4. In the absence of renal disease, oliguria is a sign of fluid depletion. A urine volume of less than one litre a day in a patient with no vomiting or diarrhoea means that the fluid intake is inadequate, and the intake of watery fluid by mouth should be increased to two litres or more.

5. A good rough test for salt deficiency is the Fantus drop test for urinary chloride, carried out as follows:

One drop of 20% potassium chromate is added to ten drops of urine. The pipette is washed in distilled water, and used to add 2.9% silver nitrate to the urine until the yellow colour changes sharply to brownish red. The number of drops used indicates the number of grammes of salt per litre of urine. The colour change may occur with the first drop of silver nitrate added, showing a salt content of less than 1 g. per litre.

This test is significant only when the urine specimen is reasonably concentrated, and when there is no disease of the suprarenal glands. Moreover, it may fail to show salt deficiency in the presence of acidosis. With these reservations a salt concentration of less than 5 g. per litre indicates the need for increasing the saline intake.

6. Whenever possible, fluid should be given by mouth, and parenteral therapy reserved for those patients whose vomiting or diarrhoea makes the alimentary route impracticable. If a duodenal tube can be passed and retained, it may enable the alimentary tract to be used in a patient with vomiting. Large amounts of fluid can be given safely in this way, and it is an old observation that fluid given by the bowel is better retained than parenteral fluid. Moreover, intravenous fluid carries some risk of circulatory overloading and pulmonary oedema.

In concentrating on the essentials of fluid therapy I have had to omit such important topics as the effect of alkalosis and acidosis, the dangers of potassium depletion by copious saline infusion, the special problems of infancy, and even the general clinical signs of fluid depletion. The excuse for this last omission must be that the diagnosis of fluid depletion is less difficult than a decision about appropriate treatment. The other omissions seem to me to concern matters which cannot well be dealt with apart from accurate laboratory investigation and hospital treatment. Marriott (1947) gives a fuller review of the problems of dehydration in his Croonian Lectures, which were published in the *Journal*.

Diagrams reproduced by kind permission of Professor Gamble and Dr. H. L. Marriott.

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A joint committee has been established in Glasgow to consider the best methods of combating tuberculosis in that city. Representatives have been appointed by the Scottish Western Regional Hospital Board, the Glasgow Executive Council, and the Glasgow Corporation. After the first meeting of this committee it was stated that there were two immediate problems: one concerned the shortage of beds and was the responsibility of the Hospital Board, and the other was the danger of infectious patients in the home, this being the responsibility of the local authorities. It was reported to the committee that notifications of pulmonary tuberculosis in the city increased by 62% between 1938 and 1949. The total number of beds available for tuberculous patients is now 1,300, and it is hoped that an additional 132 beds will shortly become available. At the end of December, 1949, 1,403 patients were awaiting admission to sanatoria: this figure compares with 1,423 in July, 1948, and 1,700 in the middle of 1949.

THE ROTHWELL STERILE-WATER SYSTEM AND ITS UROLOGICAL APPLICATION

BY

A. M. McMASTER, F.R.C.S.Ed.

Surgeon and Urologist, Rochdale Infirmary;
Urologist, Birch Hill Hospital, Rochdale

To prevent furring of the water-sterilizing plants waste condensate water from the steam-heating systems has from time to time been used in hospitals in areas where the water was exceptionally hard, but so far as I can ascertain it is only during the past few years that use has been made of the fact that this sterile distilled water was ready for use in the operating theatre.

Some years ago the original experimental plant was designed by the hospital engineer, Mr. E. Rothwell, and installed at Birch Hill Hospital, Rochdale. It is no exaggeration to say that it has continued to function without interruption or difficulty until the present day. As is the case with many brilliant inventions, the basic idea was extremely simple once the principle had been grasped. The system is founded on the fact that in all steam-heating systems cooling of the pipes causes part of the steam to be condensed as sterile distilled water, and in the normal plant this condensate is collected in steam traps and is piped back to the boilers to save fuel. Such condensate is absolutely sterile, as it is usually produced from steam delivered from the high-pressure boilers in the region of 70–80 lb. per square inch (4.92–5.62 kg. per cm²).

The Rothwell system makes use of this condensate by collecting it in a suitable tank in a basement and pumping the water by a simple steam-operated float pump, which requires no attention, to tanks over the operating theatre (Fig. 1). The hot condensate can then be carried by gravity direct to the theatre, where hot sterile water is available from a wall tap for all purposes, thus eliminating all water boilers and sterilizers from the theatre. A part of the hot

FIG. 1.—Main storage tank for sterile water, installed in the basement. Its contents are automatically pumped to auxiliary tanks above the operating theatres. A = Main storage tank. B = Automatic steam float pump. C = Condensate temperature controller (calorifier).

