Clinical Nutrition (2006) **25**, 377–385

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Clinical Nutrition

http://intl.elsevierhealth.com/journals/clnu

REVIEW

Water, mineral waters and health

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Received 7 July 2005; accepted 3 October 2005

KEYWORDS
Mineral waters;
Minerals;
Trace-elements;
Health

"Everything comes from water!And everything is kept alive by water!"
J.W. von Goethe, Faust II, 1833

Summary The authors focus on water resources and the use of mineral waters in human nutrition, especially in the different stages of life, in physical activity and in the presence of some morbid conditions.

Mineral water is characterized by its purity at source, its content in minerals, trace elements and other constituents, its conservation and its healing properties recognized by the Ministry of Health after clinical and pharmacological trials.

Based on total salt content in grams after evaporation of 1 l mineral water dried at 180 °C (dry residues), mineral waters can be classified as: waters with a very low mineral content, waters low in mineral content, waters with a medium mineral content, and strongly mineralized waters.

Based on ion composition mineral waters can be classified as: bicarbonate waters, sulfate waters, sodium chloride or saltwater, sulfurous waters.

Based on biological activity mineral waters can be classified as: diuretic waters, cathartic waters, waters with antiphlogistic properties.

Instructions for use, doses, and current regulations are included.

Contents

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doi:10.1016/j.clnu.2005.10.002

Introduction

Scientists, town planners, entrepreneurs and governors are more and more concerned with the management of water resources on Earth: water is a valuable gift that must be preserved at any rate.

Water need and its use constitute the basis of all civilizations. In Homer's poems cold baths are taken for personal hygiene, hot baths for therapeutic purposes and after physical exercise.[1]

Thales guessed that water is the basic element for the development of every form of life; another great philosopher, Aristotle, confirmed this hypothesis in his work *Politics*; in his treatise *Airs, Waters and Places* Hippocrates even wrote that water can influence human personality.[2]

The first, impressive works of hydraulic engineering were built by the Romans during the Empire Age: Roman aqueducts could bring to Rome 13.500 l/s of water and supplied 700 fontanae versantes, 500 fontanae salientes, 296 fee-paying baths, 36 horti, 12 thermal springs, five naumachiae, villae, gardens and private houses. The first Roman aqueduct dates back to 312 b.C. and was built by the censor Appius Claudius, who called the water "Appia": it drew water through a 16 km underground duct running from current via Prenestina to Foro Boario, in the center of the city.[1]

Etruscans exploited the thermal springs at Piano dei Bagni (near Viterbo) because of their beneficial properties; other testimonies can be found in the works of Strabo, Martialis, and Scribonius Largus (Emperor Tiberius' physician). Etruscan spas were visited by Popes like Bonifacius IX and Pius II, and even by Dante Alighieri and Michelangelo Buonarroti; most of them were hot, sulfurous, sulfate or bicarbonate alkaline-earth springs.[1]

Near Mezzomiglio, Tuscany, the ruins of mythical Fontes Clusinae have been located: these springs were famous for the quantity and quality of their water. Another spring at Acquasparta was visited by Saint Francis of Assisi: since the 13th century this water has been known as "Saint Francis's water".[1]

In the 16th century Andrea Bacci in his treatise *De Thermis* wrote that the water at Anagni (Fiuggi) was an extraordinary remedy for kidney stones, since it possessed a dissolving action similar to vitriol.

In 1995 a group of archaeologists from Arizona University brought to light the aqueduct "Camerelle", a sulfurous water, near Cisterna di Latina.[1]

Water in human body

Water is the basic element of living beings: they could not have appeared and could not survive without it. The discovery of water on Mars could support the hypothesis of the presence of living beings on the "Red Planet".

In the reference man, 60% of body weight (BW) (about 45 l) is represented by total body water (TBW); body fluids containing the largest amount of water are: cerebrospinal fluid and bone marrow fluid (99%), blood plasma (85%) and brain (75%).[2] TBW is subdivided into: intracellular water and extracellular water, respectively, 34% and 26% of the reference BW. Extracellular water is subdivided into interstitial liquids (14% of BW), plasma (4% of BW), trans-cellular water (1% of BW) and lymphatic liquids (1% of BW). Intracellular water is the index of metabolically active mass, or "fat free mass": it is greater in the male sex, in which a higher water percentage is observed (man: 60%, woman: 50%).[4–6] TBW amount varies according to development stage and age (Fig. 1): in the fertilized egg water reaches 90%; in the embryo 85%; in the baby water represents 74% of BW; in the adult 55–60%; in the elderly it is further reduced (51% in men and 45% in women).[2,4]

