CLINICAL LABORATORY SHORTCUTS AND SUBSTITUTES

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Ordinarily, the mention of a laboratory shortcut or substitute suggests that in some way there has been more or less of a sacrifice of scientific accuracy to rapid results, which usually cannot be so satisfactory. Therefore, in beginning, I wish to state definitely that I am not suggesting that shortcuts or substitutes should be used in anything in the nature of research work, or where absolute accuracy is of real importance. Nevertheless, in medical practice, it very frequently occurs that some laboratory work is important to either aid in diagnosis, or to indicate or control treatment, as in some kidney diseases, or in diabetes. In a case of diabetes, for example, it is not particularly important to differentiate between a blood sugar of, say, 320 mgms. per 100 cc. of blood and one of 325 mgms. The main point is that the blood sugar is altogether too high, and something must be done about it. There are numerous such things in medicine, and maybe we can find some way to do such work in cases where, without some forms of substitute, this would be impossible.

For the routine work, no satisfactory substitute or shortcut can be found, with the possible exception that, normally, when doing a blood count, the number of red cells found in one block of sixteen small squares of the counting chamber, is approximately equal to the percentage of haemoglobin. However, the apparatus for such routine work as blood counts and urinalyses is not particularly expensive, and is in the possession of practically every physician when he graduates from medical school. When, however, we come to some of the special work, where expensive apparatus is necessary, we come to something not within the reach of the average physician, or even the average small hospital—the two groups responsible for medical care of the larger part of our population.

Can we, then, find some relatively inexpensive and easy method of arriving at a sufficiently accurate result to be a satisfactory working guide, even though exact scientific accuracy cannot be claimed? Fortunately, in many cases we can, and the knowledge of some of these methods may frequently be the means of saving lives, by giving a reasonably accurate indication of the state of affairs while it is still possible to apply the right kind of treatment.

Chemical Examination of Blood

BLOOD SUGAR

Let us consider first what may be done in the way of the chemical examination of the blood. Here, of course, the chief difficulty is

the colorimeter, which is too expensive for the average physician, considering the relatively small number of times he would need it. For the purely chemical part of the test there is no substitute, but this is merely a matter of proper mixing of the blood and reagents. A satisfactory set of reagents for all ordinary blood chemistries costs only a few dollars, and the only apparatus needed is a few tubes, flasks, pipettes, and some filter paper. But what about the colorimeter? Well, in the ordinary colorimeter, such as the duBoscq, we match the colour of the test fluid with the colour of the standard by adjusting the thickness of the layer of fluid till the depth of colour is the same on both sides. But we can get the same results by diluting our test fluid with distilled water until it is the same colour as the standard (or *vice versa*, if the standard is the darker of the two) and calculating from the dilution instead of from the thickness of our layers of fluid.

For example, we set our standard in the colorimeter at 20, and find that our test fluid matches at 10. This means that we have a layer only half as thick, a solution twice as strong. We know our standard for blood sugar contains exactly 100 mgms. sugar per 100 cc., so we calculate $^{20}/_{10} \times 100 = 200$ mgms. sugar per 100 cc. blood. How is it, then, by the dilution method in this same case? We dilute a fixed quantity of the test solution, say 10 cc., and we find that its colour matches that of the standard by the time we have diluted it to 20 cc., so our calculation is the same, $^{20}/_{10} \times 100 = 200$ mgms. To match the colours more easily, a wooden block can be made with vertical holes drilled in it to hold the tubes, and transverse holes piercing these vertical holes, so that only a small circle of colour is seen against a dark ground.

CO_2 CAPACITY

Every now and again we have a patient who is very ill, and we wish to know whether there is an acidosis or an alkalosis. To find this out, we want to estimate the CO_2 capacity of the blood. For this we need a van Slyke apparatus, which is costly, awkward, and very easily broken. But the same information can be obtained by making a measurement of the acidity or alkalinity of the blood, and we can do this in a much more inexpensive and much quicker manner, though the results are not quite so accurate; but, after all, the point is that there *is* an acidosis or alkalosis, and it must be treated, whether it is slight or marked. A normal blood serum is very faintly alkaline, p_H 7.3 to 7.5.

