14. Study On Propriety Instrumentation Of Function Water

by Michio Aoyama, Nippon Rensui Co., Standard Equipment Division

A. Summary

Following the basic study of function water, its peculiar thermal characteristics were clarified. A further investigation was undertaken to determine "temperature conversion factors for function water instrumentation" by reviewing the data on thermal characteristics of function water.

B. Preface

The most convenient and general way to identify and control the feature of electrolysis equipment and quality of electrolyzed strong acid aqueous solution (ESAAS) might be the measurement of pH (concentration of hydrogen ion) and ORP (oxidation-reduction potential). ESAAS can be used for many purposes, and could change its quality according to the production process and environmental factors.

One of the themes of this study is the necessity of a sensor especially designed for ESAAS rather than a general sensor used in the past. We focused on the thermal characteristics of the sensor, and its response time as well as the special shape and stability level the sensor is supposed to have.

C. Study Process and Results

(1)We manufactured a prototype of sensor that is considered to be the best for measuring ESAAS.

Shape: Designed to fit the maintenance requirement.
(Extended the refill cycle of the liquid in the sensor.)

Mechanism: Designed to fit the characteristics of ESAAS.
(Understanding fluidity and thermal characteristics of ESAAS.)

Stability: Designed to withstand a long-term measurement.
(Selection of materials etc.)

Characteristic: Convenience of being able to measure pH and ORP at the same time.
(Two pair of electrodes for pH and ORP are placed in a sensor.)

(2) Using the prototype sensor, we underwent various experiments on thermal characteristics, response time and long-term stability of ESAAS, and analyzed all the data. (For details, see "Reports of Funded Studies" 1994 published by Function Water Research Foundation.)

(3) Results

We could test the sensor to our satisfaction due to our studies this time and our accumulated knowledge. As to the overall capability of the sensor, we could obtain the expected results for response time and maintenance requirement. We conducted the experiments under the same condition this time, but it should be noted that the resulting values change depending on the conditions.

D. Conclusion

ESAAS is expected to be used by many people in the future. Therefore, it is important to understand the water quality to be able to use it safely and effectively. Also it is critical to know the characteristics of ESAAS and maintain it properly to be able to repeatedly produce the constant quality. It is our best hope that this study will help on these matters.

15. Principle & Applications Of Devices Releasing Activated Oxygen

by Makoto Hosoya, Office Hosoya Co., Ltd. & Shoji Kubota, The Society of Water Design

Hydrogen peroxide is decomposed into water and oxygen with the help of a catalyst as shown in the equation (1).

$$2\,H_2O_2 \rightarrow_{CAT} 2\,H_2O + O_2 \quad (1)$$

By the device that produces activated oxygen called Oxidator, the above reaction occurs in the following two stages;

(1) The catalyst decomposes hydrogen peroxide in a Plexiglas container producing oxygen in gas An air cushion at the bottom of the container acts as a valve while preventing water from penetrating the unit.

(2) The ceramics of the Oxidator releases pure oxygen (O_2), and activated oxygen (hydroxyl radicals) have caused various interesting phenomena. The results are as follows;

① The amount of dissolved oxygen is always maintained in the water.

② ・OH reacts with algae and organic matters that pollute water. Therefore the water is kept clean free from bad smell.

③ ・OH is effective in killing bacteria.

④ ・OH reacts with dissolved ionized organic matters in the water and deposits them.

⑤ Plants grow up rapidly.

Hydrogen peroxide is decomposed into water and oxygen with the help of a catalyst as shown below.

$$2\,H_2O_2 \rightarrow_{CAT} 2\,H_2O + O_2 \quad (1)$$

The Oxidator that produces activated oxygen makes the above reaction (1) in two stages as follows;

(1) By a solid catalyst, hydrogen peroxide in the container is decomposed to emit oxygen gas necessary for pushing it out.

(2) Due to the high pressure of oxygen created in the air-tight container, the hydrogen peroxide is pushed out through the air cushion at the bottom of the container and reach a special ceramic container outside to produce pure oxygen (O_2) and activated oxygen (hydroxyl radicals ・OH).

・OH is one of the forms of activated oxygen, and categorized as free radical. Oxygen can be dissolved only to the extent of saturation point, whereas the amount of dissolved oxygen produced by catalytic decomposition of H_2O_2 is increased. O_2 is stable and inactive, but ・OH is especially active among activated oxygen and is quick to react.

According to the measurement by O-NMR, there is a clear difference by time between source water and produced water. A strong impact of ・OH on the water is implied. Also by a surface tension test, the tension of produced water is reduced significantly from that of source water.

On the other hand, there was not much difference in the results of both O-NMR and surface tension tests between source water and hydrogen peroxide water. These facts leave us to infer that there is a chemical composition other than H_2O_2 in produced water. Measurement of free radicals using ESR method made it clear that ・OH is actually produced.

In the process of producing ・OH at the same time as oxygen by decomposing H_2O_2, many interesting phenomena and effects occur as follows;

① The maximum dissolution of oxygen gas in water is much higher than in the case of regular oxygen.

② By oxidation, ・OH decomposes algae and deposited organic matters that pollute water in the tank or pond. There fore, it can keep water clear for a long time. It also prevents bad smell caused by increased nutrients in water.

③ By continuously increasing the amount of ・OH dissolved in water, bactericidal effects can be enhanced.

④ ・OH reacts with iron in the so-called "red water" and precipitates it by agglutination. This way, it can revive the red water that is otherwise unusable.

⑤ Growth of aquatic plants and other plants is speeded.

16. Inactivation Effects Of Acid Aqueous Solution On Feline Virus In Blood, Feces, Urine & Sputum

by Hiroyuki Koyama, Infectious Disease Division, Dept. of Veterinary Medicine, Kitasato University

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This time, we injected feline herpes virus (FHV) or feline calici virus (FCV) into cat's blood. Then we judged the inactivation effect by measuring the titer of virus right after adding EAAS to the solution. We also examined what causes the inactivation effect of EAAS.