Water is involved in many body functions, and so water homeostasis is essential for hydro-electrolytic balance, acid–base balance and thermal balance, besides metabolic and plastic processes.[2]

Water reduction of 2% of BW alters thermoregulation and plasma volume; 7% reduction may cause hallucinations; dehydration of 10% may cause death.[7] Water is lost through urine (1500 ml/day), faeces (100 ml/day), perspiratio insensibilis (900 ml/day) and sweat, and must be restored through diet.

Beverages provide 800–1500 ml of water daily; water requirement varies according to ambient temperature, physical exercise, water content in foods.

Water content is 10–15% in dry foods (flours, uncooked pasta, dry pulses, etc.), about 90% in fruits

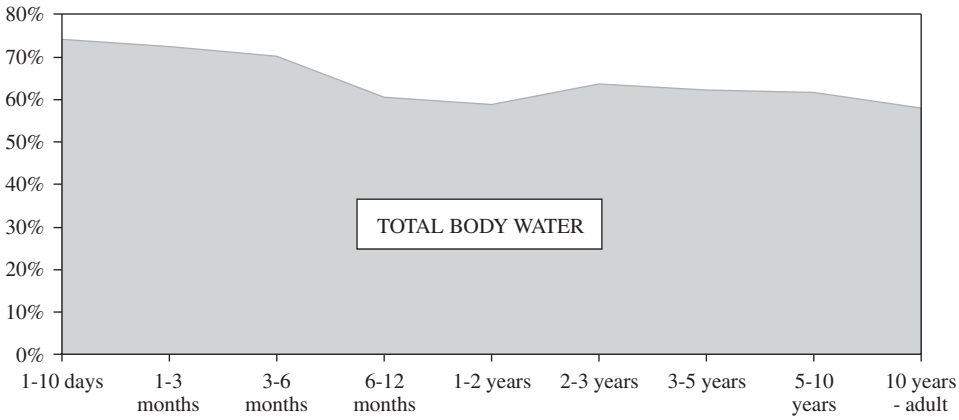

Figure 1 Total body water in different ages.

and vegetables, but it also depends on the cooking method. Food provides 500–900 ml of water daily.[8]

Besides exogenous water, there is a small amount of "metabolic water" (350 ml/day) produced by body in response to the introduction of nutritive principles. Metabolic water results from macronutrient oxidation into water and CO_2. Oxidation of 100 g lipids produces 107 ml of water; oxidation of 100 g carbohydrates produces 60 ml; oxidation of 100 g proteins produces 40 ml.[7] Since endogenous water is not enough to counterbalance water loss (about 2150–2900 ml/day), exogenous water is a necessary nutrient.

In an adult of 70 kg performing medium-intensity exercise, daily water balance is 2500 ml (range 1500–3000 ml).[9] In an adult at rest daily water requirement (water amount necessary to preserve bodily water balance) is 1 ml/kcal: it may vary remarkably according to age, climate, physical activity, and state of health.[10] Daily requirements are about 1500 ml: 900 ml counterbalance perspiratio insensibilis, 600 ml ensure elimination of catabolic waste through urine.[9]

In the child the risk of water deficiency is greater due to larger bodily surface, higher water percentage, faster water metabolism (15% of weight in the baby compared to 4% in the adult), lower renal clearance of solutes.[5] Water requirements are increased up to 1.5 ml/kcal/day[4]; in a 7 kg baby the minimum daily intake is 300 ml: 200 ml for perspiratio insensibilis and 100 ml for renal excretion.[9]

Since body water content is progressively reduced with age, the elderly too are at risk of water deficiency. Due to thirst mechanism malfunction, the elderly consume insufficient liquid amounts, and they often drink when dehydration have already appeared. Moreover, some elderly people are not self-sufficient and cannot drink by themselves. So in old age a special attention should be devoted to liquid intake, though requirements are the same as in the adult.[11]

During pregnancy and breast feeding water requirements are increased: a pregnant woman needs a 30 ml/day water increase, for amniotic liquid formation and fetus growth. During breast feeding about 650–700 ml/day should be added: in this way the mother's milk will be suitable for the baby, and the health of mother and child will be preserved.[10]

