anæmia; the toxic action of the hookworm metabolites on the hæmopoietic organs is of secondary importance.

On the important subject of the treatment of this anæmia, C. A. Lane in his book *Hookworm Infection* has but two paragraphs, he writes :— 'Anæmia is the main secondary feature requiring treatment and iron is the standby'. So far so good, but he goes on 'Nevertheless so long as infection persists the giving of iron is in general useless; and even after disinfestation the hæmopoietic organs, *particularly the bone marrow,* may be in no position to use the iron which is placed at their disposal until arsenic, organic or inorganic, has been added to the medication'. In our opinion there is not the slightest evidence to support such a statement; it is possible by iron administration alone to bring the hæmoglobin up to a level well within the normal range of the patient's class, even in a very heavily infected patient (*I. M. G.*, **76,** 1), and there is no foundation for the suggestion that after the removal of the worms there is any depression of hæmopoietic function, or that if there were arsenic would remove it.

The remaining paragraph is given, without comment, to complete the quotation. 'There is evidence that traces of copper are necessary. It is unknown whether the carbon tetrachloride which accumulates in the bone marrow after treatment by that drug produces lesions which hinder subsequent recovery from anæmia. The occasional likeness of the blood picture of ankylostomiasis to that of pernicious anæmia indicates on general principles the giving of liver or red marrow; which might perhaps also prove useful in anxiety after carbon tetrachloride administration'! Elsewhere, Lane has severely criticized writers who have laid special emphasis on iron administration in hookworm infection. It is no more irrational to treat the anæmia before removing the worms than it is to give symptomatic treatment in any other disease; frequently such treatment is definitely indicated first, to be followed later by the removal of the cause. This is sometimes the case in severe hookworm anæmia, when, for the comfort of the patient, it may be better to give a course of ferrous sulphate before administering the anthelminthic, though the natural sequence is to remove the majority of the worms by one treatment and then to treat the anæmia.

It is, on the other hand, utterly absurd to remove the worms only and allow the patient to linger on for many months in an anæmic state. Indian dietaries are usually poor, if not actually deficient, in available iron and therefore many people live on the border-line of iron starvation. On such a diet, it will be months, possibly even years, before an individual can make good his iron deficiency and build up a reserve, whereas by suitable treatment this can be achieved within a few weeks. In many cases, the disappointments with the immediate results of a hookworm campaign that have been experienced are due to this simple fact. The propaganda value of curing the anæmia should not be underrated; the immediate improvement in well-being experienced by the patient and the immediate increase in his working capacity will impress the patient and his employer far more than a post-dated promise of such improvement.

The most convenient and cheapest way to administer iron is in the form of ferrous sulphate tablets, nine grains twice daily. Ferrous iron in the form of a mixture is probably more efficacious; ferrous ammonium sulphate made up with glucose will 'keep' for some weeks, and of this mixture a dose containing twenty grains of the iron salt (equivalent to a little under three grains of metallic iron) should be given twice daily.

We will conclude by saying that no hookworm campaign is complete unless a three-point attack is made, the spread of infection curtailed by provision and habitual use of suitable latrines, the disinfestation of the individuals affected by a suitable anthelminthic, preferably tetrachlorethylene, and the anæmia cured by the administration of iron in large doses. The provision of latrines alone, even if they are used exclusively, will only effect appreciable improvement in the course of a few years but the improvement will be permanent. Deworming alone is often disappointing, unless very thoroughly carried out in the whole population, as it takes many months for the blood to improve sufficiently to be reflected in the clinical picture and meanwhile reinfection will be taking place all the time. Administration of iron alone will produce a marked and immediate improvement in health, but this improvement will disappear within a year or so. Thus, the most permanent results will be obtained by the first measure, the most spectacular by the last, whereas in practice the second is the one that is most frequently put into operation.

L. E. N.

Special Articles

HÆMATOLOGICAL TECHNIQUE

PART IX

By L. EVERARD NAPIER, F.R.C.P. (Lond.)

and

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(From the School of Tropical Medicine, Calcutta)

(15) *Gastric analysis*

Introduction.—The gastric juice in the normal individual contains hydrochloric acid, free and in the combined state, the enzymes pepsin and rennin, and the 'intrinsic factor of Castle'. Examination of the aspirated gastric juice, primarily for acidity, but also for the presence of the enzymes, and for other normal and abnormal characters, is known as gastric analysis.

