The pH of water from various sources: an overview for recommendation for patients with atopic dermatitis

Kanokvalai Kulthanan, Piyavadee Nuchkull*, and Supenya Varothai

Department of Dermatology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand

Background: Patients with atopic dermatitis (AD) have increased susceptibility to irritants. Some patients have questions about types of water for bathing or skin cleansing.

Objective: We studied the pH of water from various sources to give an overview for physicians to recommend patients with AD.

Methods: Water from various sources was collected for measurement of the pH using a pH meter and pH-indicator strips.

Results: Bottled drinking still water had pH between 6.9 and 7.5 while the sparkling type had pH between 4.9 and 5.5. Water derived from home water filters had an approximate pH of 7.5 as same as tap water. Swimming pool water had pH between 7.2 and 7.5 while seawater had a pH of 8. Normal saline and distilled water had pH of 5.4 and 5.7, respectively. Facial mineral water had pH between 7.5 and 8, while facial makeup removing water had an acidic pH.

Conclusion: Normal saline, distilled water, bottled sparkling water and facial makeup removing water had similar pH to that of normal skin of normal people. However, other factors including benefits of mineral substances in the water in terms of bacteriostatic and anti-inflammatory should be considered in the selection of cleansing water.

Key words: pH of water; Atopic dermatitis

INTRODUCTION

Water is necessary and fundamental to life. Water is a molecular substance that has unique chemical and physical properties related to functions in the human body [1]. However, water itself can cause skin irritation as demonstrated by occlusion experiments. Functional damage of the skin is shown by increased transepidermal water loss (TEWL). Factors that might account for the irritancy of water include pH, hardness, osmolarity, temperature and extraction of natural moisturizing factors in the stratum corneum [2]. The chemical content of water may also be another factor. Water rich in calcium salts is...
likely to irritate skin more easily [3].

A key feature of patients with atopic dermatitis (AD) is dryness of the skin caused by dysfunctions of the skin barrier with increase of TEWL [4]. Patients with AD have increased susceptibility to irritants [5]. Subramanyan [6] suggested that soaps and hot water temperature during showering or bathing are irritating factors. Thus, contacts with water should be minimized, moderately heated water should be used, and mild syndets with an adjusted hydrogen ion concentration (pH) (acidified to pH 5.5-6 in order to protect the acid mantle of the skin) should be used for cleansing [6, 7]. The value of diluted sodium hypochlorite baths and intranasal mupirocin for moderate to severe AD in infection-prone patients are suggested by some studies [8, 9].

Some patients with AD have various concepts or questions of using various type of water for bathing or skin cleansing. In underdeveloped or developing countries, some patients are afraid of contamination in tap water or underground water. They sometimes use bottled water, normal saline, or even distilled water for their facial cleansing. Thus, our aim is to study the pH of water from various sources to give an overview for physicians to recommend to patients with AD or even patients with dry sensitive skin.

MATERIALS AND METHODS

Available water from various sources was collected for measurement of the pH. These included bottled drinking water (still water, sparkling water, still mineral water, and sparkling mineral water), water derived from water filter, tap water, boiled tap water, swimming pool water, rainwater, waterfall water, river water, seawater, distilled water, normal saline 0.9%, facial mineral water and make up remover water.

pH measurement was performed using a pH meter (Thermo Scientific Orion 2 Star, Beverly, MA, USA) and pH-indicator strips (pH 0-14 Universal indicator strips, Merck, Darmstadt, Germany). Each sample was measured twice. Then average pH values were calculated.

RESULTS

The average pH value of water from various sources measured by pH meter and pH indicator strips were shown in Table 1. Bottled drinking water using reverse osmosis plus ultraviolet (UV) and/or ozone treatment to kill organisms had pH between 6.9 and 7.5. Bottled drinking water of sparkling type which carbon dioxide gas is filled during bottling process had an approximate pH between 4.9 and 5.5.

Bottled mineral drinking still water had pH between 7.1 and 7.5 while the sparkling ones had pH between 5.3 and 6. Water derived from home water filters had an approximate pH of 7.5 as same as tap water, whereas boiled tap water had a slightly higher alkaline pH.

Swimming pool water had had pH between 7.2 and 7.5 while seawater from the Gulf of Thailand had a pH of approximately 8. Rain water in Bangkok had a pH of 6 while the water from the Chao Phraya River in Bangkok had pH of more than 7. Normal saline and distilled water had pH of 5.4 and 5.7, respectively. Facial mineral water had pH between 7.5 and 8, while facial makeup removing water had an acidic pH.