FIG. 2.—Scrub-up sinks with faucets operated by a foot-pedal and mixing-valve with continuous-flow pipe and thermometer near by. A = Thermometer on delivery pipe to douche and scrub-up systems. Mixing valve is below thermometer.

water is transferred to a second roof tank containing a large sealed cooling coil from the ordinary water mains, and this cold water is fed, again by gravity, to a cold-water tap for delivery of cold sterile water.

As soon as the main storage tank in the basement begins to fill with sterile distilled water from the condensate mains the apparatus functions automatically, as the steam-operated float pump operates every 15 seconds and transfers a continuous supply of sterile water to the subsidiary tanks over the operating theatre. When these become full the excess water overflows by a closed pipe back to the main storage tank in the basement. Consequently, the sterile water in the whole system is always circulating and never becomes stagnant—in fact, fresh sterile distilled water is added continuously from the steam mains, any excess in the main storage tank being carried away through a water-sealed overflow to the main condensate line to the boiler-house, thus avoiding any waste of valuable condensate.

When the system is first installed it is closed and “live” steam is passed through it for three hours to sterilize it; then it is completely sealed so that it is impossible for any infection to enter and contaminate the water. It has been the practice in Rochdale to have the water bacteriologically tested once a month, and it has always been free of any organic matter and bacteria. The older methods of preparing sterile water in the operating theatre or a sterilizing-room suffered from many disadvantages, the greatest undoubtedly being the human element, for if the supply of sterile water should run out during the operating session the urgency of the need for it might lead to water being supplied which had not been boiled long enough to ensure complete sterility. Most surgeons will know of occasions when the sterile water supply was under grave suspicion when clean operation cases have become infected.

After several years' experience of the experimental plant at Birch Hill Hospital the system was installed in the Rochdale Infirmary in October, 1946, and hot and cold sterile water-taps were installed in two theatres. The experience of the original installation was so satisfactory that, in addition, the ordinary taps were removed from the scrub-up basins and sterile water was brought there. For this purpose the hot and cold sterile water is supplied direct to a thermostatic mixing-valve with a thermometer attached. This valve is alongside the wash-basins, and with its aid the temperature of the water can be instantly adjusted so that water may be delivered at a constant temperature. Each delivery pipe to the basins is controlled by a pedal or stud in the floor which is conveniently situated so that it can be opened by the foot while scrubbing up, without standing in a strained position (Fig. 2).

Once installed the apparatus requires no care or maintenance, and inquiry shows that there has been no detectable increase in fuel costs for steam production at either hospital since the system was installed, as the quantity of condensate used forms such a small proportion of the total production. Originally the amount of tap-water used by the cooling coils was extravagant, as it was allowed to run continuously throughout the 24 hours, but this has been overcome by installing taps so that the coils may be shut off when the theatres are not in use. In spite of this the cold sterile water supply is always ready for use within a few minutes of the cooling supply being restarted.

Urological Application

Having always been dissatisfied with the douche-can method of water supply for urological purposes, with its risk of infection from the transfer of water from the sterile supply to a jug and thence to the douche-can, in which the surface of the water is exposed to the air during the transfer and filling, I requested the makers to adapt the sterile water supply so that it could be delivered over the operating tables at the place where it was needed for irrigations or douches.

The first problem to be solved was that of the temperature at which the water was delivered, because all water delivered from a gravity tank to taps or scrub-up basins takes a few moments to heat up the piping and be delivered at the correct temperature. If the flow is not constant, as in urological work, the same thing occurs each time the supply is used, which is obviously unsatisfactory in urology, as cold water would be delivered into the bladder. In consequence a continuous-flow pipe was attached to the same mixing-valve, which is set at the appropriate temperature (98–100° F., 36.7–37.8° C.), and the water is carried thence across the ceiling of the theatre and back to overflow into the main storage tank in the basement for return to the boiler-house. From this supply a double delivery pipe on a flexible mounting is brought down immediately over the operating table to a height of 6 ft. 6 in. (2 m.). This device has an inner outflow-tube which delivers its contents to the main overflow pipe and which extends almost to the bottom of the main outer tube. Consequently, as the water flows in at the top, it is always circulating, even when not in use, and is delivered to the outlet nozzle at the correct temperature without any time lag (Fig. 3).

At the lower end of this flexible mounting there is a needle valve and a bayonet catch for attaching the connexion for the water supply to the instrument in use. The needle valve can be set to very fine limits so that water is delivered at any speed from a few drops a minute up to a stream much more powerful than it is safe to use in the bladder or any other form of irrigation. In practice this has proved so successful that it is now my usual procedure

FIG. 3.—Irrigation supply pipe, with needle-valve control connected to a cystoscope.

to use a flushing cystoscope for the simplest examinations, as it is easier to attach the sterilized tubing to the delivery pipe and cystoscope than to fill the bladder by syringe or any other means; while in cases of cystitis, tuberculosis, or blood clot in the bladder the medium is cleared more rapidly and efficiently than by any other method. Exactly the same benefits are achieved with the urethroscope and the "cold punch," and one has the satisfaction of knowing that only sterile distilled

water at the correct regulated temperature is passing into the bladder. In transurethral prostatectomies by the "cold punch," in addition to these advantages, the adjustment in the water flow which is necessary when the removal of prostate is completed and haemostasis is started can be achieved instantly by altering the needle valve. In practice this has rarely been necessary, as the required alterations can be made with the tap on the instrument.