We have included gastric analysis in this series on hæmatological technique, because normal hæmopoiesis is to a large extent dependent on normal gastric function, and consequently the knowledge that we obtain from this test is important in both the diagnosis and the treatment of the anæmias.

Achlorhydria or hypochlorhydria are associated with deficient digestion and absorption of a number of food substances. In some cases of microcytic anæmia, achlorhydria is considered to be the main ætiological factor; iron is more easily absorbed from an acid than from an alkaline medium. Free acid is necessary also for ensuring proper peptic digestion (*v.i.*). Further, in the absence of hydrochloric acid, fermenting organisms flourish, causing flatulence, meteorism, and diarrhœa. This mucosal dysfunction leads to a macrocytic anæmia; the anæmia of sprue is often of this type and due to this cause; but neither in sprue nor in nutritional macrocytic anæmia is achlorhydria constant, nor is there any evidence that the 'intrinsic factor' is also absent. Finally, in pernicious anæmia there is complete and constant achylia*, which is associated with the absence of the 'intrinsic factor', though this latter deficiency cannot be demonstrated directly in the laboratory.

In practically all cases of anæmia associated with achlorhydria or hypochlorhydria, the giving of dilute hydrochloric acid, alone or with pepsin, will be beneficial, and may in fact constitute an important part of the treatment.

Methods : Gastric analysis can be done by either of the following methods :—

(*i*) Single examination : This is an old method and is almost obsolete now. In this method, after complete evacuation of the fasting juice, an Ewald meal, consisting of bread and water, is given to the patient and the stomach contents withdrawn again after one hour.

(*ii*) Fractional analysis of Rehfuss : In this method, after complete evacuation of the fasting juice, a suitable test meal is given to the patient; small samples, about 10 c.cm., of the gastric fluid are drawn off every 15 minutes up to 2½ to 3 hours.

Fractional gastric analysis gives valuable information as to the motility and secretory function of the stomach. This method is followed by us in the investigation of all cases of anæmia in the hospital and in many of the cases attending the anæmia outdoor clinic.

*The following terms are in common use for the different stages of gastric deficiency:—

Achlorhydria	= absence of free hydrochloric acid during an ordinary test meal, but with response to histamine.
Complete achlorhydria	= absence of free acid even after histamine injection.
Achylia	= absence of free acid and the gastric enzymes, even after histamine.

In the course of the fractional gastric analysis, an injection of 0.5 mg. of histamine is given one hour after the test meal to the patients who fail to show any free acid in any of the previous specimens.

Apparatus required

(*i*) Rehfuss' or Ryle's tube, or any suitable modification (*vide* figure 1). These are hollow tubes made of good rubber. They are about 32 inches long with an internal diameter of about 1/8th inch. One end of the tube is open, while the other, the tip, ends in an olive-shaped bulbous protuberance filled with metal to weight it and keep it rigid. There are holes in the rubber at or near the tip for the passage of the gastric juice through the tube. The distance up to which the tube has to be passed in shown by a mark near the open end, about 20 to 22 inches from the tip.

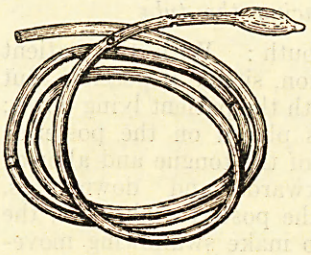


Fig. 1.

Before use the tube is sterilized by boiling water, and is kept coiled up in a sterilized petri dish until required.

(*ii*) Record syringes 10 c.cm. and 1 c.cm.
(*iii*) Twenty-five c.cm. burette graduated in 1/10th of a c.cm., with a stand.
(*iv*) Twelve labelled test-tubes in a rack, *plus* a few extra tubes.
(*v*) Capillary pipettes with teats.
(*vi*) Small glass funnel.
(*vii*) Porcelain dishes—3.
(*viii*) Glass rods—3.
(*ix*) Centrifuge machine.
(*x*) Slides.
(*xi*) Microscope.

