

A Study of Waste Water Treatment of Microbiological Laboratories of Hospitals by Electrolyzed Oxidized Water

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Abstract

Hospital liquid infectious waste is one of the most important aspects of water contamination. The present investigation was undertaken to evolve a cost effective alternate method of waste water treatment by using Oxidized Water as a disinfectant for hospital effluents. Liquid infectious waste coming from diagnostic laboratories of hospitals (Urine, Blood and Mix of both) was treated with electrolyzed Oxidized Water. Different v/v ratios (95:5, 85:15, 75:25, 50:50 and 25:75) of Sample to Electrolyzed Oxidized Water (EOW) were cultured and incubated at 37°C for 24 hours. EOW showed a direct relationship with the decontamination of inorganic urine but for blood, an unidentified pattern was observed that may be due to change in pH and/or Oxidation Reduction Potential (ORP) of EOW because of organic nature of blood. The most effective ratio of sample to EOW, at which decontamination was found to be maximum for urine, was 25:75 with treatment efficiency of 96.15 % and 85:15 with treatment efficiency of 84.8 % for blood. The study revealed that Electrolyzed Oxidized Water may be used as a better alternative for treatment of liquid infectious waste.

Keywords: Treatment, Microbiological, Hospital, Electrolyzed, Oxidized and water

Abbreviations: EOW: Electrolyzed Oxidized Water, ORP: Oxidation Reduction Potential

1. Introduction

One of the burning issues of environmental pollution is water contamination due to direct discharge of hospital liquid infectious waste into sewage. Blood and urine are the major infectious effluents from diagnostic laboratories, which require treatment prior to disposal into sewage. The methods currently being used for treatment of infectious waste are either expensive, require large space and man power for its continuous sustainability or become source of pollution themselves. For instance, incineration result in emission of carcinogenic compounds like dioxins, waste water treatment plant requires huge space while, chemical disinfection by chlorine, ammonium salts and phenolic compounds (Pruss *et al*, 1999) may lead to secondary pollution.

EOW is generated by electrolysis of a dilute aqueous solution of sodium chloride (NaCl) in an electrolysis chamber where the anode (+ electrode) and cathode (- electrode) are separated by a cationic membrane to form two compartments (Kumon, 1997). The anode acidic EOW has a low pH of 2.3 to 3.0, a high oxidation-reduction potential (ORP) greater than 1000 mV, and contains relative concentrations of chlorine (Cl₂),

hypochlorous acid (HOCl) and hypochlorite (Sharma and Demirci, 2003). The alkaline solution from the cathode has a high pH and low ORP (Kumon, 1997).

Electrolyzed oxidizing water (EOW) has proved to be an effective disinfectant, due to its strong microbicidal activities on a wide variety of bacterial pathogens including mycobacteria as well as bacterial endospores (Tanaka *et al.*, 1996; Selkon *et al.*, 1999; Loshon *et al.*, 2001). It is reported that EOW has a potential to inactivate bacterial endotoxins or fungal toxins by conversion of hazardous substances into non harmful components (Suzuki *et al.*, 2002 a,b). Large amount of HOCl at a low pH of ~3 enhances the disinfecting efficacy of EOW (Vorobjeva *et al.*, 2004; White, 1999). EOW is found to be a useful disinfectant for hospital infections. They investigated EOW against 10 of the most common opportunistic pathogens which became completely inactive after treatment (Vorobjeva *et al.*, 2004).

The present investigation was undertaken to select the best concentration of EOW to decontaminate the infectious effluents from microbiological laboratory of hospital. Comparison of number of microbial colonies grown in the sample control and treated samples was taken as criteria to determine the best ratio of EOW to treat for maximum decontamination.

2. Material and methods

2.1 Materials

2.1.1 Apparatus

Test tubes, Petri Dishes, Micro Syringes (1 c.c.), Cotton, Conical Flask, Test Tube Stand, Incubator, Laminar Flow Cabinet, Autoclave and Colony Counter.

2.1.2 Chemicals

Dermo Zell Electrolyzed Oxidized Water (Bio-Zell+ Pakistan), Nutrient Agar (Lab M. Ltd), Distilled Water

2.2 Methods

Liquid infectious waste (Urine, Blood and Mixed Waste) was collected from microbiology laboratory of hospital and different v/v ratios of sample to EOW (95:5, 85:15, 75:25, 50:50 and 25:75) were applied on prepared Petri dishes of Nutrient Agar by Spread Plate Technique and labeled. Pure samples of blood urine and mixed waste were also cultured to determine the extent of pollution in terms of number of microbial colonies. Control of EOW was also kept. All the Petri dishes were kept in incubator at 37°C and kept for 24 hours. After 24hrs of incubation, microbial growth in each of the plate was examined. Using Colony Counter, number of colonies in each of the Petri dish was counted to determine the most effective concentration of EOW for decontamination. The treatment efficiency of EOW was determined by applying following formula,

$$\text{Treatment Efficiency} = \frac{E_i - E_o}{E_i} \times 100$$

E_i = Number of Colonies in Pure sample (Urine/Blood/Mixed sample)