Mineral waters are particularly useful in bottle-feeding. Vaccine milk diluted in bicarbonate-calcium water is no longer used; the chemical composition of modern powdered milks is more and more similar to mother's milk: they should be diluted in waters with a very low salt content, in order to preserve milk formulation and to avoid overloading of the baby's immature metabolism with hyperosmolar meals. In fact, according to modern pediatric research children fed with hyperosmolar diet may become obese or hypertensive adults.[3,12,13]

Experimental evidence shows that waters with low mineral content do not result in calcium salt deficiency: in nature all animal species drink soft water (rain water).[3,12,14]

In early childhood and during pregnancy and breast-feeding natural mineral waters with nitrate content no higher than 10 mg/l should be consumed, in order to avoid methemoglobinemia.[2]

Exercise increases water waste; since dehydration may spoil the performance, 24 h diuresis measurement helps to find out the optimal water intake. It has been observed that during physical activity only 50% of water lost through sweat is replaced in response to the sensation of thirst. The athlete's actual water need can be obtained subtracting dietary water amount from theoretic need (1 ml/kcal/day) and then adjusting the result according to diuresis values: it is about 45–50 ml/kg/day.[8]

Water requirements increase in all pathologic conditions resulting in major water loss, such as diarrhea, vomit, hyperpyrexia, abundant perspiration.

In depressed areas with poor hygienic conditions serious food poisoning may lead to death in early childhood, due to major water loss and dehydration. Dehydration can be slight (5%), moderate (10%), serious (15%); it can be assessed through three series of data: anamnestic data (fever, vomit, diarrhea), clinical data and laboratory data. The degree of water deficiency can be calculated multiplying dehydration percentage by BW in kilograms.[4]

The structures connected with water intake and clearance in the human being are:

PRIMARY STRUCTURES

a. thirst centers;
b. digestive system;
c. cardiovascular system;
d. ADH activity;
e. kidney.

SECONDARY STRUCTURES

a. respiratory system;
b. skin system.

Water intake is regulated by thirst centers and can be of two kinds:

regulative intake:

- primary thirst resulting from cellular and/or extracellular dehydration;
- secondary, anticipative thirst (periprandial);

non-regulative intake:

- unnecessary;
- pharmacological and therapeutic (mineral waters, infusion therapies etc.);
- pathological (potomania).

Mineral water can be consumed in response to primary and secondary thirst, with reference to need and thirst sensation; intake of strictly medicinal mineral waters should be considered as non-regulative only.

Water resources are not fairly distributed: many areas suffer from water want, which heavily affect state of health, morbidity and mortality, besides economic and social development.

In a country like Italy daily water consumption per head is subdivided into: drinking, food preparation, other domestic uses, industrial uses (Table 1); wastes due to leaks in the distribution network and wrong behaviors are very influential (Table 2).[1]

Table 1 Water consumption in Italy.[1]

Uses	Liters per head/day
Drinking and food preparation	3–4
Domestic use	$\geqslant$100
Production of 1 kg of wheat	2000–3000
Production of 1 kg of meat	5000
Production of 1000 kg of steel	100.000–250.000
Production of 1000 kg of paper	300.000

Table 2 Domestic behaviors which may result in water waste.[1]

Behaviors	Liters/day
Leaking tap	100
Bathing in the tub	150
Tooth-brushing with the open tap	30–80
Washing the car with the pump for 30 min	200–300
1 toilet flushing	$\geqslant$10

Progressive decrease of precipitations, pollution, over-exploitation of groundwater tables, unauthorized building on the coast, seepage of brackish water in the tables make the situation worse.

FAO has estimated that water need doubles every 21 years.[1]

Drinking waters and mineral waters

The quality of drinking water is assessed by physico-chemical, biological and organic analyses. A water can be drunk only if the concentration of constituents is within the limits set by special regulations taking into account long-term maximum daily intake, the nature of the contaminating agent and its possible degree of toxicity (in Italy: DPR 236 24/05/1988 and DL 02/02/2001 n. 31).[15]

Directive 778/80 EEC regulates the use of treated and untreated waters intended for drinking and cooking, other domestic purposes, food industry; they are supplied from a distribution network, tankers, bottles.[1]

Spring water in its natural state comes from underground water tables or deposits, must be

bottled at source and can not be transported by tankers.[1] Regenerated or processed waters are demineralized and then recharged with salts or flavored, according to a fixed chemical composition.[16]

RD 09/26/1919 laid down that mineral waters must possess peculiar therapeutic properties, since they are used for healing purposes.