Chemicals required

(*i*) One per cent of cocaine, or a suitable substitute.
(*ii*) Seven per cent alcohol 100 c.cm.
(*iii*) N/10 sodium hydroxide.
(*iv*) Dimethyl-amido-azobenzene (0.5 per cent in 95 per cent alcohol (Töpfer's reagent).
(*v*) Phenolphthalein 1 per cent in alcohol.
(*vi*) Histamine—0.5 mg. in 0.5 c.cm. sterilized distilled water.
(*vii*) Adrenaline chloride solution, 1 in 1,000, for injection.
(*viii*) Sulphur powder.
(*ix*) Benzidine.
(*x*) Glacial acetic acid.
(*xi*) Hydrogen peroxide.
(*xii*) Pepsin.
(*xiii*) Mett's albumin tubes (*v.i.*).
(*xiv*) Dilute hydrochloric acid.
(*xv*) Fresh milk.
(*xvi*) Lugol's iodine solution.

Routine procedure

The following is our usual procedure in carrying out a fractional gastric analysis.

A. Preparation of the patient

On the previous night, the patient has his usual meal at 8 p.m., and at 10 p.m. he is given 4 charcoal tablets with a glass of milk. The next morning he is not allowed any food or drink before the test is finished. Indian patients

must be warned not to chew any *pan*, as it may impart a red colour, which might be mistaken for blood, to the gastric juice.

Before introducing the tube, in very sensitive patients, the nasal mucous membrane and the posterior part of the pharynx may be sprayed or swabbed with one per cent solution of cocaine, or with a suitable substitute.

B. Introducing the tube

(*i*) Through the mouth: With the patient in a comfortable position, sitting if possible, but the test can be done with the patient lying down; the tip of the tube is placed on the posterior portion of the dorsum of the tongue and allowed to drop slowly backwards and downwards. When the tip strikes the posterior pharynx, the patient is instructed to make swallowing movements and the tip will then pass into the œsophagus. The patient should be told to continue to swallow slowly, when the tube will gradually descend until the end has reached the fundus of the stomach; the mark on the tube gives an approximate indication of when this point is reached.

(*ii*) Introducing through the nose: With a little practice, the introduction of the tube through the nose is much easier than through the mouth and can be carried out even in the most sensitive patient. The tip of the tube is introduced into one of the nasal orifices and gently pushed through the nose until it reaches the posterior wall of the pharynx. The patient is now told to make swallowing movements while the tube is pushed gently down until it reaches the fundus of the stomach.

Some obstruction may be felt in passing the tube through the nose; this is easily overcome by a little manipulation, but if the resistance is great the tube must be taken out and introduced through the other nasal orifice, as not infrequently the septum is deviated to one side.

C. Drawing out the contents of the fasting stomach

When the tube has been introduced up to the required distance, introduce the nozzle of a 10 c.cm. syringe into the tube, with the piston drawn out; push down the piston so that the air in the syringe is forced through the tube, to dislodge any mucus or food debris that may be blocking it at its distal end; then aspirate the contents of the fasting stomach. If there be any difficulty in getting the juice, vary the position of the tube in the stomach by drawing it out or pushing it in, and/or by forcing more air through the tube.

Rarely, difficulty in obtaining juice may be due to contraction of the gastric muscles, which may be difficult to overcome. An attempt should be made to draw out all the fluid of the fasting stomach by altering the position of the tube in the stomach, by putting the patient in different postures, and by applying a little pressure to the stomach from outside. The contents of the stomach are placed in the test-tubes previously labelled.

After complete evacuation of the stomach contents the test meal is given to the patients with the tube *in situ*.

D. Test meals

An ideal test meal is obviously one that bears a close similarity to the ordinary diet of the patient, but, for many reasons, it is not possible to give such a test meal. Various test meals have been advocated, but here we shall describe only two with which we have had personal experience.

