

OUTLINE OF A METHOD FOR THE DETERMINATION OF THE
STRENGTH OF THE SKIN CAPILLARIES AND THE INDIRECT
ESTIMATION OF THE INDIVIDUAL VITAMIN C STANDARD*†

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THE strength of the skin capillaries can be systematically ascertained by a test which is an extensive elaboration of the clinical capillary test used by C. Leede,^{1, 2} Alfred F. Hess,^{3, 4} R. Stephan,^{5, 7} and others. The following modifications had to be made in the clinical capillary test to transform it into a test of the strength of the capillaries, satisfactory from the physical point of view:

The veins of the upper arm must be subjected to manometrically measured pressure, and in most cases *more than one degree of pressure* must be applied to make the determination. Each degree of pressure applied should be lower than the diastolic blood pressure in the brachial artery of the subject of examination. Otherwise the afflux of arterial blood is also partly obstructed. Finally, the skin area within which the observations are to be made should be definitely limited as to position, shape, and size.

In the author's method, pressures of 35 and 50 mm. Hg were selected. The skin area to be examined is circular, with a diameter of 60 mm., and its center coincides with the center of the hollow of the elbow. In order to obtain sufficient sensitiveness in this test, it is necessary to maintain the pressure for fifteen minutes. In carrying out this test it proved advisable to fix limits between the various grades of strength in the following manner, according to a descending scale:

Grade I. No petechiae within the examined skin area at a pressure of 50 mm. Hg in fifteen minutes.

Grade II. Petechiae appear at a pressure of 50 mm. Hg, but their number does not exceed 6.

Grade III. More than 6 petechiae appear at 50 mm. Hg, but none or at most one at 35.

Grade IV. At least 2 petechiae are present at a pressure of 35 mm. Hg.

As we know, A. F. Hess³ found that his "capillary resistance test" is positive in scurvy and he also states that it forms a clue in the diagnosis of latent scurvy, a conclusion which is confirmed in a paper of H. Öhnell.⁸ But where Hess applied the test only in cases of scurvy, manifest or latent, the author has gone a step further and inquired into the possibility, by means of this test, of revealing much milder deficiencies in vitamin C, viz., such as lie between the smallest discernible deviation from a normal vitamin C level and the highest deviation possible without giving rise to actual symptoms of disease. The latter class together with cases of latent and manifest scurvy form a complex to which the author suggests giving the general name of *vitamin C undernourishment*.

The author determined the serviceability of the capillary strength test as a criterion of even low degrees of vitamin C undernourishment by the following process:

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†As to the results already arrived at by this method, more detailed information is available in the author's paper, "A Method of Establishing the Vitamin C Standard and Requirements of Physically Healthy Individuals by Testing the Strength of Their Cutaneous Capillaries," *Skandinavisches Arch. f. Physiol.* 61: 225-270, 1931.

Two physically healthy adult persons were placed on a scorbutic diet which was supplemented by precisely measured daily rations of juice freshly squeezed from yellow Mediterranean oranges, and these daily rations were altered by progressive steps in the course of the investigation. It was ascertained (in January and February, 1930) that the original normal strength of the skin capillaries of the subjects of experiment fell to an abnormally low level when the ration of anti-scorbutic juice was kept low for weeks, but that this change in the capillary strength was reversible, the strength returning gradually to normal when a sufficient amount of juice was given for a sufficiently long time (several weeks).

By the testing of the capillary strength both of healthy vegetarians and of school children who had been suffering from vitamin C undernourishment, but whose vitamin C standard was raised by the eating of oranges (after which new capillary strength tests were made), the grades of capillary strength corresponding respectively to a normal and a subnormal vitamin C standard were ascertained. By this investigation, the capillary strength test was actually elaborated into a *nutritional hygiene test by means of which, in a great many cases, individual vitamin C standards can at any time be indirectly ascertained.*

A determination of the strength of the skin capillaries of an individual may, of course, be made whether he is healthy or not. In general, however, such a determination does not offer a solid foundation for conclusions as to the vitamin C standard unless the person examined is entirely healthy with the sole exception of possible symptoms of lowering of his vitamin C standard. Nevertheless, in some not unimportant diseases ("Points to be noted," No. 3, 4 and 7), conclusions as to the vitamin C standard seem to be justified, although the conditions just mentioned are not fulfilled.

I. DESCRIPTION OF APPARATUS

The principal instruments for ascertaining the capillary strength are the following (Fig. 1):*

1. A *rubber stamp (a)* and ink pad for imprinting on the skin of the hollow of the elbow a colored ring within which the capillary observations are to be made. The ring is stamped so that its center coincides with that of the elbow. For adults and children down to two years old, a stamp making a ring 60 mm. in diameter is used, and for younger children, one making a ring 40 mm. in diameter. If the small stamp is used, the corresponding number of petechiae in a circular area measuring 60 mm. in diameter can be computed by multiplying by 2.25.

