ABLE PAPER BY DR. MARTHA EVERITT

WAS READ AT A MEETING OF THE WOMEN'S CLUB.

She Discussed the Question of Water Supply in a Very Thorough Manner and Pointed Out the Dangers That Arise from a Contaminated Supply of Water for Domestic Uses. She Repeated the Old Recommendation That Water Should Be Boiled and Filtered.

Below is given in full the paper on "Water Supply," read by Dr. Martha Everitt at Monday's meeting of the Woman's Club at Green Ridge:

As regarding their uses for household and town supplies, all natural waters are divided into four classes. Rain water, surface water, including streams and lakes, ground water, including shallow wells, deep seated water, which includes deep wells, artesian wells and springs. Each class is to be studied as to advantages and disadvantages, liabilities of pollution, etc. From an aesthetic standpoint we refuse water which is so polluted as to be objectionable to sight, taste, or sense of smell, and our first thought in every instance is the relation between such a water and disease.

Perhaps more than any other danger we fear to encounter, by means of impure water, our enemy, typhoid fever, though we all know that other forms of intestinal infection may be due to polluted drinking water. There is undisputed and overwhelming evidence that typhoid excreta may be greatly diluted and be filtered through a great thickness of soil without losing their disease producing properties.

Since the character of a water supply depends mainly on the character of the soil, through or over which it passes, and moreover since we must regard the soil as the habitat of disease-producing germs, no consideration of water supply can be complete without a consideration of the soil through which water percolates and upon which water drains to meet river, or lake, or streams feeding reservoirs.

MOISTURE OF SOIL.

If soil be permeable moisture is transmitted, and thus contributes to the supply of ground water; soil with high power of absorption retains moisture. The permeability of the soil regulates the amount of surface water which shall percolate through the soil. "The moisture of the soil depends upon the power of imbibition, which varies with coarseness, or fineness of the rock, and is greater for rocks which consist of fine particles." Rain water in its passage through the soil and underlying rocks abstracts, by chemical and mechanical means, many of their ingredients and becomes charged with a great variety of mineral matter.

Impurities which are held in suspension which are easily removed by filtration do not add an element of danger to the supply. Impurities which exist in solution and are due to the solvent power of the water itself are elements of danger. All rain water contains a certain amount of CO_2. Most silicates are decomposed by the action of CO_2 and the metallic elements, alkaline metals Ca, Mg, Fe, pass into solution in the form of soluble carbonates of those metals.

Water charged with CO_2 is capable of acting directly upon limestone and dolomite, and reducing them to soluble bicarbonates of Ca, Mg, which pass into solution. The other chief mineral impurities found in rain water are silica, sulfates, chlorids of Ca, Mg, K, Na. We know from the fact that spring water issues at a natural opening that it has been constant movement and has not stagnated in underground reservoirs. Little is known as to the depth to which underground water percolates and as to the causes which check its downward course, but it is invariably found that below a certain depth rocks are completely permeated by water. Ground water, a continuous sheet of water, from which air is excluded, is found below the rocks.

MAINTAINS ITS LEVEL.

This water maintains its level just as does sea or lake. Ground water is in constant movement towards the sea, or nearest water course, moves in a lateral digrection, rises and falls. The amount of water which is held by the subsoil as ground water depends upon the saturation of the subsoil. The value of a rock as a water bearing stratum depends upon its capacity of saturation. The most permeable soils having least storage capacity. "All collections of water in free contact with the atmosphere are collections of surface water, be the collection a pool or the ocean itself. This water may move in rivers or creeks.

The water from artesian wells comes from considerable depth and is prevented from contact with water of the subsoil by impervious strata. Artesian wells are by natural channels or are made by drilling to points below layers of rocks, which cut off the ground water. Water supplies of villages, small towns is usually obtained from wells driven or dug, or from collections of rain water stored in cisterns, or natural springs, and is delivered by means of many devices varying from the bucket to the most modern pump.

The water supply of large towns and cities is in most instances collected into impounded reservoirs from which it is carried by iron mains into the locality to be supplied and thence into smaller leaden pipes to places of delivery.

The ideally pure water would be obtained from a source undoubtedly beyond contamination, and in its conveyance to point of delivery should maintain its purity. If the mountain spring with sources undoubtedly beyond danger of pollution is not to be obtained, the next best would be a water properly purified by slow sand filtration or pure ground water supply, or surface water supply with large and impounded reservoir, protected against pollution by properly enforced laws. Or the supply may be taken from large normal rivers, or rivers in which pollution may be considered to have greatly vanished through agency of sedimentation, dilution, or other causes. One of the sources above named should be chosen, but unfortunately the best furnished in many cases is found to be water from large inland lakes more or less subject to pollution, or is taken from upland streams, or small lakes, with limited water sheds, which are more or less inhabited, or from rivers, or public or private wells, which are known to be polluted with sewage or other infectious matter in varying degrees.

