tuberculosis mortality of the former is due to deficient nourishment. There can be no doubt about the importance of nutritional factors in tuberculosis, and recent research lends support to this; but I find it hard to believe that the fine physique of the peasants of the west and north of Wales is associated with serious food deficiency.

The hypothesis that I would put before you as the most probable is as follows. Where human beings are scattered and isolated, the passing of germs from one person to another is more or less restricted except within the home. A whole household may easily be infected by one of its members, but other households go free alike from infection and immunization. Where, on the other hand, human beings are herded together and constantly associated one with another, the germs carried by each are passed on indifferently to his neighbours in the factory, the tramcar, or the home. But the number of germs so passed on may be, and probably is, relatively small in most cases except in infected houses. In these circumstances what result should one anticipate? In crowded communities there should be in almost every individual some degree of infection with the tubercle bacillus. In the majority the degree of infection should be small, leading to the acquisition of a relative immunity rather than to active disease. The inhabitant of a large city must adapt himself to the bacteria that are so numerous in his surroundings in order that he may live at all. Therein perhaps lies the danger to those who quit the sparsely populated areas to seek the higher pay and the more attractive life of densely crowded towns.

In the history of every community it is the period of transition from an agricultural type of life to an industrial one that is fraught with the greatest danger. In England this transition took place during a period that reached its

climax early in the last century. During this period of transition the tuberculosis death rate in England was high, and the "young adult" type of mortality was common. When the rural and urban populations became more stabilized the tuberculosis death rate began to fall, especially in the earlier adult age groups, and this fall has continued to the present time.

In Wales a similar period has been traversed, but, though the climax has been passed, stability has not yet been reached. Many persons still leave their country homes for London or for the big industrial centres of Wales itself, and many of them get infected with tuberculosis and go home again to die, perhaps infecting a whole household before the end. Still, in Wales, as in England, the tuberculosis death rate is falling rapidly, and the young adult type is giving place to the type of middle-age mortality. All these facts seem to point to the importance of varying degrees of acquired resistance as the essential factors underlying the differences between the tuberculosis of Wales and elsewhere. If these factors are indeed the fundamental ones, if Nature is gradually getting rid of tuberculosis by a process of unconscious vaccination, then we should, in our efforts at prevention, give a great deal of attention to defending children and susceptible persons from massive doses, and we should concentrate research on efforts to discover a safe and efficient vaccine—a very difficult task, but one which may yet be accomplished.

I feel certain that it was the realization of the importance of these problems that led Major David Davies and the Misses Davies to found this chair, and it is in the hope that my work may help to solve them that I assume my new duties as Professor of Tuberculosis in the Welsh National School of Medicine.

THE "BUFFERING" OF BLOOD:

A SUMMARY.

BY

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THE "reaction" of the blood—that is, the hydrogen ion concentration (c.H) of the blood plasma—is of great importance to the body, especially in relation to respiration. The reaction of blood removed from the body is not constant; it can be changed by changing the volume of CO_2 which it contains, or by adding acid or alkali to it. The same thing may happen in the normal body—for example, exercise results in an increased production of CO_2 , severe exercise throws lactic acid into the blood, gastric digestion removes hydrochloric acid from it, which has the same effect as the addition of sodium bicarbonate to it. In the normal body, however, the c.H of the blood is not altered much thereby, since the respiratory centre is a very sensitive regulator of the blood reaction; the smallest rise of c.H leads to an increase in the frequency and depth of respiration, CO_2 is washed out and the c.H returns towards its usual level. In its function of maintaining the constancy of the blood reaction the respiratory centre is aided by two factors: (a) the activity of the kidneys, and (b) the so-called "buffers" of the blood. The regulation by the kidneys is necessarily a slow process, though very important, their function in this respect being to remove unwanted acid or alkaline bodies; the rapid regulation often required in ordinary life—for example, during exercise—falls entirely on the respiratory centre, aided by the buffers of the blood.

If acid be added to water, or to a neutral salt solution, there will result an enormous increase in the c.H; if the same quantity of acid be added to normal blood the increase will be much smaller. If a given volume of CO_2 be absorbed by blood its rise of c.H will be nothing like as great as if the same CO_2 had been absorbed by water. This relative insensitivity of blood to added acid or CO_2 is due to the "buffers" which it contains. Again, if a given quantity of

acid, or a given volume of CO_2 , be added to plasma separated from corpuscles, the rise in c.H will be less than that caused by the same addition to water, but far greater than that caused by the same addition to whole blood. Thus the "buffering" of blood is due partly to certain constituents of the plasma, but more particularly to certain constituents of the red cells.