Mineral water is characterized by its purity at source, its content in minerals, trace elements and other constituents, its storage and its healing properties, recognized by the Ministry of Health following clinical and pharmacological trials.

According to current EEC directives mineral waters are of underground origin, protected from contamination, and microbiologically wholesome; present a peculiar and constant chemical composition, and have favorable effects on health; they must be bottled at source into safe and checked containers. ''Mineral water'' does not simply mean ''containing minerals'': in fact waters that run underground and are enriched with minerals by contact with rocks cannot be considered mineral waters unless they do not possess therapeutic properties.[16]

Mineral water can be put on the market and/or exploited for healing purposes only after the recognition by the Ministry of Health. Table 3 reports permissions needed for mineral waters and spring waters.[1]

At table consumers tend to prefer mineral waters because they are safer; concern for possible contamination of drinking water by agricultural pesticides and industrial waste have been confirmed by a study of the Environment Federal Office in Switzerland: in this country 80% drinking water is significantly polluted by pesticides.[17] Nervous cells are sensitive to oxidative damage induced by pesticides: this is now confirmed by a recent research performed in areas of India where organophosphorous pesticides (banned by WHO) are used; one-third of 899 children under study have been found to present a decreased short-term memory.

Even chlorination has been called into question, due to the possible formation of haloderivatives which could give origin to intestinal tumors: but chloride, sodium and potassium amount introduced through water is actually very small. In fact 1 l of chlorinated water gives 0.2 mg chloride, whereas sodium chloride, the main source of chloride in the Italian diet, gives about 4.8 g/day. 0.5 g/day of sodium is naturally contained in food and water, corresponding to about 10% of total sodium intake in the Italian diet.[15] Potassium content in water is about 2 mg/l: in 1.5 l of water (average daily consumption) 3 mg potassium are contained, a very low amount compared to the recommended dose of 3.2 g/day.[10]

Magnesium and calcium content varies remarkably depending on the kind of water: magnesium, 1–50 mg/l; for calcium the range is wider: few milligrams to 400 mg/l.[10] Many studies have showed that mineral waters may be a good source of calcium, especially in low-mineral diets.[18–20]

Table 3 Natural mineral water and spring water: main authorized procedures (Grippo P, Mineracqua, 2001).

Natural mineral water	Spring water
Permission of research and regional mining claim	Permission of research and regional mining claim
Evaluation of hydro-geologic, chemical, physical, microbiological, chemico-pharmacological characteristics and recognition of the Ministry of Health	Evaluation of hydro-geologic chemical, physical, microbiological, but *not* chemico-pharmacological characteristics and recognition by the Ministry of Health (not laid down by Directive 70/1996 EEC)
Operations authorized by the recognition decree of the Ministry of Health	Operations authorized by the recognition decree of the Ministry of Health
Ministerial authorization for sanitary advertising	No
Regional authorization for the use of the water in the manufacture of soft drinks	Regional authorization for the use of the water in manufacture of soft drinks
Regional authorization for marketing	Regional authorization for marketing
Publication of recognition decree and regional authorization on the Official Gazette	Publication of recognition decree and regional authorization on the Official Gazette
Publication on ECOG of the lost of recognised mineral waters	No
Regulations	*Regulations*
Directives: n.80/777/ EEC, n.96/70 EEC	Directives: n.80/778/EEC, n.96/70/EEC, n.98/83 EEC
DL: n. 92/105, n.99/339	D.P.R: n. 88/236 DL: n.99/339, n.01/31

Italy is one of the European countries boasting the greatest number of mineral water springs: 700 springs are recognized and 300 are on the market with 284 brands.[1]

Classification, characteristics and indications of mineral waters

Natural mineral waters can be divided into: table waters, dietetic waters, healing waters.

Experimental evidence indicates that bottled dietetic waters can be used to restore salts and hydrate, are useful in low-sodium diets and provide the right calcium intake in particular conditions.

Healing waters possess pharmacological and clinical properties related to prevention and treatment of specific pathologies. They are used in thermal establishments, under medical control, for drinking , inhalations, irrigations, baths and muds.

