Our impression was that anatomical landmarks, particularly the mid-clavicular line, were not easy to define and apply. From Table III it will be seen that there was little difference (less than 2%) in the average girth of the total series and of those with apex beat over 4 in. from the midline. Thus there would seem to be little to bear out the assumption of a direct relationship between the girth of the chest and the position of the apex beat.

Price (1927), Parkinson (1936), Lewis (1946), and Evans (1948) state that displacement of the heart may be caused by scoliosis. At first sight (Table III) this would not seem obvious; when, however, the direction of the thoracic scoliosis is analysed a marked preponderance of scoliosis to the left, as compared with that to the right, is apparent in those cases over 4 in. The ratio of thoracic scoliosis to the left compared with the right was 2 : 1 in the total series, and 5 : 1 in those with an apex beat over 4 in. It would therefore seem that scoliosis to the left in the thoracic region is a cause of cardiac displacement in a number of cases. Some, however, had no scoliosis, and in these another cause must be sought. Bramwell (1932), King, and Parkinson regard the height of the diaphragm as important in this respect; but this point could not be investigated in a purely clinical series. Foti (1937) points out that in a narrow thorax the apex beat may be carried to the left by the lateral thrust of the heart. Sternal depression has been emphasized by Evans (1946) as a cause of displacement.

In recent years much prominence has been given to the correct assessment of patients with abnormal cardiac signs. The "innocent" murmurs have been classified (Evans, 1947) and their recognition has prevented much unwarranted cardiac invalidism. R. K. Price (1949) showed that of 200 children referred to a cardiac clinic no fewer than 39 normal children had been restricted in their activities. In a similar way the finding of a displaced apex beat on medical examination may lead to the diagnosis of cardiac enlargement, with perhaps unnecessary invalidism and the production of a cardiac neurosis. Thus the finding of an apex beat outside the range previously accepted as normal cannot be regarded as pathological unless confirmed by other signs of heart disease or by cardioscopy. The cause may be sought in the structure of the chest, particularly with regard to scoliosis, or in the relation of the heart to the diaphragm. The recognition of this was emphasized by Sir John Parkinson, who said: "In the past it has often happened that this deceptive apex beat has been attributed to real enlargement indicating a cardiac lesion, and the stigma has followed a healthy subject, perhaps for a lifetime."

Summary

A series of 500 cases examined for the position of the apex beat is presented.

The normal distribution of the position of the apex beat is shown.

The apex beat was found to be more than 4 in. from the midline in 11.4% of those palpable.

Thoracic scoliosis to the left was considered to be a cause in some cases.

The necessity for differentiation between displacement due to structural causes and true cardiac enlargement is pointed out.

We wish to thank Colonel G. Moulson, A.D.M.S., Salisbury Plain District, for permission to publish this paper.

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A SIMPLIFIED METHOD OF BLOOD-SUGAR ESTIMATION*

BY

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The majority of the standard methods for blood-sugar determination are neither simple enough nor rapid enough for general use outside a laboratory. Furthermore, many of the existing methods measure, in addition to glucose, other reducing components of the blood. In recent years new or modified tests have been devised in an attempt to provide the general practitioner with a reliable method for use at the bedside, or at least in the normally equipped surgery. With the latter end in view some of the recent modifications have been examined and a modification of one of them (Haslewood and Strookman, 1937) is proposed.

Recent Modifications

Hagedorn, Halstrom, and Jensen (1935).—This simplification of the earlier method of Hagedorn and Jensen uses a shorter period of heating, carried out over a naked flame, thus decreasing the amount of equipment required. An accuracy to within 3% of the older method is claimed. The combination of zinc hydroxide precipitation for protein removal with ferricyanide oxidation of the glucose gives results which approximate closely to true sugar values. The final operation, however, consists in the titration of liberated iodine, a procedure not readily performed outside the laboratory. Further, as the method is based on the estimation of surplus oxidizing agent, it is necessary for a blank determination to be carried out with each estimation—an unfortunate complication to add to any method designed for rapid use.