A Marion tap is also included in the delivery tubing in case it is necessary to stop the water supply completely at any time, such as when changing instruments, thus avoiding adjustments of the needle valve during an operation.

Even with a relatively slow supply of water the head of pressure, which is at least 12 ft. (3.66 m.) with a single-story building, will eventually build up in the bladder unless certain precautions are taken. All cystoscopic and transurethral procedures are given only a low-saddle analgesia by means of 1 ml. of heavy cinchocaine hydrochloride ("nupercaine") in a sitting position. This gives analgesia of the base of the bladder and the whole urethra but leaves the fundus of the bladder sensitive, so that if it is over-distended in any way the patient begins to show distress by moving even before he complains that the bladder is full.

This precaution has been found effective even in the small 2–3 oz. (57–85 ml.) capacity bladders which occur in tuberculosis or chronic interstitial cystitis, but the additional precaution is taken in each case of having a nurse or other assistant keeping a hand above the pubis to give the operator warning as soon as the bladder has risen enough to be palpable. This is probably not essential in the ordinary cystoscopy, but during transurethral prostatectomy, where the neck of the bladder may have become rather thin after removal of the median lobe, there is a risk of rupture of the bladder neck by the extra tension caused when the discomfort of a full bladder makes the patient move. In all cases it has been found wise to have the assistant's hand on the abdomen, and our experience shows that a junior probationer can be rapidly trained to

detect the fundus of the full bladder before it becomes dangerously full.

During three years' regular use no case has been detected of oedema or other change in the bladder from the use of this distilled water for irrigation, nor has any case shown symptoms suggesting haemolysis due to water being forced into the circulation through the open cut veins in the prostatic resections.

Patients in whom cystoscopies are carried out by this method with low-saddle analgesia are treated as semi-outpatients, being admitted to hospital at 9 a.m. and discharged again about 6 p.m. The majority suffer little effect and are fit for work again in 24 to 48 hours. Only an occasional patient shows any disability from post-spinal headache.

Finally, to indicate the trouble-free service which the system can give, in 1948 3,870 operations were performed in the three theatres fitted with the apparatus. Sterile scrub-up water and ordinary sterile water would be in use in every case, and more than 400 of these operations were urological procedures involving the use of the irrigating system.

I am indebted to the inventor, Mr. E. Rothwell, late engineer of the Birch Hill Hospital, Rochdale, and to the makers, Messrs. Charles F. Thackray, Ltd., Park Street, Leeds, 1, for technical information and diagrams and for the care with which they have carried out my wishes in installing the apparatus.

APPLICATION OF SCIENTIFIC METHODS IN INDUSTRY

MEDICAL RESEARCH COUNCIL THREE-DAY CONFERENCE

A conference on the application of scientific methods to industrial and other problems was held, under the auspices of the Medical Research Council, at the London School of Hygiene and Tropical Medicine on the three last days of March. The principal subjects of discussion were the technique of field surveys, health hazards in certain industries, and the improvement of human performance by attention to the working environment, better design of industrial furniture and tools, and the application of psychological studies to the worker and his job.

Field Surveys

The first day of the conference, which was opened by Dr. H. P. HIMSWORTH, secretary of the Medical Research Council, was devoted to scientific methods in field surveys. Professor A. BRADFORD HILL discussed the sampling method. If a whole population was taken for survey there would, of course, be no sampling problem, but he would prefer to have a sample of one in four of a population to taking the whole population when the answers of one in four were missing. Care must be taken in sampling to be sure that all had an equal chance of appearing in the sample, which would not be the case if, for instance, the selection was based upon the initials of surnames. He defined the steps to be taken to eliminate the bias of personal judgment which was bound to turn up when dealing with group problems, and, to quote Dr. Himsforth afterwards, "like all statisticians, he assigned to statistics a relatively subsidiary role."

Dr. D. D. REID, reader in epidemiology at the University of London, described a system used in the investigation of absence due to sickness among workers in the London G.P.O. It was a flexible system under which standardized morbidity rates were worked out for each age group, according to sex and grade of employment.

Dr. R. DOLL, of the M.R.C. Statistical Research Unit, described an investigation into occupational factors in peptic ulcer. He spoke of the need in such inquiries for full co-operation with the workpeople, who were sometimes inclined