The main classification parameters for mineral waters are: rate of flow, temperature, freezing point, dry residues at 180 °C, predominant ion composition, predominant biological activity.[1]

The rate of flow of the spring must be stable, and ground water table must be deep, with a sufficiently large basin. Springs with minimum seasonal variation, like natural mineral waters, are defined as perennial.

On the contrary, semiperennial springs are characterized by remarkable fluctuations in the rate of flow, that alter water composition; there are also seasonal springs, like Acqua Fredda at Bagni di Cantuccio (CZ), which springs from May to September.

Based on temperature, waters can be: cold waters (temperature at source up to 20 °C) and thermal waters (temperature higher than 20 °C).

Thermal waters are divided into: tepid waters (20–30 °C), warm waters (30–40 °C), hot waters (higher than 40 °C).

Based on the freezing point mineral waters are divided into: isotonic ($-0.58 < \Delta > 0.55$ °C), hypotonic ($-0.55 < \Delta > 0$ °C), hypertonic ($\Delta < -0.58$ °C).

Freezing point is influenced by osmotic pressure and mineral concentration.

Based on dry residues at 180 °C (total salts in grams after evaporation of 1 l mineral water at 180 °C), waters are divided into: waters with a very low mineral content (dry residues <50 mg/l), waters low in mineral content (dry residues >50 and <500 mg/l), waters with a medium mineral content (dry residues >500 and <1500 mg/l), and waters rich in minerals (dry residues >1500 mg/l).

Marotta and Sica classification (1929) defines mineral waters according to their predominant ionic composition: bicarbonate waters, sulfate waters, salt waters, sulfurous waters. If more than one anion predominates, we can have: salty-sulfate waters, bicarbonate–sulfate waters, etc. Chemical characterization is completed by alkaline cations such as lithium, sodium, potassium, or alkaline-earth cations such as calcium, magnesium, beryllium.

Current Italian classification is based on the predominant chemical elements resulting in the biological and healing effects of the mineral water: bicarbonate water (bicarbonate content greater than 600 mg/l); sulfate water (sulfate content greater than 200 mg/l); chlorinated water (chloride content greater than 200 mg/l); calcium water (calcium content greater than 150 mg/l); magnesium water (magnesium greater than 50 mg/l); fluorate water (fluoride greater than1 mg/l); ferrous water (bivalent iron content greater than 1 mg/l); sodium water (sodium greater than 200 mg/l); low-salt water (sodium content less than 20 mg/l).

A further distinction is based on the concentration of particular constituents. The quantity of free carbon dioxide makes the distinction between fizzy waters (also called carbonic or acidic), and still waters; radioactive waters are characterized by the presence of measurable radon quantities (1 millimicrocurie of radioemanation).

Finally, classification can be based on the biological activity: diuretic mineral waters; cathartic waters (facilitating the hepato-biliary functions through choleretic, cholagogue, cholecysto-kinetic effects and stimulating intestinal functionality directly or indirectly); waters with antiphlogistic and resolvent properties; and reconstituent waters like arsenical-ferrous waters.[1]

Labels on bottled mineral waters are regulated by legislative norms. Labels contain two kinds of information: information about the producer and the production (brand name, production lot, bottling date, bar code, the words ''respect the natural environment'', nominal content, authorization, purchase proof, consumer service toll-free number). The label or the bottle must also show a regular hexagon or a circle with an abbreviation indicating the material of the container: VE (glass), PET (polyethylene terephthalate polycondensate), PVC (polyvinyl chloride), CA (polyethylene coated board).[1]

The second kind of information guides the consumers in the choice of the water which best meets their requirements.

A detailed bacteriological analysis is not mandatory, the words ''microbiologically wholesome water'' are enough: this does not mean that water is sterile, but ensures the absence of the main

contamination indicators, and the presence of natural bacterial flora. Flora multiplication during normal storage does not damage water.

The label also reports some basic rules for a correct storage of bottled mineral water: keep in a cool, dry, clean and odorless place, away from light and heath sources. After the opening, the bottle must be closed carefully, in order to maintain the original characteristics. At the bar and at the restaurant the bottle should be opened in the presence of the client; ice should be avoided since it may spoil water taste and its original purity. Mineral water should be served in the original container, because if poured into decanters or jugs it may be confounded with tap water, and hygienically contaminated.

Plastic bottles can be recycled after use.

Finally, the terms ''mineral'' and ''microbiologically wholesome'' describe the peculiar properties of natural mineral water.