Blood, urine, saliva, and stool were obtained from mature SPF cats that show no reaction to virus antibody. The titer of undiluted virus solution are $10^{7.5}$ and $10^{6.7}$ TCD_{50} / 25 μ l. EAAS was produced by Oasis O2 manufactured by Asahi Glass Engineering Co., Ltd. The pH was between 2.54 to 2.56, oxidation-reduction potential (ORP) from 1156 to 1160 mV, residual chlorine (Cl) 32 to 35 ppm. Immediately after the EAAS was added to FCV or FHV solution to dilute to 10 times in volume, both virus were inactivated. The results are summarized as follows;

1. Blood containing EDTA and undiluted solution of FCV or FHV were combined by the same volume. Then EAAS was added twice as much all the way to 1000 times as much. By measuring the titer of virus immediately after adding EAAS, we found that the infectious titer was at 200 times dilution or more for FCV and 100 times or more for FHV.
2. In the same way, EAAS was added to the mixture of urine and virus. In this case, the infectious titer was at 50 times dilution or more and 20 times or more for FHV.
3. In the same way as 1, EAAS was added to the mixture of saliva and virus, the result was the same as the case of urine.
4. 48g of normal stool was combined with phosphate buffer solution (PBS) to make an emulsion. This was further diluted to 25% emulsion by adding more PBS, and the same amount of virus solution was added. When EAAS was combined to this solution, the infectious titer proved to be at 200 times dilution for both FCV and FHV.
5. By stirring for a long time, EAAS was modified to have pH of 2.55 to 2.67, ORP at 800 to 886mV, Cl at less than 0.05 ppm. Even with 200 times as much EAAS as undiluted virus solution, both virus were not inactivated. This seems to be caused by the changes of ORP and Cl.
6. Contrary to the above experiment 1 through 4, 500 times as much EAAS was added to blood. Immediately after, EAAS has changed to have pH2.52 to 2.56, ORP of 634 to 660, Cl at 0.88 to 1.0. Even adding this solution to undiluted virus solution at 200 times volume, neither virus was inactivated. However, when EAAS was combined with blood at 2000 times volume, the pH changed immediately to 2.48 to 2.59, ORP to 1.111 to 1.124, Cl to 20. When this solution was added to undiluted virus solution at 50 times more volume, both virus were inactivated. In this experiment, both ORP and Cl seem to be involved in affecting inactivation of virus.

17. A Field Trial For Estimating Possibility Of Controlling Powdery Mildew Of Cucumber By Function Water

by Yoshikazu Yamaki, Annette Schörner, University Orchard, Faculty of Agriculture, University of Tokyo

Function water was sprayed onto cucumber plants in order to evaluate its effects on powdery mildew. Acid water only, or alternately with alkaline water was sprayed at the intervals of 2 to 4 days. Two kinds of control methods were used, one is no-fungicide spray, the other conventional fungicide spray. Function water, although not as effective as fungicide, apparently reduced powdery mildew symptoms of cucumber leaves from the 18th day after planting the plants for about 2 weeks.

Repressive effects of function water against powdery mildew of cucumber were tested in the farm. Cucumber plants were cultivated in Ninomiya Orchard in the University Farm of Faculty of Agriculture, University of Tokyo located in Ninomiya-cho, Naka-gun, Kanagawa Prefecture. Four experimental areas were set as follows;

1. Conventional fungicide spray area
2. Strong acid water spray area
3. Strong acid water and strong alkaline water alternate spray area
4. No-spray area

The plants were replanted on May 25. pH of strong acid water is about 2.4, ORP is about 1,120. As to strong alkaline water, pH is about 11.5, ORP about 850.

Schedule of function water spray: May 27, 31, June 3, 6, 10, 12, 14, 16, 19, 21, 24, 27, 29, July 2, 7, 10, 12, 14, 18, 21, 24
Schedule of Fungicide spray: May 27, June 2, 7, 12, 16, 21, 24, 30, July 12, 18, 24
Schedule of Insecticide spray: June 2, 5, 9

The symptoms of powdery mildew were recorded only for fully developed leaves and those that have no less than 50% of the surface area. In the early stage until the fourth measurement (12 days after replanting), no effects of spray were observed. On the 16th to 31st days of replanting, the symptoms spread rapidly in the no-spray area, whereas in the fungicide spray area the symptoms were apparently repressed. In the function water spray area, the symptoms were somewhat controlled.

As the sticky-leave disease became prominent, fungicide was sprayed on the 34th day of replanting which further aggravated the powdery mildew. 37 days after replanting, however, the symptoms were most controlled in the fungicide spray area. There were no significant differences were observed in three other areas. On the 45th day, the symptoms worsened so much in the fungicide spray area that there were no significant difference any more from the alternate spray area. One of the reasons for no significant difference between function water spray area and no-spray area on the 37th day as well as between fungicide spray area and alternate spray area on the 45th day seems to be that the fungicide against sticky leave disease helped powdery mildew to propagate.

This study has been made possible by the grant from Function Water Research Foundation and equipment (to produce oxidation potential function water) by Remodeling 21 Co., Ltd. For the nursery and cultivation of cucumber, we received advice of Mr. Hideo Inao of Tama Farm of Faculty of Agriculture, University of Tokyo. We are grateful for their help.

18. Application Of Acid Electrolyzed Water In Dentistry

by Akihiko Shiba, The Third Dept. of Prosthodontics, Faculty of Dentistry, Showa University

Acid electrolyzed water (AEW) is produced by electrolysis of tap water. We verified that AEW has a strong and rapid bactericidal effect with wide range of anti-bacterial spectrum, and furthermore, with biological safety. We investigated application of this AEW to the dental field.

The result of this study indicated that AEW is effective against endodontic treatment, irrigation of periodontal pocket, washing and sterilization of the denture, and hand-sterilization and sterilization of treatment apparatus.

AEW is produced by electrolyzing tap water. This AEW is drawing more attention these days in the dental field as a replacement for conventional drugs. The reason for it is its effect is strong and rapid with wide range of anti-bacterial spectrum. In addition, it is the least harmful to the organism as compared to the conventional drugs.

I have been studying bactericidal and hygienic effects of AEW in the medical field for about 7 years. Here are some of the various findings about application of AEW to the dental field.

A. Sterilization Time and Effects, Anti-bacterial Spectrum

AEW's sterilization effect takes place in 5 to 10 seconds. This effect is believed to come mainly from residual chlorine gas. The chlorine gas attacks amino acids exposed on the surface of microorganism and bacteria, and kill them instantly. The major player is this chlorine gas, although pH and ORP take some roles. This is confirmed by the reaction specificity test of AEW. According to the test, AEW reacts with glycine that has amino group, but not with acetic acid that does not have it.

The anti-bacterial spectrum of AEW is very wide-range. AEW is effective against bacteria, anti-acid bacteria, eumycetes, and virus, especially against MRSA, HBV (B-type hepatitis), HIV (AIDS virus) that are infectious in the hospital. Also against oral bacteria, it is found effective against aerobic bacteria, yeast bacteria and anaerobic bacteria by our experiments.

B. Safety of AEW

Safety for organism is an important issue. Twelve items of safety test have been conducted including hemolysis, cytotoxic, and mutability tests. Concluding from the results, AEW has a little more risk against organism than physiological saline, but the degree is negligible.