DISCUSSION

Conflicting views about cleansing the skin in patients with AD are proposed. Some authors suggested that the dry skin of patients with AD could not tolerate soaps and frequent baths [10, 11]. In contrast, even normal of skin of AD is colonized by Staphylococcus aureus, so frequent baths, regular use of soap or antiseptic soap to remove crusts, scales, dirt, and organisms on the skin are suggested by some authors [12].

However, some patients with AD have exacerbated skin lesions or dry skin when frequent swimming or bathing. Seki et al. [13] reported that the water-holding capacity of the stratum corneum in patients with AD is sensitive to free residual chlorine exposure. Most of water supply systems in many countries use chlorine as a disinfectant. Others are chloramines, chlorine dioxide, ozone and UV [14]. Public swimming pools are usually disinfected by gaseous chlorine or sodium hypochlorite and cartridge filters. Some of disinfection by products (DBPs) such as halogenated acetic acid and haloketones can irritate eyes, skin and mucous membrane [15]. According to the Centers for Disease Control and Prevention (CDC), pH of swimming pool should kept between 7.2 and 7.8 in order to keep the germ-killing power of chlorine and cause less irritation of the eyes and skin of swimmers [16]. In our study, swimming pool water had pH between 7.2 and 7.5.

Bottled water is an alternative to municipal water because of its...
### Table 1. The pH of water from various sources

| Type of water                                | Sample | Sources/processes/composition                                                                                     | Average pH of water by pH-indicator strips | Average pH of water by pH meter |
|----------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------------|
| Bottled drinking water (still water)         | 1      | reverse osmosis plus ultraviolet and ozone water treatment                                                      | 7.0                                       | 7.15                            |
|                                              | 2      | microfilter plus ultraviolet and ozone water treatment                                                          | 7.5                                       | 7.39                            |
|                                              | 3      | reverse osmosis plus ultraviolet water treatment                                                               | 7.0                                       | 6.85                            |
|                                              | 4      | reverse osmosis plus ozone water treatment                                                                     | 7.0                                       | 7.14                            |
| Bottled drinking water (sparkling water)     | 5      | microfilter plus ultraviolet and ozone water treatment with carbonation                                        | 5.5                                       | 4.87                            |
|                                              | 6      | reverse osmosis plus ultraviolet and ozone water treatment with carbonation                                     | 5.5                                       | 4.97                            |
| Bottled mineral drinking water (still mineral water) | 7      | natural cold spring mineral water derived from Mae Rim, Chiang Mai Province, Thailand (bicarbonate, magnesium, calcium, sulfates, chloride, fluoride, potassium, sodium, silica) | 7.5                                       | 7.52                            |
|                                              | 8      | natural hot spring mineral water derived from Phop Phra, Tak Province, Thailand; with ozone treatment (calcium, fluoride, magnesium, sodium, potassium, sulfates, bicarbonate, zinc) | 7.5                                       | 7.14                            |
|                                              | 9      | natural spring mineral water derived from Évian-les-Bains, France (chloride, calcium, nitrate, magnesium, sulfates, sodium, bicarbonate, potassium, silica) | 7.5                                       | 7.37                            |
| Bottled mineral drinking water (sparkling mineral water) | 10     | sparkling natural mineral water derived from Vergèze, France (calcium, chloride, bicarbonate, fluoride, magnesium, nitrate, potassium, sodium, sulfates) | 5.5                                       | 5.35                            |
|                                              | 11     | sparkling natural mineral water derived from Bad Neuenahr-Ahrweiler, Germany (calcium, chloride, bicarbonate, fluoride, magnesium, nitrate, potassium, sodium, sulfates) | 6.0                                       | 5.70                            |
| Water derived from home water filter         | 12     | mineral stone, carbon filters and magnetic plates                                                               | 7.5                                       | 7.49                            |
|                                              | 13     | carbon-block filters plus ultraviolet water treatment                                                           | 7.5                                       | 7.22                            |
| Tap water                                    | 14     | Bangkok, Thailand                                                                                               | 7.5                                       | 7.50                            |
| Boiled tap water                            | 15     | Bangkok, Thailand                                                                                               | 8.0                                       | 8.16                            |
| Swimming pool water                         | 16     | community swimming pool, Bangkok                                                                                  | 7.5                                       | 7.27                            |
|                                              | 17     | community swimming pool, Bangkok                                                                                  | 7.5                                       | 7.40                            |
| Rainwater                                    | 18     | Bangkok, Thailand                                                                                               | 6.0                                       | 6.37                            |
| Waterfall water                             | 19     | The Bo Rai Waterfall, Trat Province, Thailand                                                                   | 7.0                                       | 7.13                            |
| River water                                  | 20     | The Chao Phraya River, Bangkok, Thailand                                                                        | 7.5                                       | 7.22                            |
| Seawater                                     | 21     | The Gulf of Thailand (Ko Si Chang Island, Chonburi Province)                                                    | 8.0                                       | 8.19                            |
|                                              | 22     | The Gulf of Thailand (Pattaya, Chonburi Province)                                                                | 8.0                                       | 8.06                            |
| Distilled water                              | 23     | Siriraj Hospital                                                                                               | 5.5                                       | 5.73                            |
| Normal saline 0.9%                          | 24     | Siriraj Hospital                                                                                               | 5.5                                       | 5.40                            |
| Facial mineral water                        | 25     | thermal spring water derived from thermal spring, France (silica, trace-elements, low salt mineral content, bicarbonated profile, calcium, magnesium) | 7.5                                       | 7.97                            |
|                                              | 26     | combination of mineral salts and trace elements, including selenium                                              | 7.5                                       | 7.91                            |
| Make up remover water                       | 27     | thermal spring water, poloxamer 184, steareth-20, phenoxyethanol, polyaminopropyl biguanide, polyethylene glycol-40 hydrogenated castor oil, cetrimonium bromide, citric acid, fragrance, butylene glycol, myrtus comnus extract, viola tricolor extract | 5.5                                       | 5.24                            |
|                                              | 28     | water, hexylene glycol, poloxamer 184, glycerin, disodium cocoamphodiacetate, disodium ethylenediaminetetraacetic acid, citric acid, dihydrocholeth 30, polyaminopropyl biguanide, fragrance | 5.5                                       | 5.37                            |