All we need to do is to get a known normal serum as a control and add a drop of some sensitive indicator, such as phenolphthalein, to 5 cc. of the test serum in one tube and to 5 cc. of the control serum in another similar tube. The normal serum turns pink, and the test serum also, if it is alkaline. If acid, however, it will not change its colour. Then we can titrate the control serum with a very dilute acid, such as .01% hydrochloric, and we find that one drop from the end

of an average 1 cc. measuring pipette is the usual amount to neutralize it, as shown by the fading of the pink colour. If our test serum is alkaline, we titrate it in similar manner, noting the number of drops needed to neutralize it. Frequent checks by means of the van Slyke apparatus have shown that one such drop of acid is equal to 5% variation in the CO_2 capacity of the blood; so, if we use four drops, we know that our test serum varies from normal on the side of alkalinity to the extent of 15%, and as average normal is about 50%, we can say that our patient's CO_2 capacity is about 65 — a fairly well established alkalosis. If, however, our blood is already acid, we can titrate it with dilute sodium hydroxide, previously titrated to neutralize .01% HCl, volume for volume, and if we find that we need five drops of our alkali to neutralize the serum, remembering to allow for the one drop of acid needed to neutralize the normal control, we can say that our test varies 20% from the normal on the side of acidity, or is about 30%, a well established acidosis.

The above mention of p_H estimation suggests a point which may be useful in a limited way in other small laboratories. A p_H colorimeter is expensive, and usually consists of degrees of variation of the same colour. But we can easily and inexpensively make a good indicator, which will give a recognizable change of colour with varying changes in reaction. This indicator might be called the 1-2-3-4-5 indicator, as it consists of 0.1 gram of phenolphthalein, 0.2 gm. of methyl red, 0.3 gm. of dimethylamidoazobenzol, 0.4 gm. of bromthymol blue, and 0.5 gm. of thymol blue, dissolved in 500 cc. of absolute alcohol, and titrated to a yellowish-green colour with normal sodium hydroxide. For our test, we merely add a drop of this indicator to about 1 cc. of our test fluid in a white porcelain dish, when we find that:

Red indicates about p_H2—very strongly acid.
Orange indicates about p_H 4—strongly acid.
Yellow indicates about p_H 6—weakly acid.
No change indicates about p_H 7—neutral.
Green indicates about p_H 8—weakly alkaline.
Blue indicates about p_H 10—strongly alkaline.

Strips of litmus paper soaked in this indicator and allowed to dry are very useful and give much more information than litmus paper.

BACTERIOLOGICAL METHODS

In bacteriological work, the chief difficulties are the sterilizer and the incubator, but the lack of these need not hinder the person far from the big laboratory. Glassware can be sterilized by boiling in an ordinary pot, and culture media can be sterilized in an efficient and inexpensive substitute for the Arnold sterilizer made from a double-boiler with some holes drilled in the bottom and sides of the inner half. Of course, with this it is necessary to use the fractional method of sterilization. For the incubator, one's vest pocket makes a thoroughly satisfactory substitute, so long as he remembers he has a glass tube there.

HISTOLOGICAL METHODS

Nor need isolation from a laboratory prevent the country doctor from making histological examinations. He can drop small pieces of the tissue in bottles of 10% or 15% formalin, and when fixed good and firm, maybe with the aid of a little heat, he can attach them to a small sheet of glass by pressing them into melted paraffin which is then allowed to cool and set, after which moderately satisfactory sections for simple purposes such as differentiating a real malignant growth from a definitely benign one can be cut by means of a new safety razor blade, guided over the surface of a piece of plate glass laid flat beside the tissue block. Ordinary Wright's stain—an alcoholic solution of mixed eosin and methylene blue—gives satisfactory results, and then all that remains is to wash the stained slices of tissue in water, dehydrate in alcohol, clear in creosote, and mount on slides in Canada balsam. Of course these sections would not be good enough to do any real study, but they will be plenty good enough to allow anyone who remembers his histopathology to recognize an established cancerous growth, and to guide his treatment accordingly. The whole equipment will cost little more than a dollar, as compared with $150 or more for a microtome.

These are only a few of our laboratory substitutes, but probably all laboratory workers know of several others.

In conclusion, let it be stated that these are all at the best substitutes, and it is not suggested for a moment that these be used when the proper equipment is available. These are merely a few things which the worker in a small community beyond easy reach of the big laboratory may use in an emergency to give a reasonably accurate idea about certain things. They are most useful when the time required to have the work done at a distance would be a serious handicap, or where, as is all too frequent these days, financial circumstances will not permit the obtaining of the proper equipment. All these methods sacrifice some scientific accuracy to either speed or necessity; but, after all, there are some times when it it is justifiable to sacrifice at least some degree of scientific accuracy to expediency, and it is at these times that our laboratory shortcuts and substitutes are useful.

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(*Continued on cover 4*)