AQUA VITÆ

A MEETING of the Nutrition Society was held on March 23 at the Royal Society of Medicine. It took the form of a symposium on "Man's Need for Water", and members of the Institution of Water Engineers were present. Prof. R. A. McCance was in the chair.

The symposium was opened by Dr. W. H. Cremer, who discussed the "Water Requirements of the Modern State". He spoke of the large reservoirs and long pipe lines necessary to provide enough water for some large industrial cities, but he had to admit that this was all very costly and not always popular where the reservoirs had to be built.

Dr. Cremer also spoke of the possibility of replenishing underground supplies of water by suitable filtration through the soil. This is an interesting prospect, but he did not touch upon the expense. Re-charging these underground supplies is evidently being investigated actively at the moment. The industrial demands for water are becoming more and more difficult to meet and the contamination of the water by the industries brings further problems. Chlorination still seems to be the sheet anchor against bacterial infection, and people do not seem to mind the taste of chlorine, although they object to that of many organic compounds which can get into a water supply in all sorts of ways. Those present were surprised when Dr. Cremer tried to persuade them that something like half the water distributed in America is used, not for industry, but for agricultural irrigation. The audience felt they were being taken over more familiar ground when Dr. Cremer spoke about fluoridization of water and iodine deficiencies. He said little about metallic poisoning, but the detergents that are now used so freely and run away down the sink are likely to cause water engineers some very serious difficulties. After a word on radioactive poisoning, Dr. Cremer concluded his remarks. He seems to see no problem over the supply of water in Britain in the foreseeable future in spite of the cost and organization involved. Some of us would like to have heard more about the problems created by the rising populations in other parts of the world, and the industrial development of dry parts of America. Confident as Dr. Cremer appeared to be in the future, one could not help thinking about the great aqueducts and storage tanks built in Ceylon, Central America, Italy and other parts of the world by past civilizations, and hoping that a fate similar to theirs would not befall our own.

Dr. J. R. Robinson gave an elegant account of the functions of water in the body. The extracellular fluids or 'middleman fluids' of the body he likened to a pond in which the cells lead an aquatic existence; but the cells are not quite like amoebæ in a fresh-water pond, for the pond in the body is warm and salt. It is, moreover, small in volume, so that the activity of the cells affects the composition of the pond. The cells are intolerant of changes in external composition and temperature and "a great part of physiology is concerned with mechanisms which enable the little over-crowded pond under our skins to maintain our cells as though it had an unlimited volume".

Dr. Robinson then pointed out that some of the chief functions of water in the body could only be fulfilled by losing it through the kidneys, lungs and skin. These losses must be made good if the cells are to function normally, for water is the great vehicle of transport in the body, and transport will break down if the volume of the blood, and of the extracellular fluids as a whole, is reduced. Dr. Robinson reminded his audience that, generally speaking, cell membranes are permeable to water, so that the volume of a cell in equilibrium with an environment with a constant osmotic pressure will be proportional to the quantity of solutes inside it, and this is profoundly affected by metabolic activity. Here Dr. Robinson was touching on a subject to which he has made major contributions, for he himself has shown that interruption of cell respiration by chilling, anoxia or poisoning with cyanide causes cells to swell. So long as metabolism is proceeding normally, however, the osmotic pressure of the extracellular fluid is the most important factor in controlling the net exchange of water between the cells and extracellular fluid. This being so, thirst and water diuresis are really the means by which the volume and osmotic pressure of the extracellular fluids and also the volume of the intracellular fluid are both kept constant. Dr. Robinson concluded with the thought-provoking remark: "The kidneys control the volume of water inside the cells by excreting water, and the volume outside the cells by excreting salt".

Dr. J. R. Elkinton, of Philadelphia, gave the next paper, which was on the relationship of water and salt. He took his audience into the realms of the palaeochemistry of the earth and its relation to the evolution of body fluids. He compared the composition of the extracellular fluids with that of sea water and described the suggestion made more than fifty years ago that the composition of vertebrate extracellular fluid is a heritage of the ancient seas in which such organisms first evolved. He referred to Conway's calculations concerning the chemical evolution of the ocean. As the rain dissolved the original igneous rock of the Earth's surface, washing the solutes into the sea, sedimentary rock was formed by precipitation. In this rock was the potassium, magnesium and calcium, whereas sodium salts remained in solution in the sea water. Whether the mechanisms responsible for depositing potassium in the cell are similar to those involved in depositing it in the soil is a matter for speculation, but the fact is clear that potassium and sodium are distributed differentially in geochemical as well as in biochemical systems.

Dr. Elkinton then discussed what happened when organisms which began life in a salty sea found themselves in a hypotonic medium of fresh water. They had to develop such mechanisms as water-tight skins and glomerular kidneys to prevent themselves from becoming over-hydrated. If they chose to return to the hypertonic oceans they were then forced to protect themselves against dehydration, and various methods of doing so appeared, such as the physiological uræmia of the elasmobranchs, salt-secreting gills and so on. Animals and birds on dry land

acquired the ability to secrete a hypertonic urine, so that they were able to regulate their salt and water balance, and hence the composition of the internal environment.