C. Medical Application

Among applications of AEW to medical fields, treatment of atopic dermatitis by AEW is outstanding as often televised about the effect. In addition, AEW is used for treatments of cuts, burns, decubitus (bedsore), nostril catarrh and atopic rhinititis. Above all, AEW is applied for cleaning and sterilization before, during and after operations as well as prevention of infections in the hospital.

D. Dental Application

Application of AEW to dental field is also diverse. It is already widely used for dental and periodontal treatments, cleansing after tooth extraction, cleaning periodontal damages, inflammation, tumor, as well as washing hands and sterilization of equipment and dental impression or mold, and for prevention of infections in the hospital. We are not the exception to use AEW clinically.

19. Effects Of Acid Electrolyzed Water In Chronic Periodontitis Treatment -- Preliminary Report

by Ken-ichi Saito, Toshiyuki Nemoto, Dept. of Oral Surgery, Kanto Teishin Hospital

This study investigated effectiveness of acid electrolytic water (AEW) used for treatments of chronic periodontitis. Seven patients were treated by AEW. They rinsed their affected part with approximately 20ml of AEW inserted through a thin needle into the pocket or fistula of their gingiva once a week.

In about a month, some difference was observed in the lesion healing from the pre-treatment conditions. Five of seven patients demonstrated progressive healing with evidence of reduced infectious condition at the lesion.

Clinical application of AEW is more popular these days since it has wide range of anti-bacterial effects against pathogenic bacteria. We have applied AEW for treatments of chronic periodontitis (so called pyorrhea etc.) that many of the middle aged and the elderly in Japan suffer from. We have not found any effective treatments against this disease. Following is a summary from our report.

A. Study Subject

The patients' group consisted of 4 men and 3 women age 38 to 56. Chronic Periodontitis is suppurative inflammation that appear around fistulae or the root of the teeth. It includes those with limited lesion around periphery (peripheral type) and those with extended lesion all the way down to the tip of the root (root-tip type). Four of the patients had peripheral type, three root-tip type. The latter three had fistulae in the gum.

B. Study Method

About 20ml of AEW was inserted through a fine dental syringe needle into the pocket or fistula of the patient's gingiva, and the lesion was cleansed by water pressure. In all cases, the gingiva pocket was curretted first before the cleaning. These procedures were followed once a week, and AEW's effectiveness was evaluated by comparing the lesion's conditions before and one month after the treatment on items such as reddishness, swelling, pain, amount of pus, and disappearance of fistulae. No anti-bacterial agents nor mouth wash were given to the patients before or after the treatment.

C. Study Results

For the peripheral type, three out of four cases saw reduction of reddishness and swelling, and the amount of pus decreased significantly. The other one case did not have much improvement. For the root-tip type, two out of three cases saw disappearance of fistulae. These fistulae have never been cured by anti-bacterial agent or root canal treatment, but have disappeared by the cleaning for once or twice. As to the other one case, fistula still remained but reduction of reddishness and swelling was recognized.

D. Conclusion

In treating chronic periodontitis by AEW for 7 patients, 5 out of 7 cases saw apparent improvement of the inflammation at the lesion. This can be recognized as AEW's effects on the disease. We are planning to test more cases in the future, and also conduct bacteriological research and control studies at the same time.

20. Analysis Of Virucidal & Bactericidal Action By Function (Electrolyzed Oxidizing) Water

by Yoshinobu Shimizu, Dept. of Oral Bacteriology, Tohoku University School of Dentistry

A. Abstract

Electrolyzed oxidizing (EO) water obtained at the anode side by electrolysis of water containing 0.05% of sodium chloride using a diaphragm between the cathode and anode has shown virucidal and microbicidal activities. Comparing virucidal and bactericidal effects of EO water with those of hypochlorous acid using herpes simplex virus type I, polio and streptococcus faecalis, the minimum concentration of chlorine contained in EO water was less than that of hypochlorous acid. This result indicates that virucidal and microbicidal activities of EO water are different from hypochlorous acid, and substances such as HClO, Cl, Cl_2 , H_2O_2 , OH^+ (hydroxyl radical) and so forth seem to synergetically exert virucidal and microbicidal effects by balancing under competitive acidic conditions.

B. Preface

EO water is obtained at the anode side by electrolyzing salt water using a diaphragm. It shows nonspecific virucidal and bactericidal effects. On the anode side, OH is consumed by a reaction described as $4OH \rightarrow 2H_2O + O_2$, and H^+ is accumulated to bring pH to acid side. In addition, hydroxyl radicals (OH^+) and H_2O_2 are produced as well as Cl_2 , HClO, ClO_2 and other oxidants since NaCl is added to the water. HClO has a strong sterilization effect, and sodium hypochlorite (NaClO) is a stable compound as one of sodium salts. EO water (035, 025, 002 type) produced from 0.05% salt water has been found to contain ClO^- at about 8 ppm. There is a good possibility that ClO^- is showing the virucidal and bactericidal effects. After producing HClO by combining HClO and NaClO ($NaClO + HCl \rightarrow Na\ Cl + HClO$) , we compared various types of EO water for their pH, oxidation-reduction potential (ORP), change of mV, amount of Cl, and virucidal and bactericidal effects.

C. Study Results

As more HCl (0.6N) is added to each concentration sample of NaClO, pH dropped down and mV went up. 0.9ml of NaClO or NaClO + HCl solution (pH3.0, 1,000mV) and 0.1ml of herpes simplex virus type I (HSV-1) and polio virus or streptococcus (S.faecalis) have been put together to react in the room temperature for a minute.

Then, the minimum concentration of chlorine (mg/l) to show virucidal and bactericidal effects was examined. This value for NaClO solution was 2.25 against HSV-1. As to NaClO + HCl, the solution of pure water and HCl with equal volume (pH2.68) also showed virucidal effects against HSV-1) Against polio virus, the minimum concentration value was 8.8 for both NaClO and NaClO + HCl. Against S.faecalis, NaClO showed 9.00 and NaClO + HCl 4.35.

Judging from these results, virucidal and bactericidal effects of both NaClO and NaClO + HCl are almost the same, and HSV-1 ceases to be infectious even in chloric acid solution of pH2.7. Then we examined the amount of chlorine included in the solution at minimum concentration as to have virucidal and bactericidal effects for each of 5 kinds of EO water with different salt concentration, electric current and voltage applied. All of them have pH of 3.00 or less and voltage of 1,000mV or more. As to the concentration of chlorine (mg/l), sample A was 43.80, B 4.19, C 8.15, D 4.20 and E 3.44. Measuring the minimum concentration of chlorine (mg/l) as to have virucidal and bactericidal effects, A was 2.74, B 2.10, C 1.02, D 1.05, and E 0.86 against HSV-1. On the other hand, A was 10.95, B 4.19, C 4.08, D 2.10, E 1.72 against polio virus, although only A and D were different from these at 5.48 and 1.05 respectively against S. faecalis.