In blood there are two chief basic elements, which we will refer to indiscriminately as B, namely, sodium and potassium, combined with various acid radicles, chiefly bicarbonates, chlorides, phosphates and haemoglobin. The phosphates reside mainly, and the haemoglobin entirely, within the red cells. Carbonic acid H_2CO_3 forming bicarbonate BHCO_3 with base B, acid phosphate H.BHPO_4 forming alkaline phosphate B_2HPO_4 , and acid haemoglobin H.Hb forming the haemoglobin salt B.Hb , must be regarded as weak, that is, only slightly dissociated acids. The salts of such weak acids, especially of the last two, may be regarded as possessing stores of base B, so that if free acid be added to their solution they surrender some of their base to form with that acid a neutral (or almost neutral) salt, while they themselves (being very weak acids) proceed to form the neutral (or almost neutral) undissociated acid. In this way considerable quantities of free acid may be added to a solution of such salts of weak acids, without a considerable rise in the c.H. This is the basis of the action of buffers.

Recent work by Barcroft and his collaborators has shown that, in the average normal man, if the volume of CO_2 taken up by blood be plotted, as in Fig. 1, against the c.H of the plasma, then over the range of importance in the living body the relation is a straight line. The slope of this line is a measure of the efficiency with which the blood is buffered; in the case of pure water the line would be nearly horizontal, since here the solution of quite a small volume of CO_2 makes a considerable increase in c.H: in a "perfectly buffered" solution (if one could exist) the line would be vertical, since here the taking up of CO_2 would not affect the c.H at all. With blood the slope of the line lies between these limits; Fig. 1 shows the v. CO_2 -c.H relation for the blood of the "average" normal man. There are certain small variations

FIG. 1.

in normal persons from this average curve, its slope varying by ± 25 per cent. and its height by rather more. We will consider the factors at work in causing these variations, a matter of importance clinically, since the same factors may produce more extensive variations in disease.

CO₂ is present in blood almost entirely in the combined form, as bicarbonate BHCO_3 ; a little is dissolved. The c.H of blood is proportional to the ratio,

$$(\text{dissolved CO}_2) / (\text{combined CO}_2).$$

Since the dissolved CO₂ is proportional to the CO₂ pressure we may say alternatively that the c.H is proportional to the ratio,

$$(\text{CO}_2 \text{ pressure}) / (\text{combined CO}_2).$$

Now suppose we add bicarbonate to blood, keeping the c.H constant while we do so by increasing the CO₂ pressure in the same proportion as we increase the total bicarbonate—that is, the combined CO₂. Then the total CO₂ held by the blood is increased by the amount combined in the bicarbonate added, plus the extra amount dissolved owing to the increased CO₂ pressure. The second amount is very small, since CO₂ is not very soluble, so that the only important increase is that due to the added bicarbonate. The same is true of adding bicarbonate at any fixed c.H, so that by adding bicarbonate to blood we merely raise the v.CO₂—c.H line of Fig. 1 by a uniform amount all along, without changing its slope; in other words, the degree to which the blood is buffered is unaffected by the addition of bicarbonate as such. By adding bicarbonate to blood we merely cause an increase in its CO₂ pressure for a given c.H; the CO₂ pressure in the alveolar air is increased therefore, the respiratory centre slowing the respiration to keep the c.H constant. Hence variations in the total bicarbonate content of the blood are not responsible for differences of slope, but only for differences of position of the curve in Fig. 1. The variations of slope are due to another cause.

The v. CO₂—c.H line of Fig. 1 is much less steep for plasma than for blood, which is natural, since the red cells contain the major portion of the phosphates, and all the haemoglobin, which provide the greater part of the base required to combine with, and so absorb, the CO₂. If, therefore, some of the corpuscles be abstracted from blood, we may expect the resulting v. CO₂—c.H line to be intermediate in slope between the line for plasma and the line for whole blood; the more red cells be left the steeper will be the line, the less be left the less will be its inclination. Hence the differences in the bloods of normal individuals in this respect may be attributed to differences in the number and contents of the red cells.

A steep v. CO₂—c.H line, implying a well-buffered blood, will be a characteristic of an individual in whom exercise produces little respiratory distress; a line of little slope we should expect to find associated with dyspnoea. It will be very interesting to study the physiological and the clinical aspects of variations in the slope and position of this line.

THE END-RESULTS OF REMOVAL OF TONSILS AND ADENOIDS.

BY

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So much has been written recently on the subject of the operation for the removal of tonsils and adenoids that there may perhaps seem to be little more which can be usefully added. There is, however, one aspect upon which little, if any, stress has been laid—namely, the general practitioner's views upon the effects and the utility of the operation. It is he who is naturally in the best position to judge the end-results, since he is able to observe the patients more intimately and for longer periods than the operator or the consultant can do. Further, it is as a rule the general practitioner who decides as to the advisability of his little patients having their tonsils and adenoids removed, and it is he who has to give the parents the reasons, based upon his previous experience, which lead him to believe that benefit will be derived from the operation.