2. A large *Politzer rubber syringe (b)*, with an air-tight connection with its nozzle.

3. A *screw compressor (c)*, so constructed that when its compressing surfaces of flat metal are farthest apart, the fully distended rubber syringe will fit in between them without distortion, while turning of the screw as far as it will go will completely compress the syringe.

4. A *rubber tourniquet (d)*, of the kind used in measuring the blood pressure, for producing an external pressure on the veins of the arm. For adults and children down to the age of about ten, the rubber part of the tourniquet should be 12 cm. wide, for children between nine and five, 8 cm., and for still smaller children,

*The complete apparatus for the test of capillary strength herein described may be obtained from Kirurgiska Instrument Fabriksaktiebolaget, Stockholm, Sweden.

5 cm. The canvas part of the tourniquet may not extend over the edge of the rubber part for more than a few millimeters.

5. A *low mercury manometer (m)* with conspicuous marks on the scale at 35, 50, and 65 mm. Hg.

6. A Y-shaped metal tube and air-tight, flexible rubber tubes, by means of which the air chamber of the tourniquet, the syringe in the compressor and the inlet tube of the manometer may be joined in a single closed air-system.

7. A *magnifying lens (e)* of 5 D with which to inspect the marked-off skin area for possible petechiae.

8. A circular *plane glass (h)* set in a metal rim with a handle, for locally pressing the blood out of the skin. By this, it is possible in cases of doubt to distinguish between merely hyperemic red spots and genuine petechiae. Hyperemic spots will disappear on pressure, whereas petechiae will become more distinct.

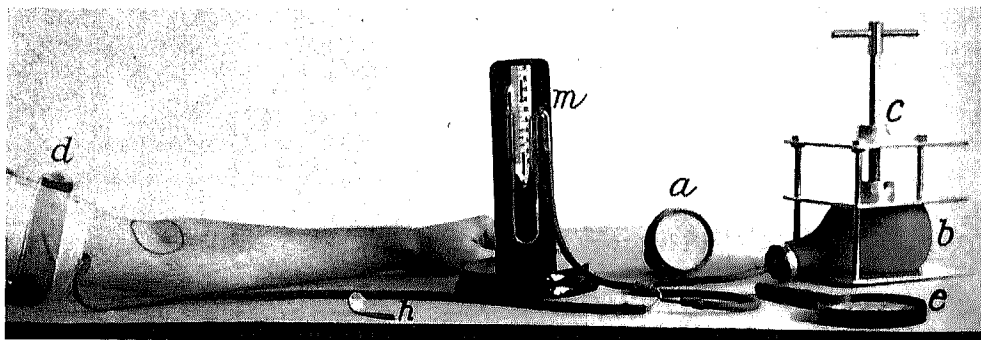


Fig. 1.

II. FURTHER REQUIREMENTS FOR MAKING THE TEST

1. In order to place the arm on a table in the plane of the heart, either an adjustable chair with back support, or a suitable number of wooden boards.

2. It is convenient to employ a block of wood for raising the manometer above the level of the table, thus facilitating the reading of the mercury meniscus. When the apparatus is set up for use, the tubes of the manometer should be strictly vertical.

3. A watch with a second hand or preferably a stop-watch.

4. Glass tubes with capillary points; black ink to indicate the petechiae and green ink for other spots with which the petechiae might otherwise be confused, and for any petechiae which in exceptional cases may be present before the application of pressure.

III. HOW TO MAKE THE CAPILLARY STRENGTH TEST

During the test, the skin area to be inspected and consequently the surrounding air as well should have the proper temperature. It has been found that an increase in the temperature of the skin (causing dilatation of the vessels) tends to increase the number of petechiae, while a lowered temperature (causing contraction of the vessels) tends to decrease the number of petechiae. In cases of more pronounced deviation from the normal temperature of the skin, therefore, the results

obtained by this method will not be reliable. In view of this influence of temperature, the following precautions are necessary:

1. The temperature of the room should be between 16° C. and 21° C.
2. The subject must not have had a hot bath or a steam bath on the day of examination, nor have taken part in any sports, nor, within the three hours immediately preceding the examination, done any gymnastic exercises.
3. In the winter, if the outdoor temperature is low, the subject must have been indoors in the required temperature sufficiently long not to feel in the least cold.

The test should be carried out in broad daylight or in *exactly equivalent* artificial light, e. g., that of a daylight lamp of sufficient strength. (The petechiae are even more distinct in green light than in daylight.)

