CHLORAMINE TREATMENT OF WATER IN THE FIELD.

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In accordance with War Office instructions a trial was carried out during divisional training and army manoeuvres. Arrangements were made for this by the Aldershot Command and the facility with which it was carried out was largely due to the Assistant Director of Hygiene, Lieutenant-Colonel J. T. Johnson, D.S.O., R.A.M.C.

The 1st Division was selected by the Command as affording the best scope for the trial and particularly the 2nd Brigade. To Major-General Sir A. A. Montgomery, K.C.B., K.C.M.G., and his staff I am indebted for ever ready assistance.

In the 2nd Brigade the trial was followed with interest by all. The Brigade Commander, Colonel Commandant J. G. Dill, C.M.G., D.S.O., visited the laboratory and inquired into the methods of manufacture of the compounds. His appreciation of the treated water which perforce he drank daily was gratifying. The men themselves were not unappreciative of an attempt to eliminate taste from doped water and when called upon to carry out the treatment entered fully into the spirit of the trial. In fact, from every point of view, in contradistinction to the usual atmosphere of suspicion which deservedly surrounds all poisoners of water, nobody could have been more happily placed.

The bacteriological and chemical check on the field trial gives accurate and valuable information regarding the value of chloramines under general service conditions and the presence of No. 1 Mobile Laboratory instead of an improvised one contributed largely to the good results obtained.

The work carried out may be apportioned as follows:—

Period 1.—Preparation.
Period 2.—Controls and examination of supplies.
Period 3.—A comparison of efficiency of the compounds by various methods.
Period 4.—Estimation of minimum safe dose.
Period 5.—The use of a standard dose of monochloramine against all types of water, and this includes the manoeuvre period.

The laboratory arrived in Tichborne Camp on September 2 and on the 2nd, 3rd and 4th we were busily engaged in opening out and getting things in order.

It may be pointed out that although this trial was lightly undertaken and at ordinary times might prove to be a simple matter, with the limited time at our disposal and in face of the abnormal climatic conditions, it was a difficult and anxious task. One source of trouble was the time taken...
in adjusting incubators recently drawn from store which were adversely affected by varying temperature under canvas.

Initially arrangements were made to take down a stock of sterilized and tubed media, so that the quality of the waters to be used could be examined and a certain number of chloramine controls could be carried out without delay. Concurrently with the performance of these the bulk of the media in sterile milk bottles was tubed and resterilized.

The troops arrived on the 4th and according to plan drew their water from the Itchen and treated it with bleach powder in the usual way. Immediately complaints re taste were received from certain units and on investigation proved to be due to faulty treatment. In several units this caused the men to evade drinking chlorinated water for three whole days. To avoid similar recurrences, from now onwards water treatment was supervised by the staff from the school and complaints regarding taste were infrequent although the taste of chlorine was perceptible.

A daily examination of the Itchen water by the Horrocks test was carried out and it proved to be a two-scoop water, usually absorbing from 0·6 to 0·8 p.p.m. of chlorine. On one occasion an increased absorption was noted and it became temporarily a three-scoop water. From the 4th to the 7th inclusive all water was treated with stabilized bleach. This period was selected because it covered a two-days’ scheme and consequently men who had been drinking authorized water would at some time be compelled to have recourse to the chlorinated water in the carts. The majority of complaints re chlorine were received at this time and were due to the reaction of chlorine with tea extractives which produced the usual nauseating results. As our procedure was not being advertised it took a little time to convince the troops that this objectionable taste was not due to our activities and that the water was not being treated with chloramines. A demonstration to N.C.O.’s of certain units, at which an issue of tea brewed with water treated with chloramines was made, combined with the assurance that chloramine treatment was being commenced that day, produced a good effect. On the evening of the 7th chloramine treatment of all drinking water was carried out by my staff and in the course of the following morning messages of thanks were received via the water supervisory staff. From now onwards the success of the trial was assured.

Bacteriological examinations of the raw Itchen water revealed that it contained presumptive Bacillus coli in from 0·01 of a cubic centimetre and gave a colony count on agar of 2,200 colonies per cubic centimetre. Control tests with unclarified water, using our standard contact period, showed that these were eliminated with doses of dichloramine of 0·2 p.p.m. and 0·3 to 0·4 of monochloramine. A reduction in dosage below this was not considered advisable when using rough field methods of dosing; for some days fixed doses of 0·3 to 0·4 p.p.m. dichloramine or 0·4 to 0·5 p.p.m. monochloramine were used with satisfactory results.
At the same time, the Meon water at Soberton was found to contain presumptive *B. coli* in 0.1 of a cubic centimetre. Samples after treatment with 0.25 p.p.m. dichloramine showed that *B. coli* were absent from 100 cubic centimetres. Later it was found that using doses of dichloramine as low as 0.25 to 0.3 p.p.m. and 0.4 of monochloramine, *B. coli* were occasionally present in fifty cubic centimetres of treated unclarified Itchen water, after heavy rain and with our standard contact period, but were absent from 100 cubic centimetres after eighty minutes. Obviously in unclarified water the presence of particulate pollutive masses must be reckoned with. An increase in the doses of dichloramine to 0.75 and of monochloramine to 1 p.p.m. produced the desired effect.