Lauber and Mattice (1944).—These authors describe an adaptation of the original method of Folin and Wu (1920), employing zinc hydroxide to precipitate the protein, but the precipitate has to be removed by centrifuging, necessitating the use of apparatus available only in the laboratory. Further, owing to the fact that some of the red cells may be laked before precipitation is completed, the values obtained are greater than the true glucose value.

Leech and Woodford (1948).—The use in this method of an oxidizing agent other than the conventional alkaline copper or ferricyanide solution permits a far simpler procedure to be planned. The reduction product of the oxidizing agent (3 : 5 dinitrosalicylic acid) has a sufficiently strong colour to enable it to be compared visually with

*A paper the substance of which was read in the Section of Medicine at the Annual Meeting of the British Medical Association, Harrogate, 1949.

standards without the addition of further reagents to produce a more intense colour, as in the case of Folin and Wu's method. Full examination of the procedure has revealed several deficiencies.

Two of these defects are recorded graphically in the calibration curves given in Fig. 1. The relationship between the colour increment and sugar level is linear over the range 90–450 mg. per 100 ml., but below this range there is sharp discontinuity and the reaction is less sensitive. The method is therefore not applicable to the estimation of values in the hypoglycaemic range, since it is impossible to distinguish visually between the colour changes at this level. The difference in slope between the two calibration curves prepared before and after an interval of three months indicated that the reagent was not stable. Since instability of the reagent affects the sensitivity of the method it would be necessary to use the standard glucose solution with each determination in order to calibrate the reagent. This considerably increases the complexity of the method.

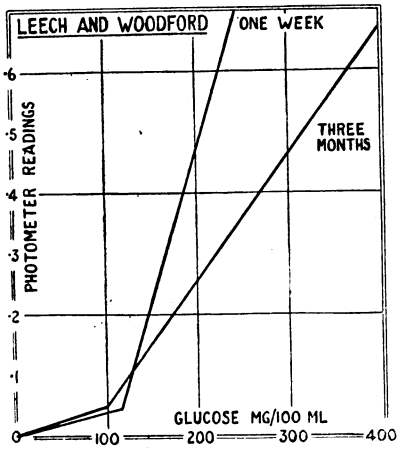

FIG. 1.—Calibration curves showing the instability of the Leech and Woodford method.

Haslewood and Strookman's Method: Necessary Alterations

In many respects Haslewood and Strookman's (1937) method also falls short of the ideal. It takes about 20 to 25 minutes to complete, and there are no fewer than nine operative steps. It is, however, capable of adaptation to give a method simple enough for occasional use.

In considering alterations to an existing method with a view to its simplification it is necessary to ascertain the degree of accuracy required in the final result. For all normal contingencies it will suffice if the general practitioner is able to distinguish between a normal individual and one whose condition is either definitely hypoglycaemic or hyperglycaemic. The finer details of blood-sugar determination are unnecessary. For this type of result a figure accurate to within 10 to 15% is adequate, and any refinements in method aiming at a higher degree of accuracy are unnecessary. Thus it is possible to replace accurately pipetted solutions by collection in graduated test-tubes. The final colour can be compared with a set of three standards, equivalent to sugar levels of 50, 150, and 300 mg. per 100 ml.

The removal of proteins from the blood is accomplished by the formation of copper tungstate complexes, and the precipitate so formed is easily filterable. No loss of accuracy can be observed between two sets of experiments, one employing a centrifuge for protein removal and the other filtration.

It is essential in a method to be used outside the laboratory that the reagents and standards should be unaffected by storage. The alkaline copper reagent as proposed by Haslewood and Strookman requires to be freshly prepared each day, but can be conveniently stored in two separate solutions, one of which contains the copper and the other

TABLE I.—*A Comparison of Results Obtained after Centrifuging and after Filtration*

Blood Levels (Mg./100 ml.)	
Centrifuging	Filtration
92	93
175	172
314	314
86	87
267	265

TABLE II.—*A Comparison of the Original Method with the Modification in which the Copper Solution is Added in Two Parts*