The subject is placed in a comfortable chair with support for his back. (Examination in the recumbent position is also practicable, but would probably seldom be chosen.) One of the arms is bared to the armpit, care being taken that the rolled sleeves exert no pressure on the arm. Any garment doing so should be removed. The arm is then placed horizontally *in the plane of the heart*. This precaution is very important if a reliable result is to be obtained. If it is neglected, the absolute pressure in the capillaries tested may vary even though the manometer records the same level of pressure. If, for instance, the arm is placed 10 cm. below the level of the heart, there will be besides the pressure registered on the manometer, an additional hydrostatic pressure of $\frac{100 \times 1.058}{13.6}$, equal to 7.8 mm. Hg, and this pressure will also affect the capillaries during the test.

With the subject sitting down, the arm is most accurately placed when the surface to be examined is in the plane of the insertion of the third rib into the sternum. This can be done either by placing the arm directly on the table and adjusting the trunk by means of a swivel chair, or by supporting the arm at the desired level above the table on top of a suitable number of boards.

During the entire test, the subject must keep his arm as well as the rest of his body perfectly quiet.

A colored ring is imprinted with the rubber stamp on the arm with its center coinciding with the center of the hollow of the elbow. The area of the skin thus outlined must be carefully and thoroughly inspected through the lens before pressure is exerted. If one or more formations which may later be mistaken for fresh petechiae (such as small areas of hyperemia, capillary ectasiae, or remains of petechiae from previous tests) are visible, they should be carefully indicated, most suitably by green ink, before the test is made.

The rubber tourniquet is then wound tightly around the arm and fixed, care being taken that *the lower edge of the tourniquet is at least 2.5 cm. above the nearest part of the colored ring*. Petechiae often appear in greater numbers just below the lower edge of the tourniquet rather than further away, and the distance between should therefore not be too small.

The compressor screw should be turned *as quickly as possible*, the pressure in the tourniquet and consequently the external pressure on the veins of the upper arm being thereby raised to the desired level (35, 50, or 65 mm. Hg). At the moment the mercury meniscus in the manometer reaches the proper level, the time is

taken or the stop-watch started. The pressure is then kept constant for fifteen minutes, if necessary by adjustment of the compressor.

When the pressure is released, nothing should be done until the cyanosis of the arm has disappeared; this may be hastened by the raising of the arm for fifteen seconds. *The petechiae should be counted within half an hour after the release of pressure.* Within an hour, some of the petechiae may already have disappeared. When the number of petechiae in the ring exceeds 3, it is advisable to indicate them by making a black ink spot close to each petechia, after which the spots are counted. If the number is very great, it is best to divide the circle into quadrants by two lines passing through the center at right angles to each other; the petechiae in only one of these quadrants need then be counted and multiplied by 4.

IV. CONCLUSIONS FROM THE CAPILLARY STRENGTH TEST

In order to ascertain by the method in question to which grade of strength the capillaries of a person belong, we proceed in the following manner:

One of the arms is subjected to a pressure of 50 mm. for fifteen minutes. If no petechiae appear, the capillary strength is of Grade I. If a pressure of 50 mm. gives up to 6 petechiae, it is of Grade II.* If a pressure of 50 mm. produces more than 6 petechiae, a new test should be made *on the other arm* with a pressure of 35 mm. If no petechiae, or not more than one appears, the capillary strength is of Grade III. If two or more petechiae appear, it is of Grade IV.

The relation between the strength of the skin capillaries of a healthy person determined in this manner and his vitamin C standard at the time of the test has been experimentally ascertained for *the Nordic race* only (cf. G. F. Göthlin⁶). In 1930, the Hygienic Section of the League of Nations was asked to take the initiative in an investigation of this matter along the same lines as in the paper cited in the case of other races living in temperate climates for whom such an investigation might be valuable.

In my investigation the following was found to be true of healthy members of the Nordic race:

If the technic outlined is adhered to and a pressure of 50 mm. for fifteen minutes does not produce more than 4 petechiae in the encircled area, we may conclude that the vitamin C standard is normal.

If 50 mm. Hg produces more than 8 petechiae, or if 35 mm. Hg produces more than one petechia, the vitamin C standard is definitely inferior.

Since by this method it is not possible to draw definite conclusions as to the vitamin C standard from differences of less than 4 in the number of petechiae within the outlined area at a pressure of 50 mm. cases with from 5 to 8 petechiae are regarded as *transitional*, 5 or 6 petechiae rather suggesting a normal standard, and 7 or 8 a subnormal one, though owing to the limits of error involved by the method, definite conclusions cannot be drawn.