CLASSED AS NORMAL.

"For a water to be classed as normal it is necessary that intake of water works should be so located, as to be above the influence of the discharge of either sewage or surface drainage from urban or suburban districts. There should be no city up stream discharging crude sewage into river within such distance that sewage would not be thoroughly and completely disbursed at the cross section of river before reaching the water works intake."

"So many complex phenomena are met with in cases of river pollution that probably no definite standard can be adopted excepting to consider all natural waters as polluted to greater or less degrees. Mountain spring waters and properly filtered water being least so." The important practical questions to be considered in the study of water are: What are the substances which defile the water supply? How may these substances be detected, and what is their significance? How shall impure water be rendered fit for use? Substances contaminating a water supply may be organic, of animal or vegetable origin, or inorganic substances dissolved from soil and rocks by the solvent action of water.

"The greater amount of CO_2 in water, the greater its solvent power, and the wider the range of soluble substances. Salts due to the action of acids derive from decomposition of organic matter on the bases in the rock." Organic substances of animal and vegetable origin find their way into water supply by washings brought down from watersheds by rain fall, by introduction of sewage into water supply, either by direct opening of sewers into streams, or by wilful pollution of springs, or by leakage of pipes, or walls of cess pools. Again, leaves, sawdust, vegetable matter, vegetable refuse of various kinds may enter the supply.

"Organic matter of animal origin is not of itself more dangerous to health than is organic matter of vegetable origin, but it possesses great power for evil." Organic matter quickly undergoes decomposition and oxidation. The C of organic matter combines with O of H_2O to form CO_2, while the N of organic matter is left to combine with H of H_2O to form NH_3.

ACID IS FORMED.

Nitrous acid is next formed which combines with those bases for which it has affinity, and nitrites are formed. These are unstable bodies which are converted by the addition of oxygen into nitrates, and represent the last stage of oxidation of organic matter. It is of greatest importance to find out whether the organic matter present is of animal or vegetable origin. The animal organic matter indicates that the way is open for the access of specific poisons as typhoid fever, dysentery and cholera. All waters, however pure, contain a small amount of free ammonia. Rain takes up ammonia which is present in the atmosphere as a result of the combustion of fuel and animal exhalations. Sewage containing urine always becomes ammoniacal.

Water containing urine yields a large amount of free ammonia. 0.03-0.08 parts per million is suspiciously high. The work of detection of injurious substances in water belongs to the province of the analytical chemist and to the bacteriologist. The processes of obtaining such information being difficult and tedious and requiring special laboratory facilities and special training.

We must bear in mind that an analysis of water is in no sense parallel with the analysis of metals, but is "a series of experiments undertaken with a view to assist the judgment in determining the suitability of water for drinking purposes." There exists differences in the formation of the soil in different localities. This one thing makes very often a radical difference in the final determination as to the character of the water. As for example, "if common salt be found in a shallow well in a Hudson River valley, it is difficult to explain its presence except upon supposition of contamination by sewage, whereas if the same amount of salt be found in a deep well water at Syracuse, New York, it would be accounted unobjectionable."

HISTORY IS NECESSARY.

The chemist must have knowledge of the history of the water. Nichols says it is a great mistake to suppose that the proper way to consult a chemist is to send a sample of water in a sealed vessel with no hint as to its source. What is called a golden rule among chemists, and is insisted upon, runs thus: "Never pass judgment upon a water the history of which is not thoroughly known." The water having been properly collected from either source of supply, or from place of delivery in clean glass-stoppered bottles, which have never been used before, the bottles having been rinsed and filled to overflowing to displace the air, then having been completely emptied and filled again, a piece of cloth should be fastened firmly about the neck of the bottle and the ends of string which keep it in place may be fastened by sealing.

The most carelessness in collecting the water will render the report worthless. Give the date of taking of sample since water even thus protected soon changes. Send also a description of the soil with which the water comes in contact in any way together with immediate or remote sources of possible contamination. The chemist considers appearance of water, odor and taste, temperature, reaction, color, total solids as to source, hardness of water, permanent or temporary, amount of chlorine present, nitrogen as nitrites, nitrogen as nitrates, as free ammonia, as albuminoid ammonia, lead copper, iron, zinc, alum, phosphates, dissolved gases. Many substances render the water turbid, as death of algae and separation of their growth.

Dead leaves, washings from tanneries, dye works, etc. Any quickly subsiding material is to be reckoned sediment and not turbidity. Odor and taste which are such important items of interest to us are not so considered from the chemist's standpoint, since it has been found by analyists that a good water may possess a marshy odor, while a dangerous water may be tasteless and odorless. In the report of the Massachusetts Board of Health, 1879, may be found this: "The lower forms of animal and vegetable life giving by their death odors described as musty, fishy, horse-pond and the like, however objectionable from an aesthetic standpoint, are not productive of disease. When the small plants themselves are swallowed they act chiefly in a mechanical way, like unripe fruit in causing diarrhoea. The filtered water is harmless."