For these reasons I feel that a summary of the cases which have been under my care during the last few years may

serve a useful purpose. I have included all the children under 10 years of age who have had their tonsils completely removed by dissection (all according to the method originated by Mr. George E. Waugh) and their adenoids removed at the same time. The very striking conclusion which this summary indicates is that, once convalescence after the operation is complete, the child's health is so greatly improved that one has hardly ever had to attend him or her again; and that the child is not so liable to other and fresh illnesses as one who retains this lymphatic tissue.

I append a table of the cases, and must add that in only one instance (Case 34) where I have not subsequently attended the child again have I lost trace of the patient. In the remaining cases I have attended other members of the family and have had the opportunity of seeing for myself the healthy condition of the children referred to. I have purposely omitted stating the signs and symptoms which led me to advise operation because I do not wish to confuse the issue, the point which I desire to emphasize being the very small number of professional attendances on these children subsequent to operation, thereby proving the undoubted benefit that has accrued from the surgical procedure. In only four cases (Nos. 12, 26, 33, 39) had an obvious tonsillitis been observed; in four cases (Nos. 3, 11, 33, 50) a cervical gland was sufficiently enlarged to attract the mother's attention; and in three cases (Nos. 21, 45, 49) chorea or acute rheumatism was the reason for advising the operation. In all the other instances it was the general survey of the case which indicated the treatment.

Summary of Cases.

Case.	Year.	Attendances Previous to Operation.	Subsequent Attendances.
1	1911	40 in 20 months	For measles and hernia.
2	"	Weekly for 3 years	For influenza 9 years later.
3	1912	45 in 18 months	Nil.
4	"	26 in 4 months	Frequently for congenital deformity.
5	"	53 in 2 years	Chicken-pox in 1920.
6	"	33 in 20 months	Occasionally for uric acid.
7	"	40 in 1 year	Nil.
8	1913	Seen once only	Occasionally for talipes.
9	"	Daily for 2 months	Nil.
10	"	5 in 2 months	Appendicitis in 1920.
11	"	Seen once only	Nil.
12	1914	Seen once only	Nil.
13	"	12 in 2 months	For small cuts, and bronchitis twice.
14	"	14 in 2 months	For fissure in ano.
15	"	25 in 2 years	Twice since.
16	"	9 in 1 month	Nil.
17	"	73 in 2 years	For gastric disturbances, 7 attendances.
18	"	19 in 6 months	Nil.
19	"	9 in 4 months	For pertussis in 1915; vulvitis in 1919.
20	"	Almost daily for years	Frequently for "congenital heart."
21	1915	13 in 3 months	In 1919 for astigmatism.
22	"	49 in 5 months	Frequently for asthma.
23	"	14 in 12 months	Nil.
24	"	21 in 2½ years	Nil.
25	"	21 in 5 weeks	Nil.
26	1919	10 in 2 months	Chicken-pox in 1920.
27	"	13 in 2 months	For gastritis and food rash several times.
28	"	12 in 6 weeks	Fractured humerus in 1920.
29	"	9 in 1 month	Two attendances for accidents.
30	"	6 in 3 months	Nil.
31	"	6 in 5 months	For gastritis several times.
32	"	16 in 5 months	Two attendances since.
33	1920	6 in 2 months	Nil.
34	"	15 in 7 months	For warts on hand.
35	"	7 in 3 weeks	For tapeworm several times.
36	"	12 in 3 months	Nil.
37	"	14 in 7 months	Nil.
38	"	15 in 14 months	Nil.
39	"	4 in 3 months	Several times for talipes.
40	"	7 in one month	Several times for talipes.
41	"	20 in 16 months	For gastric disturbance in 1921.
42	"	3 in one week	Nil.
43	1921	6 in 6 months	Nil.
44	"	6 in 4 months	Nil.
45	"	19 in 4 months	Nil.
46	"	21 in 1 month	Nil.
47	"	14 in 3 months	Three times for colitis.
48	"	3 in 4 months	Nil.
49	"	24 in 6 months	Nil.
50	"	37 in 2 years	Nil.
51	"	8 in 6 months	Nil.
52	"		Nil.

In 24 cases, or 47 per cent., no further attendance was needed. In 5 cases, or 9 per cent., attendances were required for gastric or intestinal disorders only; in 4 cases, or 7.5 per cent., for congenital deformity; in 4 cases, or 7.5 per cent., for zymotic diseases; in 2 cases, or 4 per cent., for appendicitis; and in 10 cases, or 19 per cent., for other disturbances unconnected with the throat. Thus there are left only three cases—asthma, congenital heart, and bronchitis—where attendance after the operation for removal of tonsils and adenoids was at all frequent, and in these instances it was very much reduced.