Blood Levels (Mg./100 ml.)	
Haslewood and Strookman	Modification
345	346
57	52
147	147
234	232
112	113

the alkali and the co-ordinating salts. No loss of sensitivity or accuracy is encountered if the two components are added separately (see Table II). The stability of the reagents after three months is illustrated in Fig. 2. The instability of the normal standards prepared from pure glucose solution has been overcome by the introduction of secondary standards for routine estimations. The oxidation of glucose by alkaline copper solution is not stoichiometric, but will proceed beyond the theoretical limits imposed by one reducing group per molecule owing to the further breakdown of glucose to smaller compounds with reducing properties. Thus the standards prepared by the interaction of copper reagent and glucose solutions, followed by colour formation between the liberated cuprous oxide and phosphomolybdate, darken on standing. The absorption curves given in Fig. 3 show how the colour, which consists of two components, one associated with molybdenum oxide and one with cupric ions, increases in depth and changes shade after 24 hours. The change in shade is due to the fact that the increase in intensity of the two components of the original colour is not identical, more of the molybdenum component (λ maximum 670 m.μ.) being produced than cupric ion (λ maximum 810 m.μ). Secondary standards can be made without recourse to the action of glucose by using a mixture of cuprous oxide and sodium phosphomolybdate and adding further cupric sulphate

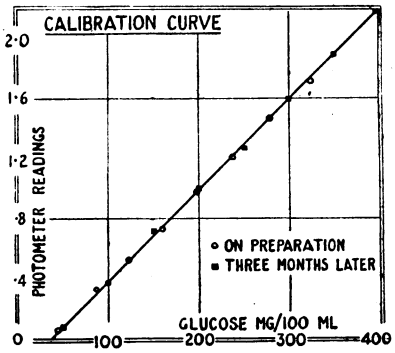

FIG. 2.—Calibration curve of the modified Haslewood and Strookman method, illustrating its stability.

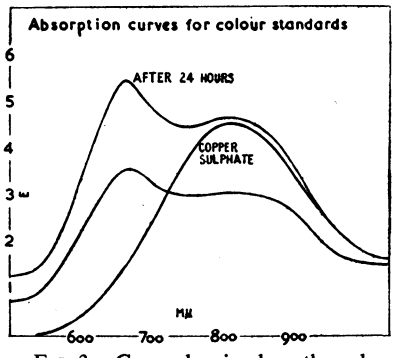

FIG. 3.—Curve showing how the colour increases in depth and changes shade after 24 hours.

solution until the absorption curve is identical with that of a freshly prepared glucose standard (Table III). Blood-glucose figures, determined by the method outlined below but compared with standards in a photo-electric

TABLE III.—*Method of Preparing the Secondary Standards*

50 mg./100 ml.	78 ml. H_2O, 1·5 g. $CuSO_4.5H_2O$, 0·5 ml. Solution 1
150 mg./100 ml.	48 ml. H_2O, 3·0 g. $CuSO_4.5H_2O$, 0·5 ml. Solution 1
300 mg./100 ml.	45 ml. H_2O, 6·0 g. $CuSO_4.5H_2O$, 0·0 ml. Solution 1

Solution 1: 59·5 mg. Cu_2O, 2 ml. H_2O, 3 ml. phosphomolybdate solution.

colorimeter, showed good agreement with figures obtained from the same blood samples using the standard Hagedorn and Jensen method. Results for sugar levels in 10 consecutive blood samples estimated by both methods are given in Table IV. In a complete series of 60 estimations the two methods agreed with a standard error of 13.2% over the whole range from 30 to 380 mg. per 100 ml.

TABLE IV.—*Comparison of New Method with that of Hagedorn and Jensen*

New Method	H. & J.	New Method	H. & J.
110 ..	.. 97	235 ..	.. 236
29 ..	.. 39	130 ..	.. 147
224 ..	.. 226	66 ..	.. 58
76 ..	.. 76	176 ..	.. 182
148 ..	.. 154	81 ..	.. 102

Apparatus.—0.1 ml. wash-out blood pipette; test-tube graduated at 3.7 ml., with rubber bung; funnel and filter papers; test-tube graduated at 1, 1.5, 2, and 5 ml.; water-bath with spirit heater; set of standards.