Lastly, some EO water at concentrations not explicable by the density of ClO^- showed virucidal and bactericidal effects. This indicates that those effects are not caused only by ClO^- but also by synergy among OH^+, H_2O_2 , ClO_2 and other substances. EO water is always produced by the same principle but have all kinds of characteristics depending on the type of machine with different diaphragms, electrodes, voltage and electric current. Its metal-corrosive nature and safety against organism are some of the problems to be solved, but they also seem to be dependent on the type of machine.

21. Efficacy Of Electrolyzed Acidulous Oxidizing Water

by Takashi Okubo, Dept. of Surgery, NTT Tokai General Hospital , Kazuhisa Inuzuka & Hiroki Kawai,
The Central Laboratory for Clinical Investigation, Anjyo-Kousei Hospital Aichi, Japan

In contrast to electrolyzed highly acidic oxidizing water that has been used as disinfectant, acidulous oxidizing water (AOW) has hydrogen ion concentration (pH) of 5.5, redox potential of 800 to 1,000 mV and dissolved chlorine concentration of 50ppm and up.

In the room temperature, the amount of residual chlorine remained high even during the activation test, and the sterilization effect lasted for a long time in a stable condition. In particular, chlorine concentration of the retained gas in the upper part of the preservation reservoir was one-hundredth of that of conventional highly acidic water. This proved that the residual chlorine of AOW is hardly volatile.

In addition, when organic substances are mixed in deactivation tests, AOW proved to be 100 times stronger than highly acidic water. This means AOW is barely inactivated by organic substances. When combined with other general disinfectants, AOW with no excessive acidity is found more effective and less corrosive than acidic water.

From these points of view, we believe that AOW can make up for drawbacks of electrolyzed highly acidic oxidizing water. This new function water is something worth more attention.

A. Preface

Electrolyzed highly acidic oxidizing water that has been used as disinfectant has pH ranging from 2.3 to 3.2, residual chlorine concentration from 7 to 50ppm, ORP from 1,000 to 1,200 mV, whereas AOW has pH of 5.5, residual chlorine concentration of 50ppm or more, and ORP of 800 to 1,000mV. AOW is designed to take advantage of residual chlorine by creating the environment near pH5, which represents the highest possible density of hypochlorous acid. It is expected to have the same level of disinfective effect as hypochlorous acid solution at the density of 200ppm (Fig.1) This is a report on the effects of this new type of function water.

B. Study Method

Effects of AOW was examined by comparison tests with highly acidic oxidizing water conventionally used on the checklist including disinfective effects, inactivation by organic matters, disinfective effects in the hospital environment, metal corrosion, concentration of produced chlorine.

C. Study Results

In inactivation tests under the room temperature, AOW had high residual chlorine concentration, and showed stability with a long-lasting sterilization effect. Especially the concentration of chlorine gas trapped at the top of the container was about 100 ppm in case of highly acidic oxidizing water as opposed to around 1 ppm in case of AOW. Therefore, it was found that the residual chlorine barely has volatility in the latter case (Table 1).

In inactivation test by mixing organic matters, the highly acidic water lost its disinfective effect at the density of 0.01% or more, whereas AOW did not lose the effect even at 1% (100 times). This indicates the fact that AOW is less subject to inactivation by organic matters (Fig. 2 & 3).

Combining with other general disinfectants, it is understandable that AOW with moderate acidity is more advantageous. As to the corrosive function against metal, the corrosion potential was somewhere between 470 and 800 mV, which is lower than that of sodium hyperchloride. That is, AOW has low metal-corrosion function.

D. Analysis

From all these results, AOW is considered to be a new type of function water that can make up for the drawbacks of conventional strong acidic water in terms of inactivation by organic matters as well as metal corrosion function. In addition, AOW's concentration of residual chlorine is so high that it is effective for preventing infections in the hospital.

* Refer to the original document for the following figures;
  - Fig.1: Equipment to produce AOW
  - Fig.2: Disinfective effect of AOW
  - Fig.3: Disinfective effect of super-acidic oxidizing water

Table 1: Concentration of chlorine gas by environmental conditions

Type of acidic water Place of measurement	Highly acidic oxidizing water pH=2.39, ORP=1,122mV residual chlorine 20ppm, 25℃	Acidulous oxidizing water (AOW) pH=5.55, ORP=890mV residual chlorine 80ppm, 25℃
Upper opening of 100 liter tank	100 ppm	1 ppm
Opening of small portable tank	30	1 ppm or less
Near faucet, small portable tank	3	ditto
Bottom of hand-washing sink	3	ditto
Near faucet, hand-washing sink	7	ditto
Empty container of acidic water	9	1 ppm
Mop washing water in bucket	1 - 3	1 ppm or less

22. Infection Control by Electrolyzed Strong Acid Solution In Intensive Care Unit

by Keiji Kumon, Naoki Yahagi, Yasuhiko Watanabe, Masaki Haruna, Jyunki Matsui, Hideaki Hyashi, Yukiko Kishizoe, Masakakazu Sakamoto, Miyuki Watanabe, Surgical Intensive Care Unit, National Cardiovascular Center

We studied prophylactic effects of oral cavity lavage by electrolyzed strong acid solution (ESAS) for patients of silent aspiration pneumonia intubated after cardiovascular surgery as compared to the effects of conventional method applying iodine solution for infection control in the surgical intensive care unit. One time lavage by ESAS resulted in a slight decrease in colony counts in the oral cavity to the same extent as in the case of conventional method. After the lavages for several times, however, the colony counts decreased significantly. The effects of lavage by ESAS exceeded those by iodine solution.

We concluded that the oral cavity lavage by ESAS is recommended as an alternative for preventing silent aspiration pneumonia for intubated patients in the intensive care unit.

A. Preface

Serious patients in the intensive care unit have lower immunity against infections. They are also connected with various artificial devices such as intravenous catheter, tracheal intubation, bladder balloon catheter, and other drains necessary for evaluating quick changes of patients' conditions and treatment. There are all kinds of possibilities for pathogens to enter the human body. Therefore, the patients are susceptible to the infections, and once infected, they easily get in critical conditions difficult to treat. This is why very tight infection control is expected in the intensive care unit.

We issued a report last year on the effects of cleaning hospital environment, hand sterilization by ESAS, and the effects of ESAS on the treatment of silent aspiration pneumonia which is a serious infectious disease. This time, we report our study results on the effects of oral cavity lavage by ESAS to prevent silent aspiration pneumonia which is major complications of serious patients who need artificial respiration as compared with that by conventional method by iodine solution.