(*i*) Gruel test meal: In making this we have always used Quaker oats, but any form of prepared oats can be used, and in this country some workers prefer to use a rice gruel. Take a tablespoonful of Quaker oats in two pints of water, add a pinch of salt, boil down to a pint, and strain through fine muslin. This meal does not contain any lactic acid and is thus almost an ideal test meal, but, with the tube *in situ*, it becomes very difficult and sometimes impossible to swallow such a large quantity of thick gruel.

(*ii*) Alcohol test meal: One hundred c.cm. of 7 per cent alcohol is used for this meal. The measured quantity of alcohol is placed in a beaker from which it is drawn up into a syringe and introduced into the stomach through the tube—the process is repeated until the whole amount has been introduced.

This meal is very easy to administer, while the fluid that is subsequently withdrawn is almost clear; this allows of easy titration for acidimetry.

E. Withdrawal of post-prandial specimen

Note the time when the test meal is given, aspirate with a syringe about 10 c.cm. of gastric contents every 15 minutes up to 2½ or 3 hours. The specimens are kept in labelled test-tubes until the time of examination.

Histamine.—As the fasting and post-prandial juices are withdrawn, they are examined for the presence of free hydrochloric acid by the bedside.

Take one c.cm. of the gastric juice in a small test-tube, add a small drop of Töpfer's reagent. Note the colour—red or orange colour indicates the presence of free hydrochloric acid and further bedside examination of subsequent specimens is not necessary.

If free hydrochloric acid is not present in the fasting juice and in the first four post-prandial specimens, an injection of 0.5 mg. of histamine is given and the procedure of withdrawing samples is continued as before. A little flushing of the face is seen after injection of histamine, and occasionally the patient may complain of palpitations which generally pass off quickly.

In the event of the patient becoming distressed by these symptoms, an injection of 0.5 c.cm. adrenalin chloride should be given; this will give instantaneous relief.

Examination of gastric contents

A. *Macroscopic examination.*

(*a*) *In the fasting juice.*

(*i*) Amount : measure and note the amount. Normally 20 to 25 c.cm. are found. Marked increase over 50 c.cm. suggests hypo-motility, obstruction, or hyper-secretion.

(*ii*) Odour : normally it has no striking odour. An offensive odour suggests cancer, and a sour odour fermentation.

(*iii*) Remnants of food or charcoal : normally no food remnants or charcoal are found after 10 hours' interval. The presence of food remnants or charcoal particles suggests hypo-motility, pyloric obstruction, or ptosis.

(*b*) *In the fasting juice and in the post-prandial specimens.*

(*iv*) Mucus in large quantity in the fasting juice, and in many of the later post-prandial specimens, indicates catarrhal gastritis.

(*v*) Bile : traces of recently regurgitated lemon-yellow bile may be seen in a few specimens and are usually due to retching caused by the introduction of the tube. A large quantity of turbid green bile in the fasting and in any of the early post-prandial samples is almost always pathological.

(*vi*) Blood : macroscopic examination for blood gives more valuable information than the chemical examination. Flecks of fresh blood are usually the result of trauma in passing the tube, while large quantities of fresh blood in any specimen would indicate varices, erosions, or even malignant ulceration of the œsophagus. Blood from gastric ulcer or carcinoma of the stomach is changed to brown acid hæmatin by the acid in the stomach juices; it is found most frequently in the fasting juice, but it may be found also in any post-prandial specimen.

B. *Chemical examinations.*

(*i*) *Acidimetry.*

Place 5 or 10 c.cm. of clear gastric contents in a shallow porcelain dish. If there be an excess of mucus in any specimen, filter the gastric juice through a plug of cotton wool to remove the mucus; this will then allow of easy titration.

Add a drop of Töpfer's reagent to the gastric juice in the porcelain dish, the presence of free hydrochloric acid will be indicated by the red or orange colour of the juice.

(*a*) *Estimation of free hydrochloric acid.*

Titrate with N/10 sodium hydroxide until the red or orange colour is discharged : this is done as follows :—

Fill a graduated 25 c.cm. burette with N/10 NaOH up to the zero mark. With one hand regulate the flow of NaOH and allow it to fall drop by drop from the burette into the procelain dish; stir all the time with a clean glass rod with the other hand. The end point will be shown by a brownish and not a yellow colour. Take the reading of the burette, the difference between the two readings (the first should be zero) gives the amount of NaOH that was required to neutralize 5 or 10 c.cm. of gastric juice.