1, Namthip Brand; 2, Singha Brand; 3, Cooly Fresh Brand; 4, Siriraj Hospital Brand; 5, Singha Brand; 6, Chang Brand; 7, Aura Brand; 8, Mont Fleur Brand; 9, Evian Brand; 10, Perrier Brand; 11, Apollinaris Brand; 12, Giffarine safe plus Brand; 13, Amway eSpring Brand; 25, Avene Brand; 26, La Roche Posay Brand; 27, Uriage; 28, La Roche Posay Brand.
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pH of water

hydrotherapy in some AD patients. Castex-Rizzi et al. [32] showed that mineral thermal spring water could inhibit tumor necrosis factor-α-induced ICAM-1 and E-selectin expression in human endothelial cells in vitro. A sampling of facial mineral water spray in this study had slightly alkaline pH.

Makeup remover water is designed as a gentle formula that will remove makeup without rubbing, while simultaneously hydrating skin. Some are labeled as soap-free, oil-free and alcohol-free so that they should not cause stinging, burning, or irritating against the skin. A sampling of makeup removing water in this study had pH near that of normal skin of normal people.

In conclusion, our study showed that normal saline, distilled water, bottled sparkling water and facial makeup removing water had an approximated pH as that of healthy normal skin of normal people. However, other factors, for example benefits of mineral substances in the water in terms of bacteriostatic and anti-inflammatory should be considered in the selection of cleansing water. Our study shows an overview of knowledge about water for physicians for recommendation to patients with AD, or even patients with dry sensitive skin.

