

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

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**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 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-inflammation 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

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**Received:** June 7, 2013

**Accepted:** June 20, 2013

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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 halo ketones 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 comunis 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.

taste and smell. Drinking bottled water implies a hygienic lifestyle and good looks. This may be the reason why some people use bottled water to wash their faces or even to bath. For sparkling water, the carbon dioxide gas is added in the bottling process which affects the pH of the water. Bottled natural mineral waters have various mineral contents. There are many regulations and standards for water intended for human consumption which limit the levels of disinfectants, DBPs (bromate, chlorine, chlorite, haloacetic acids, total trihalogenometals), inorganic chemicals (aluminum, ammonium, antimony, arsenic, barium, beryllium, boron, cadmium, chloride, chrome, copper, cyanide, fluoride, iron, lead, manganese, mercury, molybdenum, nickel, nitrate, nitrite, selenium, silver, sodium, sulfate, thallium, uranium, zinc), organic chemicals (acrylamide, benzene, total pesticides, polycyclic aromatic hydrocarbons, phenolics) [17]. In our study, bottled drinking still water had slightly alkaline pH, while the sparkling ones had lower pH.

Boiling or filtration of tap water through home purification systems is widely used to abolish the contamination in the water to improve water quality by treating it in the home. There are many types of home water filters, for example, faucet mounted activated carbon/hollow fiber membrane filter, ceramic and biosand filters [18]. These water treatment technologies empower people to believe that the water they used is safe. Boiled water and filtered tap water in our study gave an alkaline pH.

The river water used in our study derived from the Chao Phraya River in Bangkok which contains clay and humus substances from the northern part of Thailand down to Bangkok. The water supply in Bangkok Metropolitan area is prepared from the Chao Phraya River water. The Chao Phraya River water showed pH of approximately seven in this study. However, water content of the rivers depends on geographic locations which affect the water pH.

Panyakapo and Onchang [19] reported 4-year investigation of rainwater at a rural area of Nakorn Pathom Province which is located near Bangkok. The pH value ranged from 4.0 to 7.8 with an average of 6.1. The ions in rainwater in their study included  $\text{Ca}^{2+}$ ,  $\text{NH}_4^+$ ,  $\text{SO}_4^{2-}$ ,  $\text{HCO}_3^-$ ,  $\text{NO}_3^-$ ,  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^+$ ,  $\text{H}^+$ ,  $\text{HCOO}^-$ , and  $\text{PO}_4^{3-}$ . The influence of various local emission sources such as soil, biomass burning and agricultural emissions might affect the chemical composition of rainwater. In our study, fresh rainwater in Bangkok in March had a pH of 6.

Ionized waterfall aerosol was shown to improve lung function parameters of some pediatric patients with allergic asthma [20]. However, to our knowledge, there is no study concerning waterfall

water and AD. In our study, water derived from the waterfall in Trat Province, which is located in the Eastern part of Thailand, had a pH of 7.

Seawater derived from the Gulf of Thailand had an alkaline pH. Water treatment in forms of balneotherapy and spa therapy has become popular as an adjunctive treatment for some dermatologic conditions [21]. Balneotherapy involves the immersion of patients in mineral waters baths or pools. Mineral waters contain different natural solutions according to different geologic conditions. Inoue et al. [22] reported that balneotherapy using Kusatsu hot-spring water in Japan can control the skin symptoms of the acute flares of patients with refractory AD. The proposed mechanism is due to the bacteriocidal activity against *Staphylococcus aureus* by the coexistence of manganese and iodine ions in water under acidic condition (pH 2-3).

Climatological and balneotherapies are recognized as natural spa treatments. The Dead Sea is one of the most famous for balneologic properties and for providing climatotherapy. Chemical composition of the Dead Sea water includes magnesium, calcium, potassium, bromide, sodium, sulfate, bicarbonate, chloride, sodium chloride, potassium chloride [23]. Bathing in a magnesium-rich Dead Sea salt solution was reported to improve skin barrier function, enhance skin hydration, and reduce inflammation of atopic skin [24]. Moreover, there is more UVA radiation at the Dead Sea than elsewhere [23]. Balneophototherapy using salt water baths combined with artificial UV was reported useful in patients with AD [25].

Distilled water or deionized water is commonly used for lavage to check homeostasis at the end of various operations [26]. The efficacy of pleural lavage with distilled water during surgery for esophageal squamous cell carcinoma was proposed from the cytotoxic effects of hypotonic shock on tumor cells [27]. It is also used as an alternative agent for wound cleansing. Distilled water in this study had pH similar to pH of normal skin of normal people (pH 5.4-5.9) [28]. Normal saline or 0.9% sodium chloride solution is a sterile, nonpyrogenic solution for fluid and electrolyte replenishment. It is composed of 154 milliequivalents (mEq/L) of both sodium and chloride with the pH between 5.0 to 6.0 and an osmolarity of 308 mOsm/L [29]. Normal saline is widely used to clean wounds because of its isotonic nature and it does not interfere with the healing process [30]. Some AD patients prefer to use normal saline to wash their face as it is an isotonic solution and therefore it should not damage the skin.

Pigatto [31] reported the effectiveness of mineral water

hydrotherapy in some AD patients. Castex-Rizzi et al. [32] showed that mineral thermal spring water could inhibit tumor necrosis factor- $\alpha$ -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-inflammation 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, Maibach 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. Subramanyan K. Role of mild cleansing in the management of patient skin. *Dermatol Ther* 2004;17 Suppl 1:26-34.
7. Solodkin G, Chaudhari U, Subramanyan 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, Tloughan 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, Glauner 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. Panyakapo 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, Kolarž P, Moder 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, Nakahara 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;132:6S16-6S18.
  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.