A METHOD FOR THE DETECTION OF FLAWS IN NOMINALLY AIR-TIGHT SEALED GLASS VESSELS.

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I WAS working as an assistant in the Plague Research Laboratory in Bombay in the autumn of 1902 when the lamentable accident at Mulkowal in the Punjab occurred whereby 19 men were killed by being inoculated with the contents of a bottle of Haffkine's plague prophylactic which had become contaminated with tetanus before reaching the inoculator. As soon as my then existing engagement with the Government of Bombay had expired I resigned so that I might be free to come to England to work out the details of a method of filling bottles with fluid intended for inoculation, the principle underlying which I had thought out soon after the Mulkowal accident had happened. The object which I had in view was to fill the bottles in a small, closed sterile chamber connected with the vessel containing the fluid. As an additional safeguard the purity of the contents of each bottle was to be verified by a sample being taken from each bottle without opening the bottle. I am of the opinion that I have achieved the objects I had in view and the whole apparatus and method of using it have recently successfully passed a thorough trial on a very large scale in the principal Government bacteriological laboratories in India.

I am indebted to Mr. Haffkine for having shown that however good a system of filling and sealing bottles may be there remains a risk—quite appreciable though small—that a certain proportion of these sealed bottles may have a flaw in the glass situated almost invariably at or near the point where the glass has been fused for closing the bottle. Mr. Haffkine very kindly showed me several bottles which he had received in Bombay from various continental laboratories in which such flaws existed, the flaws being too small to be detected by the ordinary methods of examination but being sufficiently patent to have allowed the contents of the bottles to become contaminated, and only from this fact had the presence of the flaws been suspected. I believe it is quite possible that many of the cases of untoward results which have followed inoculation may be explained by the presence of such flaws in the bottles which contained the fluid used for the inoculation which have led to the contamination of the fluid. It would also be of interest to know to what tests sealed test-tubes containing broth which has shown the presence of living organisms subsequently to sterilisation had been subjected to show that their glass was without minute flaws.

I have recently designed an apparatus, extremely simple and easy to work, which will show the presence of any flaws in the glass above the level of the fluid contained in the bottle, provided the flaw be sufficiently large to allow air under a pressure of about 14 pounds per square inch to pass through it, and will also show the presence of any flaw below the level of the fluid contained in the bottle, provided such flaw be large enough to allow the passage through it of a film of the fluid contained in the bottle under the same pressure. It is difficult to imagine the existence of a flaw which will allow the passage of micro-organisms into a bottle and which will not be detected by the apparatus.

I would not trespass on the space of THE LANCET were I not firmly convinced of the reality of the danger which this flaw-finding apparatus is intended to remove, and did I not feel it my duty to place the method at the disposal of all who are responsible for the purity of fluids issued for purposes of inoculation.

The apparatus consists of: 1. A cylindrical glass vessel one end of which terminates in a ground flange making an air-tight joint with a disc of thick plate glass and the other end of the cylinder being continued into an oblate hemispheroid. As near the ground flange as is convenient is a short tubulure holding a rubber plug centrally perforated. Through this plug passes a piece of glass tube bent upwards at a $\perp$, the inner arm passing up parallel to, and near, the cylinder, to end immediately below the inner edge of the ground flange.

2. Copper wire baskets circular horizontally and with

detached circular covers. These baskets are made with wire gauze bottoms and two layers of square meshes which serve to hold the bottles to be tested vertically in the baskets. The loose covers have the same number of meshes as the baskets but the meshes are smaller so that the shoulder of each bottle is embraced by a mesh of the cover. Each mesh of the cover is numbered so that each bottle can be easily identified. The basket is provided with three small hooks placed at equal distances apart and attached to the edge of the basket by short pieces of indiarubber cord, these hooks serving to hold the cover in position. The outside of the basket is provided with three rather thick pieces of rubber cord placed axially at equal distances apart and serving to prevent the basket of bottles from moving in the glass vessel whatever position the latter is made to assume, the rubber cord at three points filling up the space between the glass cylinder and the basket.

3. A good air pump or other means of producing a vacuum and a vacuum gauge, both of these being connected with a vacuum chamber which is also connected with the glass vessel described above, the connexion being made by means of a piece of pressure tubing of a length sufficient to allow a complete rotation of the glass vessel.