B. Study Subject and Method

57 adult patients who had gone through cardiovascular operation were examined. 11 of them were given oral cavity lavage by 20ml of ESAS, 21 of them were given 40ml, 14 of them were given 20ml of iodine gargle diluted to 30 times, 11 of them 40ml of the same gargle. The bacterial culture samples were taken starting from the first oral cavity lavage in the ICU, and continued to be taken several times around the times of the lavages.

Carrymate was used for the method of sampling. Secretion of the oral cavity was taken by a swab inserted through the corner of the mouth or a bite block. The virus were cultivated in media of chocolate agar, Sabouraud agar, blood agar, and MacConkey agar. Only aerobic virus were cultivated by seed swab method. The lavage of oral cavity was done by injecting cleansing liquid through a syringe into the corner of the mouth and sucked at the same time.

For both one-time and several-time lavages, changes of colony counts of gram-positive virus and negative virus were compared between the conditions before the first and after the last (second to sixth) lavages. The amount of virus colony was divided into 5 stages. 10^4 or more was categorized as stage 5, 10^3 or more 4. 10^2 or more 3, 10 or more 2, less than 10 1, and negative 0. The results are shown as average$\pm$standard deviation. Statistical studies were conducted by paired tests with less than 0.05 as significant correlation.

C. Study Results

Around the time of one-time lavage, all the group showed slight decrease of colony counts, although significant correlation was identified only for the colony counts of gram-positive virus of the group given 20ml of iodine gargle diluted to 30 times, and gram-negative virus of the group given 20ml of ESAS (Table 1)

The effects of several-time lavage were recognized for both groups of ionized gargle diluted to 30 times and ESAS. However, the degree of decrease in bacteria colony counts was more distinct for the groups that used ESAS, especially against gram-negative virus (Table 2).

Table 1: Effect of one-time lavage of oral cavity

		n	before lavage	after lavage	P
Diluted iodine solution					
20ml	G(+)	44	4.18±1.08	3.93±0.93	0.027
	G(−)	44	4.41±1.13	4.23±0.94	NS
40ml	G(+)	30	3.07±1.89	3.00±1.76	NS
	G(−)	30	4.80±0.48	4.67±0.55	NS
ESAS					
20ml	G(+)	34	4.06±0.81	3.91±1.14	NS
	G(−)	34	3.97±0.94	3.68±1.20	0.034
40ml	G(+)	68	3.34±1.41	3.24±1.39	NS
	G(−)	68	3.78±1.24	3.71±1.29	NS

G(+): gram-positive virus G(−): gram-negative virus NS: Not Significant mean±SD

Table 2: Effect of several-time lavages of oral cavity

		n	before lavage	after lavage	P
Diluted iodine solution					
20ml	G(+)	11	4.55±0.69	3.55±1.04	0.004
	G(−)	11	4.91±0.30	4.27±0.79	0.013
40ml	G(+)	8	3.25±1.75	2.88±1.89	NS
	G(−)	8	4.88±0.35	4.63±0.52	NS
ESAS					
20ml	G(+)	11	4.37±0.67	3.27±1.56	0.019
	G(−)	11	4.27±0.65	3.00±1.55	0.015
40ml	G(+)	19	4.05±0.85	2.79±1.58	0.002
	G(−)	19	3.84±0.83	3.37±1.54	NS

G(+): gram-positive virus G(−): gram-negative virus NS: Not Significant mean±SD

D. Analysis

Judging from the results of our study, the disinfectant effect of oral cavity lavage by ESAS is comparable to that by conventional iodine solution diluted to 30 times. In case of lavages for several times, ESAS showed more effective reduction of bacteria colony counts than iodine solution after the lavages. It seems that ESAS is good for oral cavity lavage.

However, in case of one-time lavage, the colony counts did not drop down as much as expected by both 30 time dilution of iodine solution and ESAS. Some of the reasons for this seem to be deteriorating self-cleansing function in the oral cavity after the operation, its long-lasting dryness, difficulty of care during the operation. Furthermore, it seems to be the result of increased colony counts of bacteria because of bleeding in the oral cavity due to the damage by intubation, in addition to the fact that both ESAS and 30 time dilution of iodine solution were inactivated immediately after contacting organic matters in the oral cavity.

On the other hand, the amount of solution used for one-time lavage was increased from 20ml to 40ml, and it did not result in much improvement in the data. However, after the lavages repeated 2 to 6 times, significant reduction of colony counts was recognized for both gram-positive and gram-negative virus in each group with a few exceptions. It became clear that the oral cavity lavage is effective for preventing aspiration pneumonia caused by silent aspiration, which is virus found in the oral cavity. Nevertheless, patients who just had an operation have such poor conditions in the oral cavity that the number of lavages should be increased as necessary, as we believe, according to the degree of contamination in there.

E. Conclusion

It was confirmed that the lavage of oral cavity by ESAS to prevent aspiration pneumonia for serious patients who need artificial respiration is no less effective in reducing the colony counts of bacteria than that by conventional iodine dilution.

23. Effects Of Function Water On Skin Ulcers

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There have been great difficulties in managing infections of burn patients. Effects of antibiotic agents are uncertain. Recently, function water has been used as disinfectant in many hospitals, and its effects are getting recognized. In this study, we tried to identify changes of bacterial flora on burned skins by applying function water, and found out it affects bacterial flora distinctively. (No bacteria were identified during the first 3 hours after disinfection.) To the best of our knowledge, function water is useful in managing disinfection of burn patients.

A. Preface

In treating burns, prevention of infections is still an important issue. Increased resistance of bacteria against multiple antibiotics combined with uncertain effects of drugs applied to the burn lesion due to its specificity make the treatment very difficult. The antibiotics injected in the body would not get to the lesion surrounded by thick layers of dead tissues where the blood does not circulate well, and they hardly reach the effective concentration for treatment. Antibiotics for external application also have hard time getting into the depth of dead tissues.

B. Purpose of Study

Function water has been used these days for cleaning medical equipment, interior surfaces, hands of medical staff etc., and its effects are getting recognized. To examine the effects of function water on infected lesion of burn patients, we applied it to the lesion of third degree burn, and measured its changes of bacteria counts by time.

C. Study Method

Once the scab of third degree burn after 4 weeks has been cut off, function water and iodine solution were applied to each ulcerated skin. Using food stamps sold in the market, bacteria colony counts in the lesions were measured before and every one hour after the application up to 8 hours later. In addition to these two tests, a control sample was prepared without applying any solution for measurement. The food stamp was pressed hard on the skin, then the temperature was kept at 37℃ for 48 hours to cultivate the bacteria. The number of colonies was counted by naked eyes. Aside from these food stamp tests, regular bacteria cultivation tests were conducted for each part.