In clinical work the result is always expressed as the number of cubic centimetres of N/10 NaOH which would be required to neutralize 100 c.cm. of the gastric juice, each cubic centimetre representing *one degree* of acidity. So, the number of degrees of acidity is calculated by multiplying the number of cubic centimetres of N/10 NaOH by 10, if 10 cubic centimetres of gastric juice was used, or by 20, if 5 c.cm. of gastric juice was used.

The result may be expressed in grammes of hydrochloric acid by multiplying the number of degrees of acidity by 0.00365 (an easy way to remember this is that 365 is the number of days in the year, the last figure—5—indicating the number of decimal places).

Example.—If 10 c.cm. of gastric juice was taken and if the end point was reached when 2.3 c.cm. of N/10 NaOH had been added, the degree of acidity is $2.3 \times 10 = 23$.

And in terms of hydrochloric acid $23 \times 0.00365 = 0.08395$ g. of hydrochloric acid.

(*b*) *Estimation of total acid.*

After the estimation of free hydrochloric acid, or if there be no free HCl at all, 1 or 2 drops of phenolphthalein (1 per cent solution in alcohol) is added as an indicator and the titration with N/10 NaOH is continued until the development of a permanent faint red colour.

The third reading minus the first reading (zero in this case) multiplied by 10, if 10 c.cm. was taken, or 20, if 5 c.cm. was taken, gives the degree of total acid.

The total acidity is made up of free HCl together with the HCl which is combined with protein and mucus, *plus* the organic acids, such as lactic and butyric, which result from fermentation.

The estimation of total acidity is of little practical importance. It is usually about 10 degrees higher than the free HCl, except in cases of marked lactic or butyric acid fermentation, when it may be very much higher than the free HCl. In these cases the typical 'rancid butter' odour enables one to detect fermentation.

(c) *Lactic acid.*

Test for lactic acid must be applied in all cases where there is no free HCl in the fasting juice.

Add two drops of 5 per cent aqueous solution of ferric chloride to half an inch of clear gastric fluid in one tube and half an inch of water into another tube of the same size which will serve as a control. To each add 6 drops of saturated solution of mercuric chloride. If lactic acid is present in the gastric contents a deep yellow colour will be produced in that tube, but not in the other.

(d) *Bile.*

The presence of bile will be denoted by the colour in the gastric fluid. If in doubt, Hay's sulphur test can be done, by sprinkling sulphur dust on the surface of a specimen of clear juice. If bile salts are present, the sulphur will fall to the bottom.

(e) *Blood.*

Dissolve a little benzidine in 2 c.cm. of glacial acetic acid, warm if necessary; add 2 c.cm of 3 per cent hydrogen peroxide. Finally, add 1 c.cm. of the gastric juice, and mix well by shaking. A blue or bluish-green colour indicates the presence of blood.

The test is very sensitive and will detect blood in dilution of 1 : 3,000,000.

C. *Examination for enzymes.*

(i) *Detection of pepsin.*—Normally pepsinogen is secreted by the stomach, and is transformed into pepsin by the free HCl in the stomach. Its presence is detected by the digestion of egg-albumin.

Method.—Take three small test-tubes.

In tube 1, put 1 gm. of pepsin, 2 c.cm. of the HCl solution and a one-inch length of capillary tube of albumin*.

In tube 2, put 2 c.cm. of clear gastric fluid and one capillary tube of albumin.

In tube 3, put 2 c.cm. of clear gastric fluid, 2 c.cm. of the HCl solution and one capillary tube of albumin.

Place all the three test-tubes in a warm incubator overnight, examine them for digestion of the albumin next morning.

Tube 1 in which digestion should be complete serves as a control.

Interpretation.—Digestion in tube 2 indicates the presence of both pepsin and free hydrochloric acid in the gastric juice.

If digestion fails in tube 2 but occurs in tube 3, pepsinogen is present, but it required the free HCl added to the tube to convert it into pepsin.

If there is no digestion even in tube 3, then both pepsin and pepsinogen are absent.