Method of using the apparatus.—A basket of the bottles to be tested is placed in the glass vessel which is then filled up with clean cold water (from which all air has previously been removed by boiling) to a point just below the open end of the glass tube described above. The ground flange of the vessel is smeared with tallow or resin cerate and the plate-glass cover put on. Communication is now made between the glass vessel and the vacuum chamber which has previously been exhausted of air to a point near the vapour tension of water at the temperature of that in the glass vessel. An inspection of the bottles in the vessel is now made and this is best carried out by looking at the rows of bottles through the cylindrical sides of the vessel, this acting as a strong convex lens. Any flaw in any of the bottles above the level of their contained fluid is now revealed by the passage through the water of a stream of bubbles of air which, being at the ordinary atmospheric pressure, is exerting an expansive force on the inner surface of each bottle of about 14 pounds per square inch. Having finished the inspection of the upper parts of the bottles, which takes only a few seconds, the glass vessel is turned on its side with the projecting glass tube touching the table. The whole vessel is then slowly rotated or rolled on the table until the glass tube again reaches the table during which time close watch is kept on the surface of the water in the vessel for rising air bubbles. Unless the projecting tube is needlessly long or the air contained in the bottles is very small in amount this rotation of the vessel will have served to bring every part of the inner surface of each bottle (except a circular area at the top and bottom of the bottle) into contact with the air contained in the bottle and any flaw will be shown by escaping air. Finally, the vessel is inverted to allow flaws in the bottoms of the bottles over the area hitherto covered with fluid to be detected.

A SERIES OF CASES OF LEAD POISONING DUE TO HARD WATER.

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LEAD POISONING due to the action of potable water on lead pipes and cisterns has been so common that it would almost appear superfluous to report other cases, but practically all the recorded cases have been due to the use of very soft moorland waters, and it does not appear to be realised generally that hard well-waters occur in certain districts which are capable of taking up poisonous quantities of lead. I have repeatedly directed attention to the fact that water from the Bagshot sands contains so small an amount of carbonate that it dissolves appreciable quantities of lead, but during recent years I have found waters from gravels not classed by the Government geologists as belonging to the Bagshot sands which are of a similar character and which have seriously affected the health of persons using them and it is possible that they occur in many localities besides Essex.

Within the last few weeks I have had occasion to examine a water from a shallow well, which contained a very appreciable amount of lead and which had caused serious symptoms of poisoning in three out of four members of the family using it. The family consisted of a widow lady, her child and governess, and a maid. Four years ago the lady took a country house, the water-supply of which was derived from a well in the garden. About 18 months ago she exhibited symptoms of what was supposed to be gout and was sent to Buxton, where she became accustomed to drinking rather considerable quantities of hot water. Upon returning home she continued this practice only to find the "gouty" symptoms increased in intensity. She became very anæmic, suffered from colic and constipation, and finally had intense pain in the occipital region. The governess also suffered from anæmia, colic, and constipation, the last being so severe that at one time the question of some operation being performed was discussed. The maid did not suffer so severely and the child, who drank distilled water only, was not affected. Lead poisoning as a cause of all these symptoms does not appear to have been suspected until the lady's gums became very tender. These were then examined and the blue line pathognomonic of lead poisoning discovered. The same line was then found on the gums of the other patients. The source of the lead was at first a mystery but ultimately two samples of the water were submitted to me for analysis taken from two different pumps on the premises drawing from the same well. One was found to contain 0.65 grain of lead per gallon and the other 0.30 grain. Samples of water which had stood in the pump pipes all night gave 1.8 and 1.4 grains of lead per gallon respectively. When the water was allowed to stand 24 hours in contact with a piece of bright sheet lead it dissolved as much as 8.8 grains of the metal per gallon, the water remaining quite clear. Both the pumps referred to had long lead suction pipes leading to the well. One pump was over the kitchen sink and supplied the drinking water; the other was a force pump driving the water into the cistern supplying the bath, &c. Although the latter had a longer pipe attached to it it yielded water containing less lead, which fact I attribute to the pump itself being of gun-metal, whereas the kitchen pump was of lead and worked with a good deal of friction.

The analysis of a sample of the water taken directly from the well gave the following results in parts per 100,000: Pb, 0.3; Ca, 7.3; Mg, 0.75; K, 1.6; CO₃, 0.9; SO₄, 8.35; Cl, 8.7; NO₃, 15.1. The combinations were probably as follows:—

Lead carbonate	...	...	...	...	...	0.4
Calcium carbonate	...	...	...	...	...	1.35
Calcium sulphate	...	...	...	...	...	11.85
Calcium chloride	...	...	...	...	...	9.05
Magnesium chloride	...	...	...	...	...	2.9
Sodium chloride	...	...	...	...	...	1.25
Potassium and sodium nitrates	...	...	...	...	...	21.35

Total saline constituents 48.15

The carbonates would be retained in solution by the excess of carbon dioxide in the water. 100 cubic centimetres of the water contained 0.7 cubic centimetre of free oxygen and 1.9 cubic centimetres of free carbonic acid (over and above that necessary to convert the carbonates into bicarbonates). Like all other waters which dissolve lead the amount of carbonates present was very small and the water had an acid reaction to litmus, lacmoid, cochineal, and phenol phthalein, but not to methyl-orange. After boiling in a platinum vessel it became neutral but the boiled water acted as vigorously upon the lead as the unboiled.