D. Study Results

In the lesions where function water or iodine solution was applied, no bacteria were found for three hours after the application. The number of bacteria colonies increased gradually 4 hours after the application, and tended to return to almost the original number in 8 hours. For the control sample, there was no tendency for the colony counts to drop down.

E. Conclusion

According to our measurement, function water had almost the same effect of reducing bacteria colony counts as the iodine solution, and was considered to be clinically effective. This time, only function water was applied to preempt the effect of physically removing bacteria by cleansing. If we come up with better way of applying the solution, it can become an effective means to fight infections in the burn lesion.

*See the graph in the original text: Changes of colony counts by time on the ulcerated skin.

24. Treatment Of Infectious Ulcer With Function Water

by Kiichi Inagawa, Takahiko Moriguchi, , Dept. of Plastic & Reconstructive Surgery, Kawasaki Medical University

Chronic ulcer caused by infections by MRSA (Methicillin Resistant Staphylococcus Aureus) and others is hard to heal. We often see chronic ulcer resistant to surgical treatments or various conservative treatments. Therefore, we tried conservative treatments using function water to our satisfaction.

The lesion was washed by function water once a day. 12 cases of infectious ulcer are reported here. Out of these, 5 cases were healed, 3 cases well granulated, and 4 cases had the infection disappear.

The definition of function water is not clarified yet. So far, the best definition seems to be "solution that is produced by combination of water and electrolyte that is given physiochemical treatment and a certain level of activation energy, and can be applied to life science."

The function water we used this time is produced in the electric field for physiochemical treatment. More specifically, acidic solution with low pH was produced at the anode by electrolysis of electrolytes such as sodium chloride and potassium chloride using irreversible electrodes separated by a membrane. Because chlorides are used as electrolyte, chloric acid, active chlorine ion group, and active oxygen ion group are produced. This is similar to the process that occurs in organism as a result of redox reactions.

For example, it is already confirmed at the molecular level that the bactericidal effect of neutrophil is caused by active oxygen ion group. The active oxygen ion group in acidic solution shows the similar function. Therefore, this acidic solution is considered to be useful as disinfectant and getting more popular in the medical field. Above all, there are a number of reports about its effects on infections in the hospital as well as the promotion of granulation on the skin.

This time, we treated 12 cases of chronic ulcer resistant against various conservative treatments by acidic solution (hereinafter called function water). They consist of 2 cases of decubitus (1 at sacrum, the other at ischium), 3 cases of burn (1 at sinciput, 1 at knee, the other at knee), 3 cases of external skin injury (2 at leg, the other at foot), 3 cases of skin fistula (1 at sinciput, 1 at knee, the other at leg), and 1 case of infection by inserting a tissue expander (at cheek).

Pus came out of each lesion. In 6 cases, MRSA was detected in the pus. As a treatment, the lesion was washed by function water once a day. As a result, 5 cases saw the lesions covered by epithelium, 3 cases did not go as far but had granulation, and the rest of 4 cases saw remission of pus and foul odor. During the treatment, no abnormality was identified seemingly caused by side effects of function water whether is self-conscious or not. It is reported that lavage of the lesion by function water demonstrates an excellent débridement effect as compared to that by only salt water or iodine solution. In our tests, the débridement effect was recognized since, according to our experience, it was easier to remove the dead tissues in the lesion than otherwise, and also remission of pus and foul order was identified.

Furthermore, the speed of this function deserves special mention. In all cases, remission of pus and foul order was identified within 3 days of function water treatment. However, if infection reached deep into the tissues, pus could not be stopped completely. It seems possible that this problem is solved if the application method is somehow improved. Finally, function water can be applied on burn lesions without damaging newly formed granulation. Rather, epithelium was formed quickly by the granulation effect of function water.

25. Experiences Of Treating Infectious Wound & Chronic Ulcer With Function Water

by Katsumi Tanaka, Tohru Fujii, Dept. of Plastic & Reconstructive Surgery, Nagasaki University School of Medicine

In cases of infectious wounds and chronic ulcers such as diabetic and ischemic ulcers, it is necessary to treat them by washing and cleansing before application of ointment therapy or performing an operation. Bathing, washing and wet dressing (wet to dry dressing) with function water was applied to 37 clinical cases. Then we observed conditions of the wounds and bacterial changes.

In this study, all cases saw improvement in regards to bactericidal effects and granulation. Among these, the wounds were conservatively healed in 7 cases, whereas the rest of 30 cases had the wounds gradually cleansed and reduced. In most cases, the bacterial counts have dropped down to aseptic condition. It is implied that function water has bactericidal effects in clinical cases and effectively promoted wound healing.

A. Preface

Cleaning the lesion is needed first before the operation or ointment therapy to treat infectious wounds and chronic ulcers. We tried to treat them by bathing, cleansing or wet dressing with function water, and observed remission of infections and formation of granulation to evaluate effectiveness of this method. Our study reports on how to apply function water, list up the clinical cases, and drew a conclusion on the effectiveness of function water.

B. Study Subject and Method

Function water was applied to 37 patients who were treated at the Department of Plastic and Reconstructive Surgery in Nagasaki University, School of Medicine during 12 months period from August 1994 to July 1995. Among them, 28 were men, 9 women, age 3 to 94 averaging at 46.

17 cases had infectious wounds due to external damages or operation, 7 had chronic ulcer caused by blood vessel malfunction, 3 had gangrene or chronic ulcer accompanied by diabetes, 8 fresh burns, 2 decubitus.

The methods of applying function water differ slightly by clinical case. In general, bathing or cleaning by function water and gauze exchange by wet to dry dressing were applied to the patients of infectious wounds and chronic ulcers. In case of fresh burns, function water was used to clean and remove secretion and pus on the lesion at the time of bandage exchange. The method and frequency of applying function water were decided on a case-by-case basis and were modified whenever the symptoms changed.

C. Evaluation

Criteria were set for each symptom to conduct economic observation. Among these criteria, lesion's characteristics were categorized into location, size, condition of granuloma (color, bleeding), amount and character of secretion, degree of pain, foul odor, extent of epithelium formation. As to bacterial infections, bacteria were cultured on a regular basis. They were identified and the patient's sensitivity was checked. At the same time, types of disinfectants and side medicine, dressing materials, and operation procedures were described.

Regarding the side effects, we made notes about stimuli against skin and membrane, sharp pain, and allergy.

D. Study Results

The period of treatment by function water was 1 week minimum to maximum 4 months. In all the 37 cases, each lesion was cleaned and reduced. None of them got worse. The bacteria turned negative or got reduced in 19 cases. In the worst 3 cases where infections spread to the entire body, bacteria colony counts did not decrease dramatically, but the lesions have been reduced and cleaned. 7 out of 37 cases have healed conservatively whereas the other 30 have gone through operations.