REFERENCES

1. Jéquier E, Constant F. Water as an essential nutrient: the physiological basis of hydration. Eur J Clin Nutr 2010;64:115-23.
2. Tsai TF, Malbach HI. How irritant is water? An overview. Contact Dermatitis 1999;41:311-4.
3. McNally NJ, Williams HC, Phillips DR, Smallman-Raynor M, Lewis S, Venn A, Britton J. Atopic eczema and domestic water hardness. Lancet 1998;352:527-31.
4. Seidenari S, Giusti G. Objective assessment of the skin of children affected by atopic dermatitis: a study of pH, capacitance and TEWL in eczematous and clinically uninvolved skin. Acta Derm Venereol 1995;75:429-33.
5. Tupker RA, Pinnagoda J, Coenraads PJ, Nater JP. Susceptibility to irritants: role of barrier function, skin dryness and history of atopic dermatitis. Br J Dermatol 1990;123:199-205.
6. Subramanayan K. Role of mild cleansing in the management of patient skin. Dermatol Ther 2004;17 Suppl 1:26-34.
7. Solodkin G, Chaudhari U, Subramanayan K, Johnson AW, Yan X, Gottlieb A. Benefits of mild cleansing: synthetic surfactant based (syndet) bars for patients with atopic dermatitis. Cutis 2006;77:317-24.
8. Craig FE, Smith EV, Williams HC. Bleach baths to reduce severity of atopic dermatitis colonized by Staphylococcus. Arch Dermatol 2010;146:541-3.
9. Huang JT, Abrams M, Tlougan B, Rademaker A, Paller AS. Treatment of Staphylococcus aureus colonization in atopic dermatitis decreases disease severity. Pediatrics 2009;123:e808-14.
10. Gelmetti C. Skin cleansing in children. J Eur Acad Dermatol Venereol 2001;15 Suppl 1:12-5.
11. Cheong WK. Gentle cleansing and moisturizing for patients with atopic dermatitis and sensitive skin. Am J Clin Dermatol 2009;10 Suppl 1:13-7.
12. Breneman DL, Hanifin JM, Berge CA, Keswick BH, Neumann PB. The effect of antibacterial soap with 1.5% triclocarban on Staphylococcus aureus in patients with atopic dermatitis. Cutis 2000;66:296-300.
13. Seki T, Morimatsu S, Nagahori H, Morohashi M. Free residual chlorine in bathing water reduces the water-holding capacity of the stratum corneum in atopic skin. J Dermatol 2003;30:196-202.
14. Chowdhury S. Heterotrophic bacteria in drinking water distribution system: a review. Environ Monit Assess 2012;184:6087-137.
15. Zwiener C, Richardson SD, DeMarini DM, Grummt T, Glauer T, Frimmel FH. Drowning in disinfection byproducts? Assessing swimming pool water. Environ Sci Technol 2007;41:363-72.
16. Centers for Disease Control and Prevention. Your disinfection team: chlorine & pH [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2004 [accessed 2013 Jun 4]. Available from: http://www.cdc.gov/healthywater/pdf/swimming/resources/disinfection-team-chlorine-ph-factsheet.pdf.
17. Diduch M, Polkowska Z, Namieśnik J. Chemical quality of bottled waters: a review. J Food Sci 2011;76:R178-96.
18. Sobsey MD, Stauber CE, Casanova LM, Brown JM, Elliott MA. Point of use household drinking water filtration: a practical, effective solution for providing sustained access to safe drinking water in the developing world. Environ Sci Technol 2008;42:4261-7.
19. Panyakapọ M, Onchang R. A four-year investigation on wet deposition in western Thailand. J Environ Sci (China) 2008;20:441-8.
20. Gaisberger M, Šanović R, Dobias H, Kolarč P, Modr A, Thalhamer J, Selimović A, Huttegger I, Ritter M, Hartl A. Effects of ionized waterfall aerosol on pediatric allergic asthma. J Asthma 2012;49:830-8.
21. Matz H, Orion E, Wolf R. Balneotherapy in dermatology. Dermatol Ther 2003;16:132-40.
22. Inoue T, Inoue S, Kubota K. Bactericidal activity of manganese and iodide ions against Staphylococcus aureus: a possible treatment for acute atopic dermatitis. Acta Derm Venereol 1999;79:360-2.
23. Oumeish OY. Climatotherapy at the Dead Sea in Jordan. Clin
Dermatol 1996;14:659-64.
24. Proksch E, Nissen HP, Bremgartner M, Urquhart C. Bathing in a magnesium-rich Dead Sea salt solution improves skin barrier function, enhances skin hydration, and reduces inflammation in atopic dry skin. Int J Dermatol 2005;44:151-7.
25. Gambichler T, Küster W, Kreuter A, Altmeyer P, Hoffmann K. Balneophototherapy--combined treatment of psoriasis vulgaris and atopic dermatitis with salt water baths and artificial ultraviolet radiation. J Eur Acad Dermatol Venereol 2000;14:425-8.
26. van den Tillaart SA, Busard MP, Trimbos JB. The use of distilled water in the achievement of local hemostasis during surgery. Gynecol Surg 2009;6:255-9.
27. Kosuga T, Shiozaki A, Ichikawa D, Fujiwara H, Komatsu S, Itaka D, Tsujiura M, Morimura R, Takeshita H, Nagata H, Okamoto K, Nakahari T, Marunaka Y, Otsuji E. Pleural lavage with distilled water during surgery for esophageal squamous cell carcinoma. Oncol Rep 2011;26:577-86.
28. Braun-Falco O, Korting HC. Normal pH value of human skin. Hautarzt 1986;37:126-9.
29. Shahid N, Mehra S. Fluid resuscitation. In: Raoof S, George L, Saleh A, Sung A, editors. Manual of critical care. New York (NY): McGraw-Hill; 2009. p. 81-90.
30. Fernandez RS, Griffiths R, Ussia C. Water for wound cleansing. Int J Evid Based Healthc 2007;5:305-23.
31. Pigatto P. The efficacy of Avène thermal spring water in light to moderate atopic dermatitis. Ann Dermatol Venereol 2005;132:6516-6518.
32. Castex-Rizzi N, Charveron M, Merial-Kieny C. Inhibition of TNF-alpha induced-adhesion molecules by Avene Thermal Spring Water in human endothelial cells. J Eur Acad Dermatol Venereol 2011;25 Suppl 1:6-11.