I have since examined three other well waters from the same locality and find two of them have a similar action and there is reason to believe that other families have been affected by the lead. In such cases where another source of water-supply is not available I have recommended the removal of all lead piping and the introduction into the well of a load of clean chalk. The latter is necessary to absorb the carbonic acid and to prevent the oxidation of iron pipes, as waters which act on lead also corrode iron and dissolve zinc (from galvanised iron). The chalk appears to prevent this action or to minimise it to such an extent that the water does not become unsightly in appearance. The addition of two or three grains of carbonate of soda to a gallon of the water did not entirely neutralise the plumbo-solvent power but reduced the amount dissolved in 24 hours from 8.8 grains

to 0.5 grain. Digestion for an hour with chalk reduced the action but not nearly to the same extent. Notwithstanding the immense amount of work which has been done to elucidate the action of water on lead, both erosive and solvent, all theories so far advanced fail to explain the whole of the facts, but this is a subject which I purpose to discuss later. My present object is merely to direct attention to the possibility of lead poisoning being due to waters not generally regarded as being capable of dissolving that metal.

Chelmsford.

A CASE OF LARGE CHYLOUS ABDOMINAL CYST; OPERATION; RECOVERY.

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IN THE LANCET of March 4th, 1905, is quoted a case recorded in the *Boston Medical and Surgical Journal* of Feb. 9th, 1905, of a "rare condition of chyloous cyst of the abdomen." This case quoted was in a boy, aged 11 years. For two years there were symptoms of pain, wasting, and accumulation of fluid in the abdomen, and a provisional diagnosis of tuberculous peritonitis was arrived at and an operation was undertaken; a large vascular-walled retro-peritoneal cyst was found containing a gallon of chyloous fluid. The sac was separated carefully from the ascending colon, hepatic flexure of the colon, and vertical portion of duodenum. Whether the cyst was a dilatation of the receptaculum chyli or of one of its tributaries could not be made out. The boy made a complete recovery. The fluid was milky, of specific gravity 1020, and contained fat globules.

The following case taken from my surgical note-book bears so close a similarity to the above that there seems little doubt that the two were similar in origin. A coloured male, aged 20 years, was admitted into Somerset Hospital on May 26th, 1905, with a history of four years' pain in the stomach and bowels and gradually distending abdomen. Examination showed the abdomen generally to be distended; it was very dull over the lower and middle parts of the abdominal walls and there was some dullness in the flanks, which did not vary with alteration of position. There was only a small tympanitic area under the liver and upper part of the abdominal wall. Liver dullness was much diminished. Pain on pressure was present over the hypogastric and umbilical regions. There was no elevation of temperature or general wasting of the body. A provisional diagnosis of encysted collection of fluid, probably tuberculous peritonitis, was made. (N.B.—This was the same diagnosis as was come to in the American case quoted above.)

Operation—An incision was made in the middle line midway between the umbilicus and symphysis. The abdominal wall was very rigid even under an anæsthetic. The peritoneum was thickened. On opening into the peritoneal cavity a little blood-stained serum escaped. No intestines were visible but beneath the fingers was a large uniform swelling apparently filling the whole abdominal cavity, the surface of which looked like congested bowel and gave the impression of peritoneum closely adherent to congested bowel. This membrane was opened and a large quantity of milky chyloous fluid gushed out, showing the doubtful membrane to have been the sac wall of an enormous cyst which extended from the pelvis to right up under the liver, pressing the intestines into an extremely small compass. There were one or two subdivisions to the large cyst, making it apparently multilocular. In the cysts were also large quantities of pink jelly-like material and also a mass of the size of a large lymphatic gland filled with a fatty substance looking like thick cream. The walls of the cyst were adherent to the ascending colon near the appendix and to the transverse colon where there appeared to be a sort of pedicle attached to the reflection of the transverse mesocolon. Near this point of attachment was a knotted tumour of about the size of a Tangerine orange, looking like an inflamed lymphatic gland in consistence. This gland and as much of the cyst wall as could be safely detached, together with all contents, were removed and the abdominal cavity was freely flushed with saline solution. The abdomen was finally filled with saline solution and stitched up.

The patient made an uninterrupted recovery. Two weeks