Dr. Elkinton next posed the question, "How does the kidney know how much sodium and potassium to excrete?", and he mentioned some of the mechanisms, the secretion of aldosterone, for example, which are known to play a part, but it is still not known what tells the adrenal cortex how much aldosterone to secrete. He concluded by describing some experiments of his own. In pure dehydration the concentrations of sodium and chloride in the serum rises, but the excretion of the two ions in the urine falls, whereas the excretion of potassium increases. This he interpreted as a conservation of extracellular fluid at the expense of intracellular water. In contrast, a deficiency of salt leads to a fall in the concentration of sodium and chloride in the extracellular fluids, and to a fall in their volume with a movement of water into the cells.

Dr. E. M. Widdowson opened the afternoon session with a paper on "Water Equilibrium in Health". She first described the sources of water, from drink, from food, and from water of oxidation, and the four routes by which water is normally lost—through the lungs, the skin, the intestine and the kidneys. A healthy person's kidneys can easily excrete all the excess of fluid he or she is likely to drink, but a shortage of water may be disastrous, and dehydration is always due to the losses of water from the body exceeding the intake. The losses by the lungs and skin go on whatever the supply of water and the state of hydration of the body may be; only the losses by the kidneys vary with the intake and the requirement.

A baby loses more water by all routes than an adult in proportion to its body-weight and it therefore needs more fluid. If a man drank as much as a baby per pound of body-weight he would have to consume two gallons a day. Dr. Widdowson raised the question as to which would be able to survive longer when deprived of all water, an adult or a baby. Conventional teaching suggested that the baby would die sooner, but Dr. Widdowson was not so sure.

The effects of experimental dehydration were described, and Dr. Widdowson told the story of "The Welsh Fasting Girl", who was in the news nearly a hundred years ago. She was supposed to be able to live without any food or water, but when "four reliable nurses from Guy's Hospital" were sent to watch her night and day to prove or disprove the miracle she lived only eight days. Many at the time assumed that starvation had been the cause of death, but the records clearly point to dehydration. Dr. Widdowson concluded with a reference to the castaway at sea. Records collected from members of the Merchant Navy whose ships were sunk during the Second World War provide convincing evidence of the disastrous effects of drinking sea water.

The last two speakers handled the problem of the metabolism of water in disease. By a series of witty little rationalizations, Dr. D. A. K. Black managed to exclude salt from his programme and to limit his responsibility to water depletion and water intoxication. As has happened before, both these departures from the normal were well characterized experimentally before they were recognized to be relatively common in the wards. Even with water beside their beds patients may take far less than they need if

they are comatose, lethargic or simply too weak to make the necessary effort. Oesophageal obstruction may have the same effect. Sweating and hyperpnoea may increase the loss and so may various renal abnormalities such as diabetes insipidus or, much more commonly, an inability to produce a concentrated urine. This can follow potassium deficiency as well as the more classical forms of nephritis. Dr. Black then made the point that the recognition of clinical dehydration demanded considerable fundamental knowledge coupled with a study of the patient's history and his disease.

Water intoxication remained a clinical rarity for many years after its first recognition and description by Rowntree in 1922. It has, however, recently been accepted as a dangerous feature in the treatment of patients who have for some reason ceased to pass any urine. Such patients often recover if given time, but the temptation to try to improve their chances by giving them water in large amounts by mouth must be avoided at all costs. Only enough water should be given to meet the losses by the lungs and skin, and even less than this is desirable because of the water which is always being produced inside the body by the oxidation of protein, fat and carbohydrate.

With years of experience behind her, Dr. Winifred Young gave the meeting a masterly exposition on the restoration and maintenance of water equilibrium in sick children. She went into the question of how to decide how much water and salt ought to be given within a few hours of admission to hospital, and then passed on to discuss the assessment of the infant's maintenance requirements. She touched upon the thorny question of how much, if any, potassium should be given intravenously, and stressed the impossibility of getting results back, even from a well-equipped laboratory, in time to do more than give one confidence, or the reverse, in what one had already done. She illustrated this by a vivid description of a dehydrated child which had been treated with too much water and not enough salt in preparation for an emergency operation. The child developed water intoxication, which was recognized clinically and treated. The surgeons did their part—and all was well.

A lively discussion followed both the morning and afternoon sessions. Dr. W. S. S. Ladell demonstrated from his own experience that troops in moderately hot climates might lose almost ten litres of water a day. Whether to drink sea water or to chew fish if cast away in a rubber dinghy received a good deal of attention, and questions were answered by Dr. J. R. Elkinton, Dr. G. R. Hervey and the chairman.

Dr. Windle Taylor, director of Water Examination at the Metropolitan Water Board, asked how much salt would be permissible in water which was provided for a patient on a salt-free diet, and was told that in the majority of cases the amount of sodium in tap water would not matter.

Dr. Cicely Williams suggested that in the tropics one of the chief causes of malnutrition was often gastro-enteritis and dyspepsia, which arose because water was not easily available, and the staple food was inadequately cooked in insufficient water.

Other people taking part in the discussion were Prof. J. Yudkin, Dr. R. J. L. Allen, Mr. A. L. Bacharach, Dr. D. C. Wilson and Miss D. Hollingsworth.

R. A. McCANCE
E. M. WIDDOWSON