Partial digestion either in tube 2 or 3 denotes the presence of pepsin or pepsinogen in small amount.

(ii) *Detection of rennin.*—The enzyme rennin coagulates the protein of milk. Fresh milk is used as the reagent.

Neutralize 5 c.cm. of clear gastric fluid with very dilute sodium hydroxide. Add an equal amount of fresh milk and place in a water bath at 40°C. for 15 minutes.

Interpretation.—Coagulation of the milk in 10 to 15 minutes denotes the presence of a normal amount of rennin; delayed coagulation denotes a decreased amount.

D. *Microscopic examination of the gastric residues.*

This examination has very limited application and need only be done if carcinoma is suspected. The fasting contents when no free HCl is present is most suitable for the test.

Centrifugalize the fasting contents, take a small loopful from the bottom and smear it on a glass slide. Fix by heat and stain by Lugol's iodine and examine with the oil-immersion lens for 'Boas-Oppler' bacilli.

'Boas-Oppler bacilli are large (5 to 10μ long) non-motile and usually arranged in clumps. or end to end in zig-zag chains. They stain yellow to brown with iodine solution, which distinguishes them from *Leptotrichia buccalis,* which is not infrequently swallowed, and hence found in stomach fluid' (Todd and Sanford, 1939).

Method of recording results

The results are best recorded on a special chart which may be printed or cyclostyled.

Figure 2 shows the form of chart that we use, except that in this figure a shaded area has been added to show the range within which 80 per cent of gastric analyses in 'normal' individuals fall.

Both free acid and total acid are recorded in the chart preferably in different colours. The presence of mucus, bile, and blood is indicated by a *plus* or a double *plus* sign in the appropriate place.

Normal standards

Acid curves will vary not only in height but in shape, and one cannot judge them solely on one feature, *e.g.*, on the highest point reached during the test. Nevertheless, if a curve is to be classified on a single feature this is probably the best one, as it usually reflects fairly accurately the rest of the curve. We have adopted

* Mett's capillary tubes of albumin are prepared in the following way:—

Mix the white of 3 or 4 eggs, beating them gently.

Make some capillary tubes of uniform bore. Fill the tubes with the egg albumin and cut them into pieces of about 10 to 12 inches long. Seal the ends with sealing wax. Boil a large quantity of water in a big vessel. Just as the water begins to boil, put the capillary tubes containing albumin into the boiling water. Remove the vessel from the source of the heat. After 5 minutes take out the capillary tubes—the egg albumin will be lightly coagulated. Store the tubes in a refrigerator.

Before use, cut the egg-albumin tubes into lengths of one inch, taking care that the ends are clean-cut and circular.

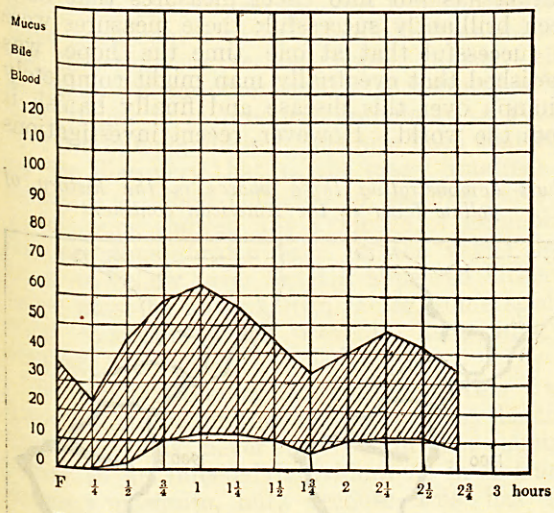
Fig. 2.