E_o = Number of colonies in treated samples (Urine/Blood/Mixed sample)

3. Results

3.1 Decontamination of Urine

The experiment revealed that there is a directly proportional relationship between the amount of EOW and reduction in number of microbial colonies is shown in graph 1. The different ratios of urine to EOW i.e. 95:5, 85:15, 75:25, 50:50 and 25:75 showed average treatment efficiencies as, 5.59, 15.54, 34.5, 61.7 and 96.15 respectively. The best sample to EOW ratio for treatment of urine is 25:75 with average treatment efficiency of 96.15%. Comparison of microbial growth in control of urine and microbial growth after treatment of urine with 75% of EOW is shown in figure 1.

3.2 Decontamination of Blood

Unlike urine, blood treatment with EOW showed an unidentified pattern of decontamination i.e., reduction in number of colonies was observed at sample to EOW ratios, 95:5 and 85:15 is shown in graph 1. But after 85:15, increase in number of colonies was observed at higher percentages of EOW. The different ratios of Blood samples to EOW i.e. 95:5, 85:15, 75:25, 50:50 and 25:75 showed average treatment efficiencies as, 46.73, 84.81, 75.19, -232.6 and -47.8 respectively. However, the most effective ratio of blood sample to EOW was found to be 85:15 at which the average treatment efficiency calculated as 84.81%. Comparison of microbial growth in control of blood to microbial growth after treatment of blood with 15% of EOW is shown in figure 2.

3.3 Decontamination of Mixed Waste (Urine and Blood)

For mixed waste (blood and urine) the effect of EOW with the selected concentrations showed an unidentified pattern is shown in graph 1. The different ratios of mixed waste sample to EOW i.e. 95:5, 85:15, 75:25, 50:50 and 25:75 showed average treatment efficiencies as, -167.4, 47.69, 33.1, 67.65 and 49.72 respectively.

4. Discussion

In hospitals for medical purposes such as diagnostics and research a large variety of substances are in use. After application, diagnostic agents, contaminated with viruses, protozoa, and other microorganisms reach the local sanitary sewage system. The bacteria contamination is the most serious risk associated with domestic sewage exfiltration with sufficient virulence to transmit disease. It was needed to find out most cheap and feasible method of liquid infectious waste management. Therefore, Electrolyzed Oxidized water was taken for decontamination of infectious waste prior to discharge into sewage. It was found to be a successful study giving an effective approach in terms of environmental conservation and being socially and economically feasible.

The pattern of growth of microbes shows that ratio of EOW to sample i.e. 75:25, is the best ratio for treatment of urine, with average treatment efficiency of 96.15%. The experiment revealed that there is a directly proportional relationship between the amount of EOW and reduction in the growth of microbial colonies. This is because urine, being inorganic and water based in nature, did not affect pH of EOW. However, the most effective ratio of EOW to blood sample was found to be 85:15 at which the average treatment efficiency calculated as 84.81%. The unidentified pattern shows that the organic nature of blood affects the pH and/or ORP of EOW from 2.5 towards neutral pH. Secondly some kinds of microbes may activate with change in pH due to change in concentration of EOW.

The effect of EOW with the selected concentrations showed an unidentified pattern for mixed waste. It is may be due to effect of its organic nature on the pH and/or ORP of EOW from 2.5 towards neutral pH. Secondly some kinds of microbes may activate with change in pH due to change in concentration of EOW. Each of the samples showed a different effective percentage of EOW for its decontamination but in each sample effective percentage of EOW for Mixed waste sample matched with effective percentage for blood or urine of the same sample. Having an unidentified pattern it followed the pattern of decontamination of that sample viz. less infectious rather than to follow the pattern of infectious waste sample.

5. Conclusion

Use of EOW for decontamination of liquid infectious waste may help overcome the problems associated with other treatment methods. It is most practicable, efficient and user-friendly for all types of health care facilities. It is also an economic method, without need of costly equipment and continuous supervision. Waste is decontaminated without generation of secondary pollution. To ensure this Blood and Urine, being different in their chemical composition and nature, should be treated with different concentrations of EOW separately prior to disposal.

