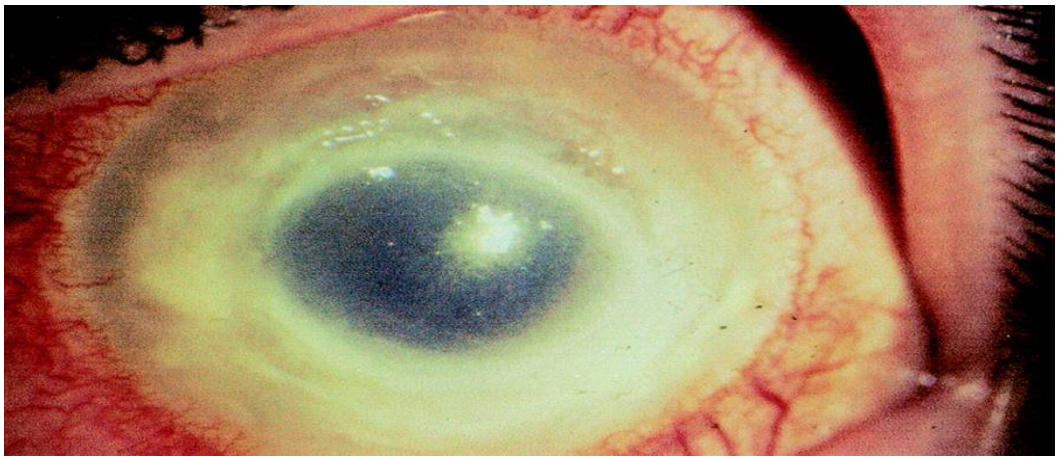

Fig. 6.*Acanthamoeba* keratitis.

Studies has confirmed that *Acanthamoeba* are ubiquitous and have been isolated from many ecological habitats [43-46], (water, air, and soil environments) [47,48], fresh, salt water and dental irrigation systems [49], Potential pathogenic *Acanthamoeba* spp., for humans, are resistance to water treatments [50-52], and the risk of *Acanthamoeba* spp. is more and dangerous due to prove that bacteria and virus survive and grow within *Acanthamoeba*, so *Acanthamoeba* is important waterborne pathogens. The global concern over public health increased with the isolation of pathogenic amoeba species from water sources in hospitals and dental water lines [53-57]. Figure 7 showed the life cycle of *Acanthamoeba*[58].

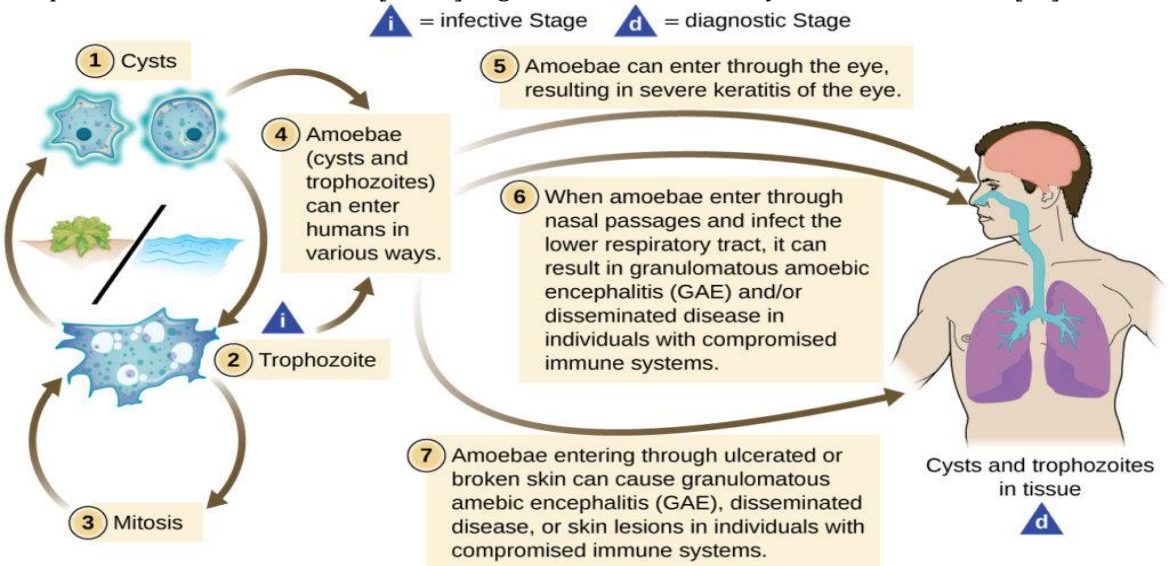

Fig.7. The life cycle of *Acanthamoeba*.

Huws *et al.* [59] reported the enhancement of methicillin-resistant *Staphylococcus aureus* survival, replication and virulence in association with *Acanthamoeba polyphaga*. Other reports found *Acanthamoeba* spp., in dental water lines [60-62]. Not only that, but Dendana et al. [49] found genus *Acanthamoeba* in water at the entrance of haemodialysis apparatus contained. They attributed it to the long stagnation of water, which could lead to the development of biofilms, providing favourable conditions for the growth and proliferation of many microbes and *Acanthamoeba* [54]. A result confirmed by Cirillo et al. [62], where *Legionella pneumophila* were reported with *A. polyphaga*, and also, a high-level resistance of *L. pneumophila* released from *A. polyphaga* to disinfectants and antimicrobials [63,64].It is also confirmed by Fukumoto *et al* [65]that *Parachlamydia acanthamoebae* coexist with *Acanthamoeba* in hospital environment. *Parachlamydia acanthamoebae* is a potential pathogen causing hospital-acquired pneumonia.Herein lies the danger role of *Acanthamoeba*, as it facilitates the spread of *Parachlamydia acanthamoebae* due to its ability to survive for long periods through a hospital environment [67], and especially immuno-compromised patients, including those on haemodialysis. Patients in hospitals may be exposed to Acanthamoeba associated nosocomial infections, as documented in previous reports [66-69].
It was the first human infection with *Acanthamoeba* and it was reported under the name of *Hartmannella*. It was announced in the early1970s [70] after the discovery of amoebae and cysts in brain sections from a patient with brain abscesses. In addition to chronic granulomatous amoebic encephalitis, it causes keratitis, lung and skin infections. *Acanthamoeba* spp. were isolated from fresh water sources associated with human activities [71]. Sadaka *et al.* [72]. isolated, *A. gruberi* and *A. rhysodes* were isolated from the nasal passages of six healthy children living near the contaminated canals. However, previously published appraisal by Hikal et al. [55]showed that *Acanthamoeba castellanii*, *A. griffin*, *A. hatchitti* and *A. lenticulata* were isolated from dental unit waterlines (DUWLs). Also, Hassan et al. [24] isolated *Acanthamoeba* spp. from the hydraulic systems of haemodialysis and dental units.

CONCLUSION

Parasites were isolated from biofilm accumulated in the dental units' waterlines. The contamination of the dental units' waterlines is a reality, which can develop infectious risks for public health. So, we need to do everything possible to better management and application of decontamination protocols for waterlines need to be applied. Monitoring the microbial quality of water in dental unit waterlines is an important part of infection control measures carried out in dental clinics.

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