Reagents (in Dropping-bottles).—Isotonic copper and sodium sulphate solution: 320 ml. 3% $Na_2SO_4.10H_2O$ and 30 ml. 7% $CuSO_4.5H_2O$. Sodium tungstate, 10% w/v. Solution A: 1.3% $CuSO_4.5H_2O$. Solution B: 2.4% sodium potassium tartrate; 4% sodium carbonate; 5% sodium bicarbonate; 3.68% potassium oxalate; 0.14% potassium iodide. Colour reagent: Phosphomolybdate solution of Folin and Wu (1920).

Method.—0.1 ml. of blood is collected from a finger or ear puncture and washed into 3.7 ml. of isotonic sodium and copper sulphate solution in the tube graduated at this level. (The determination may be stopped at this stage for an hour or two if necessary.) Four drops (0.2 ml.) of sodium tungstate are added and the tube stoppered and vigorously shaken. The protein precipitate is removed by filtration through a fluted paper and 1 ml. of the filtrate collected in the tube graduated at 1, 1.5, 2, and 5 ml. Solution A is added to the 1.5 ml. mark and Solution B to the 2 ml. mark, the tube being agitated after each addition. It is then placed in boiling water for 10 minutes. After cooling, the colour reagent is added to the 5 ml. mark and the colour compared with the standards.

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The British Council has arranged to hold courses this year for specialists from overseas on the following subjects: "The Nursing Profession" (Edinburgh, June 22–July 6); "British Health Services To-day" (Cardiff, May 31–June 14); "Public Health" (Bristol, September 8–29); "The Psychological Treatment of the Problem Child" (Glasgow, November 1–22); and "Juvenile Delinquency" (London, October 4–25). The average length of the courses is two to three weeks.

Medical Memorandum

Foreign Body in Pharynx

The swallowing of foreign bodies by mentally deranged patients is an occurrence of considerable frequency. The variety and size of the objects have been described in many previous articles. The following case is recorded as the foreign body was exceptional in its type and size.

CASE REPORT

A man aged 32 had been an in-patient of a large mental hospital in the London area as a chronic schizophrenic with an escapist complex. He was noted for his ability to swallow foreign bodies, and gave a detailed account of previous objects he had successfully swallowed. During the morning of May 1, 1949, a quarrel occurred between the patient and another inmate, and the former extracted a crucifix from the pocket of the other patient and deliberately swallowed it. When seen 48 hours later his condition was poor, he was markedly dehydrated, and he complained of considerable soreness in his neck.

On examination the neck was found to be red and oedematous just below the cricoid cartilage. No foreign body was palpable. *X*-ray examination revealed a crucifix situated in the oesophagus, extending from the lower border of the cricoid cartilage to the upper border of the manubrium sterni, being held up just on the thoracic inlet and situated in an upright position (see illustration). Oesophagoscopy under gas, oxygen, and ether was performed on May 2 at the mental hospital, but the muscular relaxation was not sufficient to allow removal.

Radiograph showing position of the crucifix.

The patient was then transferred to Westminster Hospital, and it was decided to attempt removal by oesophagoscopy under general anaesthesia. Thiopentone induction, 0.6 g., was given, an intratracheal tube passed, and the anaesthesia maintained with gas and oxygen and 15 mg. of tubocurarine intravenously. Complete relaxation of constricted musculature was obtained. A large Mosher oesophagoscope was passed by Mr. Miles Foxen, and a curved wire was introduced through the hole at the upper part of the crucifix. The foreign body was then successfully trailed with minimal trauma. The crucifix was 2 in. (5 cm.) in length, with a transverse bar of 1¼ in. (3.2 cm.). Penicillin was given intramuscularly for three days. The patient made an uninterrupted recovery.

I wish to thank Dr. Beccle, superintendent of the mental hospital, Mr. G. T. Mullally, and Mr. Miles Foxen for permission to publish this case, and the Department of Medical Photography, Westminster Hospital, for the radiograph.

D. WYNN WILLIAMS, M.S., F.R.C.S.

During the year 1949 Dr. Barnardo's Homes admitted 1,219 boys and girls. In 84 years' work they have rescued about 138,500 needy children.