From now onwards, these, the normal doses of chloramines employed during experimental trials at the Army School of Hygiene, were adhered to and proved satisfactory both bacteriologically and from the point of view of taste. From a survey of the wells in the Tichborne area it appeared that many of these might be seriously polluted and subsequent bacteriological and chemical tests confirmed this opinion. In every instance after contact with our standard doses of chloramine presumptive *B. coli* were absent from 100 cubic centimetres of treated water within the usual time limit.

The performance of bacteriological examinations during the period of active movement (Army Manoeuvres) was not practicable, but a chemical control of the casual supplies was exercised. On one or two occasions even this could not be carried out, particularly during the heat of the battle centring around the Wallops. In all, water derived from three rivers (the Itchen, Meon and Test), and from more than fourteen casual supplies, wells, &c., was treated with chloramine during the trial. The majority of these waters were hard and were from lime-bearing areas.

The chloramines were made in accordance with the methods described in previous communications. The source of the chlorine water was a new type of sparklet generator with bulbs, and a tablet of ammonium carbonate supplied the N₂ radical.

The chloramines used were:

1. Monochloramine, made in the sterilizing kettle in a concentration of 25 p.p.m. by the interaction of standard chlorine with ammonium carbonate solution.
2. Dichloramine, in a similar concentration but using only half a tablet of ammonium carbonate.
3. Dichloramine, made in an ordinary enamelled mug by the action of two measureful of chlorine upon \( \frac{1}{2} \) or \( \frac{3}{4} \) a tablet of ammonium carbonate. This allows for a fifty per cent loss of Cl₂ as HCl and the ratio of Cl₂ : NH₃ is from 8 : 1 to 4 : 1.
4. Dichloramine, made by the action of one measureful of double strength chlorine water upon other inorganic salts of ammonium using the same ratios as in (3).

The method selected by the Director of Hygiene for general use was (1).
Chloramine Treatment of Water in the Field

Briefly described—One tablet of ammonium carbonate is dissolved in 4 to 6 gallons of water in the sterilizing kettle carried on the cart. After stirring well, one measureful of standard chlorine water is poured into this solution and monochloramine results. The contents of the kettle are poured into the cart when three-quarters full of water.

In the past, from the point of view of taste, it appeared advantageous to use monochloramine, and it was suggested that this compound was more effective in the presence of iron and when contact periods were restricted, but dichloramine, as far as taste was concerned, using our standard dose, was also free from objection, and this combination appeared to be superior to monochloramine in the presence of excess nitrites and easily oxidizable organic matter, such as fresh urine.

During the trial no results were obtained which might lead us to modify these opinions. Monochloramine and dichloramine appeared equally effective, but the impression gained after carefully checking the results confirmed the view that dichloramine might not be so rapid in its germicidal action as monochloramine. It also appeared possible that dichloramine made by our standard concentration method of 25 p.p.m. might not be quite so stable under all conditions as dichloramine made by the interaction of chlorine with ammonium salts. In any case the differences suggested are slight.

During this period, when the efficiency of the different combinations was being examined and the doses varied, all chloramine treatment was carried out by my staff. Later, at the request of the Director of Hygiene, Colonel H. P. W. Barrow, the water duty men of the 2nd Brigade were instructed in this method of water treatment, and were issued with the necessary equipment. After a couple of demonstrations the majority found it quite a simple matter, and were permitted to perform this duty. It was reported that they found it simpler to carry out than the standard bleach treatment controlled by the Horrocks test. My supervisory staff kept a close eye upon all water duty men during this period and if difficulties had arisen they would have been noted.

It is reported that during the battle at Middle Wallop the water duty men of a certain unit belonging to the 3rd Brigade hearing of a new method of tasteless water treatment called upon my staff to treat their carts, and commented on the fact that at Soberton, where we designedly left a residual dose of chlorine of 0.3 p.p.m. in the water delivered by the water sterilizing lorry, complaints in regard to the taste of tea were frequent. My staff at this time were also asked to treat certain carts belonging to the 1st Brigade as the water duty men wished to avoid the use of bleach.

Throughout the trial no complaints re taste were received either as regards drinking water, or in the case of tea. As a matter of fact on occasions officers believed they were drinking untreated water, and did not credit the presence of any chemical until the addition of an indicator demonstrated its presence.
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The apparatus issued to the water duty men was returned to the school at Aldershot on the termination of manoeuvres and no breakages or difficulties were noted or reported.

It is a matter for satisfaction that within such a short time we were able to test the efficiency of chloramines in such a variety of waters, i.e., rivers, wells and even stagnant pools. This would not have been possible but for the keenness and loyalty of my staff, particularly Serjeants G. W. Mace and H. W. Watson, R.A.M.C., who acted as general overseers, and for days laboured in the laboratory, and Lance-Corporal Warminger, R.A.M.C., who cycled with the Brigade and kept in touch with the laboratory throughout. He was of the greatest assistance to the troops, being at hand night and day carrying out the Horrocks tests on the selected casual supplies, and assisting in their treatment. The advantage of having these highly trained men available was quickly grasped by the units, and on numerous occasions their aid was invoked by officers and men alike.