As to the side effects, 1 case had reddish skin immediately after the application of function water, and another had irritation at the lesion. Since the symptoms were so light that the application has been continued and eventually they healed by themselves without deterioration. No abnormality was found for other treatment cases.

There are more to be clarified about bactericidal effects and efficacy of function water. However, we believe that cleaning the lesion promotes its healing when function water is used for the treatment of infectious wounds and chronic ulcers.

26. Treatment Of Skin Infection Ulcer With Function Water

by Hiroyuki Kanazawa, Yoshiyuki Minamimoto, Kouichi Honda, Hiroharu Igawa, Dept. of Plastic & Reconstructive Surgery, Hokkaido University, School of Medicine & Tsuneki Sugihara, Keiseigeka Memorial Hospital

Function water has unique characteristics including high positive oxidation-reduction potential, strong acidity, high concentration of dissolved chloride and oxygen. Skin ulcer with infection by MRSA (Methicillin Resistant Staphylococcus Aureus) is hard to heal. We, plastic and reconstructive surgeons, treat skin ulcers resistant to surgical procedures of various conservative therapies. We treated the ulcers by function water and have obtained satisfactory results. We hereby report 13 cases of ineffective ulcer.

This clinically applied therapy proved to be so effective against the symptoms that it can be conveniently applied to many more.

A. Preface

In the past several years, Methicillin Resistant Staphylococcus Aureus (hereinafter called MRSA) is becoming the main cause of infections in the hospital. Since our ward combines plastic and reconstructive surgery with dermatology, patients of chronic diseases and skin ulcer due to decubitus as well as those who need high-tech and long-term treatments are concentrated.

Under these circumstances, it is known that strong acidic electrolyzed solution (hereinafter called function water) has a powerful bactericidal effect, can be easily produced, and is very cost-effective. The bactericidal effect of function water comes from physical function of oxidation-reduction potential, which is proved to have very low toxicity compared to chemical agents.

Therefore, in our department with many skin ulcer patients, it is expected to be widely used if clinical effects and safety of function water are established. This time, we would like to present some cases of conservative treatment against infectious skin ulcer by function water together with our analyses.

B. Study Subject and Method

Function water was applied to 13 patients of MRSA-infected skin ulcer from December 1994 to September 1995. 9 of them were men, 4 women, age 16 to 76 averaging at 44. 4 cases were decubitus ulcer, 2 burn ulcer, 6 infectious ulcer due to injury or operation, the other was ulcer caused by blood vessel malfunction.

Function water was produced by the membrane-type electrolyzer installed in the hospital. It was stored in shaded airtight plastic bottles at the room temperature. The entire volume was renewed every week.

C. Study Results

The period of application of function water ranged from 1 week to 1 month. 12 out of 13 cases saw reduction of secretion, cleaning of the lesion, benign granulation etc. In addition, the bacteria turned negative with reduced colony counts. In one case, almost no changes were observed during the treatment by function water. No particular side effects were recognized in all cases.

D. Analysis

Because of its high oxidation-reduction potential, function water kills bacteria by taking away their electrons and oxidizing them several seconds after the first contact. Function water itself gains electrons and gets neutralized to turn to low-concentration salt water. Unlike regular bactericidal chemical agents (disinfectants), function water does not have problems of osmosis or residua of chemical substances.

Among others, bactericidal effects of function water are reported to be effective against not only general germs such as yellow staphylococcus, coliform (Escherichia coli) and bacillus pyocyaneus (Pseudomonas aeruginosa), but also against drug resistant bacteria such as MRSA. Function water is also said to have even virucidal and eubactericidal effects.

We have applied function water to treat 10 patients of infectious skin ulcer by washing the lesion. In comparison with the effects by salt water, we had the following impression about function water;

1) The lesion was cleaned and benign granulation occurred more rapidly.
2) Epithelium formation from surrounding tissues was made more quickly.
3) The total period of treatment was shorter.

As to MRSA, lavage by function water made it turn negative quicker than that by conventional method. However, we also had a hunch that it is not easy to completely kill bacteria in deeply infected lesions.

27. Electrolysis Conditions Of Tap Water & Composition Of Alkaline Water

by Zempachi Ogumi, Yoshiro Tomida, Div. of Energy & Hydrocarbon Chemistry, Graduate School of Engineering, Kyoto University, & Kenji Kikuchi, Dept. of Materials Science, University of Shiga Prefecture

Impacts of electrolytic conditions on the composition of electrolyzed water were examined. The structure of the experimental cells was similar to that of commercially available apparatus. However, the quantity of electricity passed per unit water volume was ten times larger than that designed for commercial use aiming at testing under accelerated conditions.

Metal dissolution of electrodes into electrolyzed water was examined. Platinum-coated titanium, ferrite and stainless steel were tested as electrode materials. As to ferrite electrodes, the content of Ni (II) went up immediately after the electrode polarity was reversed while ion concentration decreased with electrolysis time. Using nickel-free ferrite electrodes, no nickel was detected. Stainless steel anode resulted in high concentration of Cr (VI) and Ni (II) above regulated maximum in electrolyzed water. Concentrations of formaldehyde and acetaldehyde as well as trihalomethane in electrolyzed alkaline water has increased during electrolysis. This increase was dependent on the properties of the separator.

Chlorine came out at the anode by permeating through the separator causing a haloform reaction with organic matters to produce trihalomethane. Electroosmosis seemed to play an important role in this transport.

A. Preface

We manufactured a prototype apparatus to produce alkali ionized water with similar structure to those sold in the market. Electrodes and membrane sold at stores were used. By this apparatus, we studied electrolytic conditions and the composition of electrolyzed water.

B. Experiment

Many alkaline-ion electrolyzers use tap water supplied to the cells after going through active carbon. In our study, we followed this process to supply source water to our apparatus with or without calcium lactate. The electrolysis was conducted by constant electric current at 0.3A. Since the flow of source water was slow at 2 liter/hour, the quantity of electricity passed per unit volume of water was 10 times larger than that of a regular electrolyzer in the market.

C. Study Results and Analysis

Source water was electrolyzed for an hour using a separator (septum) made of polyester with high affinity treated by sucrose acid ester. Metal ions were analyzed in the produced solution. During this process, the electrolyte moves from the anode cell to the cathode side by electroosmosis.

In the electrolyzed water produced with electrodes made of platinum and iridium-coated titanium, no oxidation dissolution of electrode materials was detected. Fe^{2+}, Fe^{3+}, and Ni^{2+} were found in both anodic and cathodic solutions. When stainless steel was used for electrodes, ions such as Fe^{2+}, Fe^{3+}, and Ni^{2+}, CrO_4^{2-} were detected in anodic solution, whereas no CrO_4^{2-} was found in cathodic side. This means Fe^{2+}, Fe^{3+}, and Ni^{2+} that were produced by oxidation dissolution of electrode materials in the anode cell have shifted to cathode side, but CrO_4^{2-} remains in the anode cell. Using ferrite electrodes that does not include nickel, or negative ion exchange membrane for the separator, no Ni^{2+} was detected in the cathode cell.