S. T. M. ANÆMIA DEPT.

GASTRIC ANALYSIS REPORT

Name_____ Age____ Sex____ Ward____

Fasting Juice: Quantity: Charcoal: Food remnants: Microscopic:



Free acidity_____ Total acidity_____

Peptic digestion—

Opinion:

Date_____

the following criteria for classifying acid curves, according to the highest free-acid reading :—

		c.cm. of N/10 NaOH required to neutralize 100 c.cm. gastric juice
Achlorhydria	..	0
Hypochlorhydria	..	< 10
Isochlorhydria low	..	10 to < 25
" medium	..	25 to 45
" high	..	> 45 to 65
Hyperchlorhydria	..	> 65

These criteria are based on our personal experience in India (Napier and Das Gupta, 1935; Napier, Chaudhuri and Rai Chaudhuri, 1938) but they do not differ materially from those adopted by workers in other countries. About 80 per cent of 'normal' individuals fall within the isochlorhydria range; within this range women will usually be lower than men (figure 3). There is no evidence that the gastric acidity of Indians in India is lower than that of Europeans in their own countries. The data available from our own experience suggest that in South Indians and Bengalis the acid range is a little higher than the textbook figures which are based on Europeans and North American subjects (figure 4).

From 2 to 4 per cent of apparently normal Indians are completely achlorhydric even with histamine; this is in keeping with experience in other countries.

With the alcohol test meal the acid curve on the whole tends to be higher; this is particularly noticeable in the first post-prandial sample in which the initial drop in acidity, due mainly to the neutralization of the acid by the meal, may be absent. Another difference is that the maximum acidity is usually reached earlier when alcohol is given as a test meal.

Other indications given by gastric analysis

In chronic gastritis, in the early stages there is hyperacidity and hypersecretion; this latter is shown by the large quantity of fasting juice, but in the later stages there is gastric atrophy with accompanying hypoacidity or achlorhydria.

In gastric ulcer there is usually increased acidity and blood may be present.

In gastric carcinoma, the findings are sometimes very characteristic, but in the early stages there may be no indications, so that it is dangerous to exclude carcinoma on the strength of a normal gastric analysis. There is achlorhydria, excess of lactic acid, and usually blood, and the Boas-Oppler bacillus is often present. If the cancer is at the pylorus there may be delayed emptying, and food or charcoal will be found in the fasting juice which will usually be very sour and offensive.

In gastric neuroses there is usually hypersecretion, and in dilatation of the stomach food retention and fermentation.

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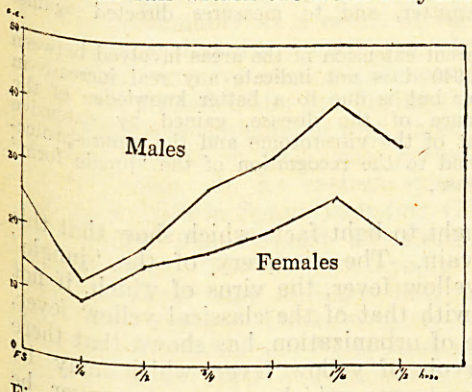

Fig. 3.—Assam coolies: males and females.

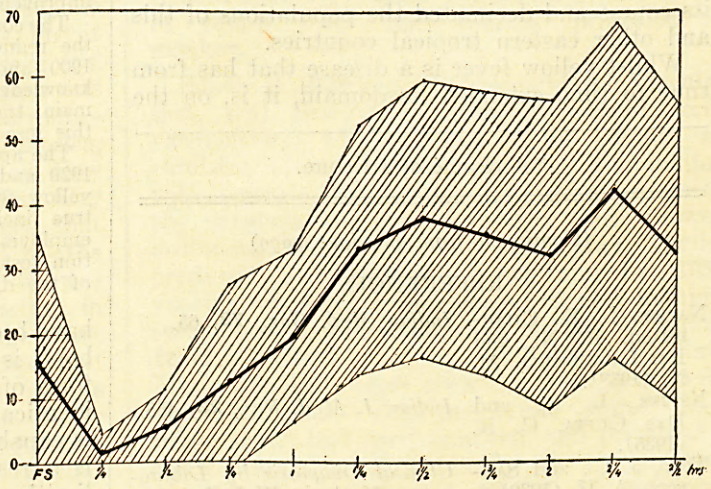

Fig. 4.—Normal Indians in Calcutta (gruel test meal).