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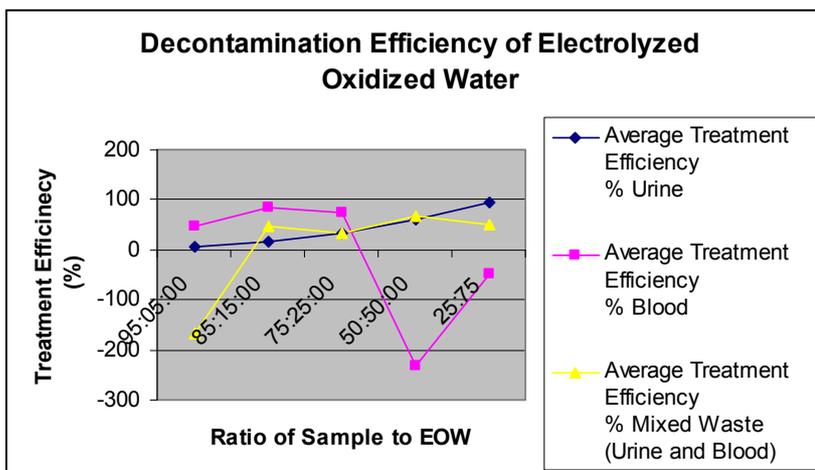
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Table 1. Decontamination Efficiency of EOW

Sr No	Ratio of Sample to EOW	Average Treatment Efficiency %		
		Urine	Blood	Mixed Waste (Urine and Blood)
1	95:5	5.59	46.73	-167.4
2	85:15	15.94	84.81	47.69
3	75:25	34.5	75.19	33.1
4	50:50	61.7	-232.6	67.65
5	25:75	96.15	-47.8	49.72



Graph 1. Decontamination efficiency of Electrolyzed Oxidized Water (EOW)

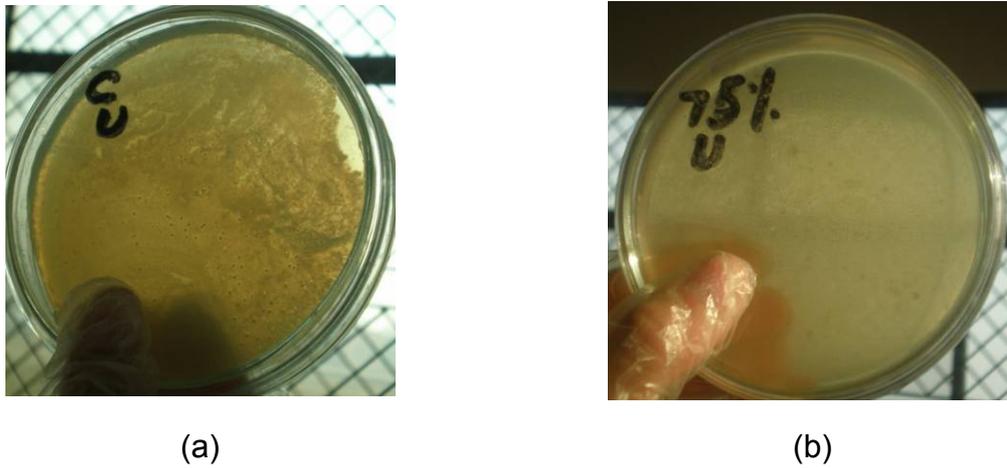


Figure 1. Comparison of Microbial growth in control of Urine (a) and Microbial growth after treatment of Urine with 75% of EOW (b)

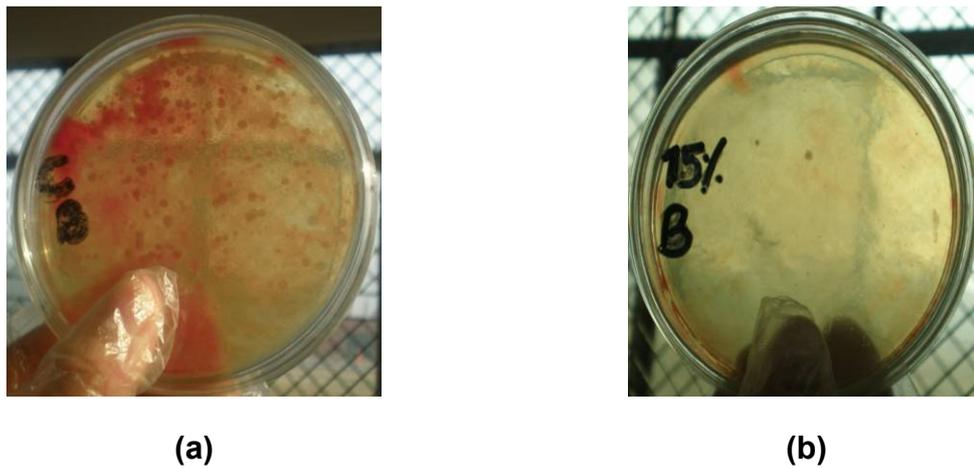


Figure 2. Comparison of Microbial growth in control of Blood(a) to Microbial growth after treatment of blood with 15% of EOW (b)



Figure 3. Control of EOW showing no microbial growth