Microbiological tests of mineral waters are far stricter than those of drinking water, since mineral waters cannot undergo purifying treatments; current regulations lay down four tests a year, one every season.

The Local Health Authority and the Team of Health Inspectors of Carabinieri make inspections, tests and analyses in establishments and shops throughout the country. Moreover, producers have adopted a widespread self-control system, in order to protect safety and to prevent possible risks; this system must be registered, and approved by the Ministry of Health. Tests and analyses are performed during every work shift: they are hundreds of thousands every year. The label reports chemical tests, including date and laboratory.[1]

Waters with a very low mineral content are 9% of the waters on the market. They have a diuretic effect and are indicated in urinary stones; facilitate uric acid clearance; are suitable for powdered milk dilution since they do not modify its formulation; are also indicated in hypertension for their low sodium content.

Waters with a low mineral content are 65% of mineral waters on the market. They have diuretic effects, and are indicated in urinary stones and gout because facilitate uric acid and ureic nitrogen clearance.

Waters with a medium mineral content are 20% of the mineral waters on the market. They are similar to low-mineral waters in the action, but their diuretic effect is inversely proportional to the amount of dry residues.

Waters rich in mineral salts are 6% of the mineral waters on the market and are defined as medicinal waters.

Bicarbonate waters may neutralize acid secretion, accelerate gastric empting, provoke the release of gastric peptides (like gastrin and endorphins).[21,22] They are indicated in hydrochloric-peptic hypersecretion and gastro-esophageal reflux disease.[23] During physical activity they restore liquids and salts, facilitate nitrogen waste clearance and counterbalance metabolic acidosis, which is typical of the effort syndrome of the sportsman.[1] Five hundred to 700 ml should be drunk before physical activity, whereas during a competition excessive water intake should be avoided; hypotonic waters are the best, since they are absorbed faster.[24]

Sulfate waters stimulate intestinal motility and are mainly indicated in chronic primitive constipation, in fact they have osmotic effect and facilitate CCK release, due to the action of sulfate on endocrine–paracrine system cells.

Sulfate–bicarbonate waters are used for gall bladder hypokinesis, biliary sand, post-cholecystectomy syndrome. Richness in cation Mg facilitates cholagogue action, thanks to its relaxing effect on Oddi sphincter.

Sulfurous and bicarbonate waters are indicated in diabetes: in particular, decrease of glycemia, polydipsia and polyuria, and reduction of insulin requirements have been observed after treatment with sulfurous waters. Bicarbonate waters neutralize metabolic acidosis in decompensated diabetes.

Chloride-sodium waters (salt waters) stimulate intestinal peristalsis and intestinal secretion of water and electrolytes. They have a choleretic and cholagogue action by increasing biliary secretion and bile inflow into duodenum. They are used in primitive constipation, irritable colon, biliary pathology.

Mineral waters rich in calcium are indicated when calcium requirements are increased (children, pregnant women, menopause, old age, osteoporosis); moreover, recent studies suggest that calcium may prevent hypertension.

Magnesium waters are mainly cathartic; recent studies indicate that they may prevent atherosclerosis. They are useful in obstetric-gynecologic pathologies: premenstrual syndrome, climaterium, post-menopausal osteoporosis.

Ferrous waters are indicated in sideropenic anaemia, and hyperthyroidism.

Sulfurous, salt-iodine, salt-bromine–iodine waters are mainly used for external use (baths and muds) or for inhalation in ENT and respiratory system affections, chronic phlogosis of woman's genitals, in some skin pathologies.

Carbonic waters are mainly used for baths, in the treatment of peripheral vasculopathies.

Fizzy water quenches thirst best because carbon dioxide anaesthetizes nerve endings of oral mucous membrane, involved in thirst sensation; moreover, they are generally bicarbonate waters facilitating digestion.

The following indications point out the main properties, established based on pharmacological and clinical trials and recognized by the Ministry of Health: "may be diuretic", "may be laxative", "stimulates digestion", "may facilitate hepato-biliary functions", "suitable for the preparation of infant food", "suitable for low-sodium diets" (LD 25/01/1992 n.105 art.11 comma 4).[1]

Proper doses of water can be drunk in two ways: water loading or subdivided doses. Water loading means to drink 1 l in 30 min on an empty stomach; to a basic amount of 500 ml, 10 ml/kg of BW should be added. Water loading can be made with hypotonic and diuretic waters, whereas the treatment in subdivided doses can be made with all waters.