ABOUT FREE ACIDS.

Unless water contains free acid usually sulfuric, and this occurs in manufacturing centers and in coal regions, and is washed down by the rains, the reaction of the water is alkaline. Water of all degrees of hardness and variety of color and turbidity are due to material dissolved or suspended in the water derived from the strata through which it has passed. Permanent hardness of water is due to sulfates of calcium and magnesium, and does not disappear upon boiling. Temporary hardness of water is due to Carbonates of Ca and Mg held in solution by CO_2 present in the water. Boiling expells CO_2 and the salts separate from the water and the hardness disappears. Chlorin in water is indication of contamination by sewage unless its presence can be explained as having been washed from air or soil.

Mallet says: "I am inclined to attach special and very great importance to the careful determination of nitrites and nitrates in water to be used for drinking purposes, and this because their presence is always an indication of contamination." Nitrites are always suspicious if found in ground or surface water. However, the absence of nitrites proves nothing. Mason cites a case in which a most foul cistern water showed upon analysis but a trace of nitrites and nitrates, and yet the water was contaminated, with entire house drainage, and produced most serious illness. This case shows plainly the necessity for the chemist to use his judgment, to know the history of the water and to make actual inspection of premises in order that a correct judgment may be arrived at.

"Nitrates indicate putrefaction of animal rather than of vegetables tissue on account of a greater amount of oxygen in animal tissue and because of its more ready decomposition. Surface and ground water of good quality are low in nitrates, for the reason that such material is quickly absorbed by growing vegetation." So-called albuminoid ammonia does not exist ready formed in water, but is a product of the decomposition of organic nitrogenous substances by alkaline permanganate. (The term is derived from the fact that ablumin gives off ammonia in like manner when similarly treated. Dr. Smart believes that a water which in the third or fourth measure of distillation gives a persistent evolution of free ammonia which is followed in the progress of the experiment by a persistence of twice that quantity of albuminoid ammonia probably contains urea which is the chief solid constituent of urine, and the principal nitrogenous end—product of tissue change.

NITRITES FORMED.

"Nitrites are formed at the expense of ammonia and they in their turn are converted into nitrates by further oxidation." Lead and copper and zinc because of their distinctly poisonous properties are most objectionable constituents of the water supply. Iron, if in considerable quantity, is also objectionable. Phosphates are never present in more than minute traces in water fit for domestic use, but are always present in contaminated water.

Bacteria under very adverse conditions may be transported by flowing water to very great distances without losing their vitality, and thus it becomes necessary in a complete analysis of water to make bacteriological examination of water for the discovery of possible germ contamination. Nichols says "in the matter of determining the suitability of a stream for city supply the service of the bacteriologist should be unquestionably secured." Dr. DuPre has pointed out that chemistry anticipates what may happen in the future, and by timely advice may prevent an outbreak of disease, while on the other hand the discovery of disease germs in a water is only possible after the water is infected.

Bacteriology is of special value and greatly superior to chemistry for the testing of filters and watching the variation in their efficiency. Numerous bacteria in water indicate that there is food for their substenance since they cannot live without nourishment, and this food is usually supplied by sewage. Ordinary boiling for a half hour will destroy 99 per cent. of all bacterial life, and that which remains is harmless.

Since ice enters so largely into the drinking water in general usage, and because it is popularly supposed that freezing destroys germs, and because this has been proven absolutely incorrect, it seems wise in this connection to speak of ice, and to point out its danger.

Ice, if cut from a stream whose flowing water is suitable for drinking purposes, may with safety be used in cooling water. Artificial ice made from distilled water contains no element of danger. Unfortunately in many instances ice is cut from any place where it is found of sufficient thickness to make it seem worth while to take it, notwithstanding the water of such place is so impure that the most ignorant would not drink of it.

In conclusion I cannot give more timely nor more useful advice than to repeat to you the words of that most accomplished physician Hippocrates, which are repeated in these days so often without reference to their distinguished author, and which constitute our bulwork of defense in all times of danger from poisons of typhoid fever and cholera, and with which you are all so familiar, repeating them whenever you say, "Water should be boiled and filtered".

Mr. Reuben Haines offered the following figures representing the averages of 34 different determinations of uncontaminated waters and recommended them as standards for pure waters in the neighborhood of Philadelphia.

Parts per million:
Free amonia 0,031
Albuminoid amonia 0,044.
Chlorin 11,9.
Nitrogen as nitrates 5,075.
Total solids, 125,7