YELLOW FEVER*

By L. EVERARD NAPIER, F.R.C.P. (Lond.)
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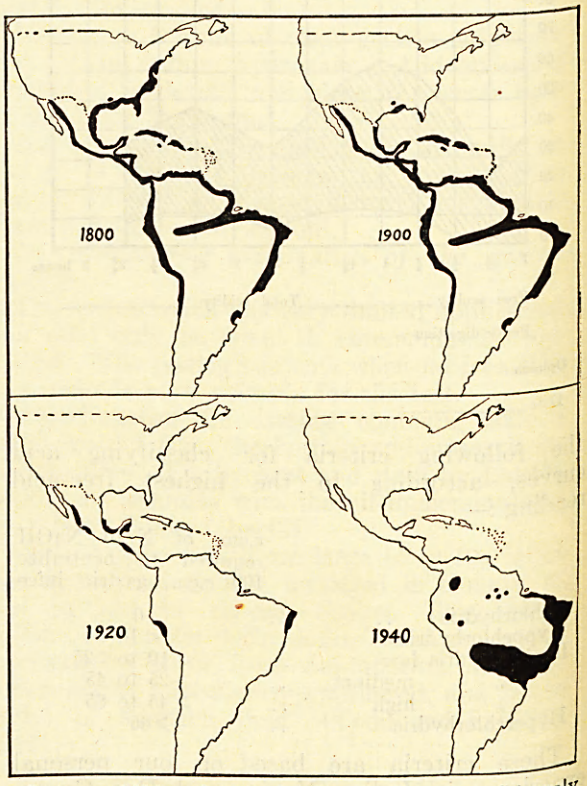
Definition.—Yellow fever is an acute specific fever of varying severity, but in its most characteristic manifestation of great intensity, and associated with toxic jaundice, caused by a filtrable virus, with a limited tropical distribution, in its urban, epidemic and endemic forms transmitted from man to man by stegomyia mosquitoes, and in its jungle or sporadic form transmitted from its jungle reservoir to man by other means.

Introduction.—The importance of yellow fever to India and countries further east lies in the fact that, though the disease has up to the present never appeared in these countries, there seems to be no explainable reason why it should not invade them at some, near or distant, future date. The history of this disease shows that it is capable of geographical extension, and, in the American continent, from time to time it has invaded countries which were previously immune. In India, the stage is apparently set for an explosive epidemic should the virus ever be let loose here. It is therefore essential that we in this country should take every precaution to prevent this catastrophe and, if this invasion ever occurs, we should be ready to deal promptly with any isolated case that appears, in the hope that we may stamp out the disease before it gets a firm footing.

In this matter India has not only herself to consider, but she has a special mission in being in the front line of the defence of the rest of Asia; she has not only her hundreds of million of inhabitants to protect, but the thousands of millions in China and the Far East, for, if yellow fever were to gain an effective hold in this country, it is almost inevitable that it would sweep through the rest of tropical Asia, and in these sanitarily backward countries there would be little hope of controlling it until it had run its course and decimated the populations of this and other eastern tropical countries.

Whilst yellow fever is a disease that has from time to time extended its domain, it is, on the other hand, one that has been very effectively controlled in many countries where it was firmly established and had become a serious menace to the community. Yellow fever has always been held up as an example of how, medical research having shown the way, sanitary organization has put into effect measures that have been brilliantly successful; these measures were so successful that at one time the hope was cherished that eventually man might completely triumph over this disease and finally banish it from the world. However, recent investigations have brought to light facts which show that this hope is vain. The discovery of the 'jungle' form of yellow fever, the virus of which, if not identical with that of the classical yellow fever, is capable of urbanization, has shown that there is a reservoir of yellow fever which may be limitless and over which man may never be able to exercise effective control.

Chart demonstrating three phases in the history of yellow fever in the American continent



Between 1800 and 1900 the disease disappeared largely from the United States as a result of general sanitary improvement.

The complete disappearance from the United States and the reduction in Central and South America between 1900 and 1920 was due to the application of the knowledge that the mosquito *Aëdes ægypti* was the main transmitter, and to measures directed against this insect.

The apparent extension of the areas involved between 1920 and 1940 does not indicate any real increase in yellow fever but is due to a better knowledge of the true incidence of the disease, gained by extensive employment of the viscerotome and the mouse-protection test, and to the recognition of the 'jungle form' of the disease.

* A résumé of a lecture.

(*Continued from previous page*)

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