With respect to treatment in subdivided doses, the patient must consume on an empty stomach 1–2 l, taking small sips, while walking. Hypotensive, asthenic and dyspeptic patients should drink in clinostatism: in this position the liquid flows more easily towards thorax, stimulating atrial receptors and increasing atrial natriuretic factor and diuretic effects; moreover, intestinal absorption is enhanced, portal load decreased.

These waters can be drunk at natural temperature or slightly warmer. Graduated measures containing 250 ml can be used.[3]

Diuretic waters generally have a low or medium mineral content, and dry residues at 180 °C less than 2–3 g; they should be drunk cold, in ortho-clinostatism and in subdivided doses; water loading is preferred in case of renal stones, since it facilitates expulsion.

Daily amount of liquids should not be lower than 2 l throughout 24 h.

In phlogistic affections of excretory system, bicarbonate-alkaline waters consumed in subdivided doses may be useful; diuretic activity reaches its peak after some days of treatment and metabolic modifications become more evident within 10–15 days of therapy. Diuresis enhancement does not depend only on the hypotonicity of the solution but also on chemico-physical composition of water.

Most cathartic waters are salt, salt-sulfate, sulfate-alkaline or alkaline-earthy and sulfureous waters. Doses are 50–150 ml for strongly mineralized waters, up to 1–1.5 l for low-mineral waters.

Water should be consumed in the morning on an empty stomach, cold, in order to enhance intestinal motility, or warm.

Arsenical-ferrous waters can be diluted to a half or one-third, based on arsenic and iron concentrations, and they should be consumed on an empty stomach. The dose is 1–3 teaspoonfuls for children and 3 spoonfuls for adults 3 times a day; waters containing less arsenic can be consumed at higher doses.

Cold bicarbonate waters, rich in gas, should be taken in small sips: they stimulate gastric secretion and are indicated in hypochlorhydric dyspepsia. Warm bicarbonate waters are consumed at doses of 300–400 ml more times a day: buffer effect is predominant, in fact the main indication is hypersecretive gastritis; these waters also facilitate digestion if drunk at meals in moderate doses.

In gout spa therapy is an effective adjuvant to pharmacological and dietetic therapy; low-mineral bicarbonate waters are the most indicated, since they enhance diuresis and uricuria, alkalinize urine and reduce uricemia.

Water loading before going to bed avoids physiological oliguria during the night.

Liquids should be assumed throughout the day, even between meals.

Bottled waters allow to carry on at home the therapy of renal stones and gout all year round; nonetheless, therapy at the thermal establishment is of the utmost importance due to peculiar climatic and environmental conditions. Moreover, long bottling alters the characteristics of waters, especially bicarbonate waters.[3,25]

Finally, sportsmen should drink water with a low or medium mineral content during 2 h before the competition; the doses are 100–150 ml every 15–20 min, up to 500 ml; 400–500 ml in the last quarter of the second hour, after beginning the warming-up. During the performance 200–250 ml every 15–20 min are necessary; after performance liquid intake should be 150% of weight variation; in general daily intake is about 50 mg/kg/day.[24] In sports like boxing or weight lifting, BW must be kept within the category limits, moreover the use of diuretics has been banned as doping agents since 2000: mineral waters with very low and low mineral content (1.5–2 l/day) may be useful for their diuretic effect.

Contraindications of waters with low content in minerals are: water retention, renal insufficiency, cardio-circulatory decompensation; waters rich in sodium are contraindicated in hypertension; sodium chloride waters in acid hyersecretion, peptic ulcer and hypertension; Sulfureous waters in respiratory diseases with bronchospasm; bicarbonate waters in gastric hypochilia; sulfate waters, in digestive diseases with ulcerative lesions.[1]

Scientific research

In the past the efficacy of mineral waters was mainly assessed by observation, but since the late 1950s the use of experimental models has been adopted.

A memorandum by the Ministry of Health (Circolare n.80) indicates mandatory information: methodological approach of the investigation and the kind of clinical trial (randomized, double blind, non-randomized, etc.); characteristics of the study group and the control group (number of patients, age, sex, main associated diseases, diet, associated therapies etc.); dosage of the water under study and the water used in the control group; duration of the treatment; parameters used for the evaluation of the results and laboratory methods; statistical evaluation of results; possible side effects; observations on the efficacy of the treatment in the long term.

Acknowledgments

The paper is supported by Rome University ''La Sapienza''.

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