In the next step, we examined changes of metal ions in the electrolyte when the electrode polarity was reversed. In case of electrodes made of titanium coated with platinum and iridium, no oxidation dissolution of the electrode materials was detected. When ferrite electrode was used on the other side of platinum-coated electrode, high concentrations of Fe^{2+}, Fe^{3+}, and Ni^{2+} were detected in cathodic solution (alkaline) immediately after the polarity of ferrite electrode was switched from negative to positive. In the same token, Fe^{2+}, Fe^{3+}, and Ni^{2+}, and CrO_4^{2-} were detected in case of stainless steel electrodes. In both cases, ion concentration in the negative cell decreased rapidly (Fig.1).

We also examined changes of organic matters in the source water. First of all, we studied the effects of calcium lactate to be added to tap water treated by active carbon. Even without adding calcium lactate, formaldehyde and trihalomethane not included in tap water were found in the electrolyte. When acid lactate was added to the source water, concentration of chloroform in the cathodic solution went up from 0.003ppm to 0.059ppm, acetaldehyde concentration in the anodic solution increased from 0.02ppm to 0.81pm, whereas residual chlorine dropped down from 1.0ppm to 0.01ppm. At the anode, chloride ions are electrolyzed and produce chlorine, which is transported to cathode side by electroosmosis.

In the alkaline solution contained in the cathode cell, the chlorine produces trihalomethane by haloform reaction. Taking advantage of these facts, the speed and effects of electroosmosis by different membranes were studied. The types of

membrane were polyester sheet (SP) treated by sucrose ester to give hydrophilicity, vinylidene-fluoride-coated polyester sheet (FP), mixed fabric sheet of polytetra-fluoroethylene and polyethylene-terephtharate (TE), and polyethylene sheet (PS).The results are shown in the table 1 below. Wiedeman constant, which indicates the speed of electroosmosis in our measurement for SP, FP and TE were 1.38, -0.15, 0.21 $cm^3\ S^{-1}A^{-1}$ respectively. If the constant is very small, trihalomethane concentration got smaller when FP and TE were used for the membrane. In other words, it was found that the speed of electroosmosis was an important factor to determine the haloform reaction.

Furthermore, to confirm the effect of electroosmosis, the source water was supplied to the pressurized cathode cell so that the flow of electrolyte through the membrane was from cathode to anode side against the direction of electroosmosis. As a result, no formaldehyde, acetaldehyde nor trihalomethane was found in the cathodic solution.

D. Conclusion

Using a ferrite plate as anode, high concentration of Ni^{2+}, and using stainless steel, high concentration of Ni^{2+} and CrO_4^{2-} appeared at the anode. Especially after the anode turned to cathode by reverse electric current, high concentration of Ni^{2+} and CrO_4^{2-} remained in the alkaline water for a while. However, as time goes by, the concentration gets lower rapidly. By this electrolysis, concentrations of formaldehyde, acetaldehyde and trihalomethane increase. Since the rate of increase depends on electroosmosis, it became clear that the speed of chlorine molecules produced at the anode by oxidizing chloride ions to move into the cathode cell is an important factor.

28. Safety Evaluation Of Function Water

Ⅱ. 1-month & 6-month Repeated Oral Dose Tests For Electrolyzed Basic Aqueous Solution In Rats

by Atsunobu Matsuo, Hitoshi Yamamoto, Nobuaki Ni-i, Takeshi Hisa, Motohiro Nishikawa, Noriko Ktsutou, Yohkazu Matsushima, Shigeru Morita, Yukio Yanagimoto, Life Science Laboratory

In order to evaluate effects of function water on human health, electrolyzed basic aqueous solution (EBAS) with various pH (11.0, 10.0, and 9.0) was given orally to male and female rats of Sprague-Dawley strain at 20ml/kg/day in 1-month and 6-month toxicity tests where the control group was given deionized water during the period. In addition, a recovery group was tested for 2 weeks.

Body weights, food and water intakes were measured once a week for the first 3 months and thereafter once a month. Biochemical examinations such as urinary, hematological and serum exams were also performed at the end of both tests. By autopsy, major organs and tissues were removed and weighed. They were fixed in 10% neutral formalin for a pathological exam. No apparent adverse effects of EBAS were observed in both of the toxicity tests.

Water is drawing public attention in the health-oriented trends these days. Among others, alkaline ionized water is used by many to promote health in everyday life. It is reported that alkaline ionized water has some effects such as repressing abnormal intestinal fermentation as well as controlling gastric acid. Therefore, we performed repeated oral dose tests of EBAS for 1 month and 6 months using rats. Here is our report on the tests.

A. Test Materials and Method

(1) Lab animals and their management

All the rats used in the experiment were male and female SD rats (SPF: bought from Japan Charles River Co., Ltd.). They were kept in the lab for 7 days before the test. 4 groups of 15 male and 15 female rats were prepared for each of 1-month and 6-month tests (one each was a control group). In each group, 5 rats were designated for recovery tests. They were all raised in a barrier-system breeding room with the temperature at 22±3℃, humidity 55±10%, ventilation ratio 12 times/hour or more (all fresh air), and 12 lighting hours/day. They were given free access to solid food sold as NMF (produced by Oriental Yeast Industry Co., Ltd.) and tap water.

(2) Preparation of test materials and method of dosage

Solution of calcium lactate (Wako Junyaku Industry Co., Ltd.) was added to the electrolyzer certified by Alkaline Ionized Water Association Unified Standard. Alkali-ion solutions with pH11.0, 10.0 and 9.0 (calcium ion at 30±10ppm in all cases) were prepared for the test. The rats were forced oral dose of them for 1 month or 6 months. Solutions of pH11.0, 10.0 and 9.0 were given at the rate of 20ml/kg/day using a gastric balloon made for rats. Purified water was given at 20ml/kg/day to the control groups. For each of the test groups, a recovery group was tested for two weeks.

(3) Test items

Tests were conducted on the items ranged from general observation, measurements of body weights, intake of food and water, urinal, hematological and serum exams. Weight of organs, their weight percentage, and pathological tests were also examined.

B. Test Results and Analysis

In all of the above-described tests for both 1-month and 6-month groups, alkali ionized water did not result in any toxicity. Among these tests, the serum exam showed some increase in GOT (glutamate-oxaloacetate transaminase) and changes in the quality of some electrolyte, although these changes were within the normal range.