V. POINTS TO BE NOTED

1. In investigations, on a large scale (as in schools, regiments, and the like), into individual vitamin C standards or average standards on certain diets, a good deal of time can be saved by connecting the tourniquets of three persons at a time

*In the examination of members of the *Nordic race*, it is very unusual for more than one petechia to appear at 35 mm. Hg in a case in which there are only 6 or less at 50 mm. Hg.

to one and the same manometer and compressor. For this purpose a tube with 6 branches is substituted for the Y-tube. To the sixth branch is coupled an air blowing pump (like those used in blood pressure determination).

When the pressure has been raised by the aid of this pump almost to the required level, the pump is shut off from the air system by the application of a clamp on its rubber tube. By means of the compressor the pressure is exactly adjusted and maintained. In this way, three people are subjected simultaneously to the fifteen-minute period of compression.

2. If a series of tests on one person is desired, it is necessary to allow at least a fortnight, but preferably a month, to intervene between each test so that the ruptured vessels may have time to heal perfectly. By the testing of alternate arms, it is possible to have a month intervening between tests on the same arm and yet have new tests every fortnight. More frequent tests than this are hardly worth while.

In such series of tests, a careful inspection of the skin before the test, is of especially great importance. When only one arm is tested, the 35 mm. pressure should be applied *before* that of 50 mm., and it is desirable that at least an hour be allowed to elapse between these two tests.

3. It is remarkable that simple arteriosclerosis does not by itself reduce the strength of the skin capillaries, at least to judge from the observations hitherto made on a small scale (10 cases). This method apparently can therefore also be used to determine the vitamin C standard of persons suffering from simple arteriosclerosis, but otherwise healthy.

4. Since there may be cases of latent tuberculosis among those tested in a mass investigation, it is interesting to note that tests made on a small number (12 cases) of persons with manifest pulmonary tuberculosis do not support any assumption that tuberculosis alone reduces the capillary strength.

5. In various acute infectious diseases (such as measles and scarlet fever), a reduction in the strength of the skin capillaries is found^{1, 2, 6, 7} and may persist in many cases for a rather long time, but the cause of this reduction has not yet been investigated. In the case of persons who have within the two months immediately preceding the investigation suffered from an acute infectious disease, it is therefore, at the present stage of our knowledge, wisest not to estimate the vitamin C standard from the strength of their capillaries.

6. No such estimate can be made in albuminuric conditions either, since these appear generally to reduce the strength of the skin capillaries.

7. In cases of achylia and uncomplicated afebrile stomach ulcers the vitamin C standard may be estimated from the results of the capillary strength test.

When inferior capillary strength is found in persons suffering from achylia or chronic enteritis, it should be kept in mind that part of the vitamin C in the food may be lost; in the former cases through the unfavorable conditions for the preservation of that vitamin in the digestive canal (alkaline reaction), and in the latter because of the difficulties in resorption of the vitamin, which are presented by the catarrhal alteration of the mucous membrane.

SUMMARY

1. A test is described which makes it possible to determine the degree of strength of the skin capillaries in the hollow of the elbow.

2. The capillary strength, ascertained by this method, indirectly reveals the vitamin C standard of persons who are quite healthy or exhibit only such deviations from health as are in themselves due to a low vitamin C standard.

3. It is suggested that with this same method it is probably also possible to estimate the individual vitamin C standard in cases of uncomplicated arteriosclerosis, afebrile tuberculosis, achylia, and uncomplicated afebrile stomach ulcers.

4. This method may be used as a test of the individual vitamin C standard by physicians, hygienists, and dentists in their practice. It can also be used in the statistic examination of groups (e. g., in the army, in boarding schools, in orphanages, in old people's homes, in asylums, and in prisons) in order to ascertain whether the diets in use provide a sufficient supply of vitamin C.

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TWO CASES OF ANEMIA OF PREGNANCY WITH THE CLINICAL
FINDINGS OF MYASTHENIA GRAVIS*

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A LARGE number of cases of pernicious anemia of pregnancy have been reported in the literature and the symptoms, signs, and blood findings have been clearly stated by Schmidt,¹ Larrabee,² Allan,³ Rowland,⁴ McSwinney,⁵ Balfour,⁶ and others. The signs and symptoms most frequently present are: weakness, breathlessness, palpitation, pallor, and gastrointestinal disturbances such as nausea, vomiting, and diarrhea. There is usually a history of fever or its presence during the course of the disease. These signs and symptoms may be accompanied by a blood picture of a primary (Schmidt,¹ Balfour,⁶ etc.), hemolytic (Minot,⁷ Rowland,⁴ etc.), secondary (Osler,⁸ Evans,⁹ Mills,¹⁰ etc.), or aplastic (Larrabee²) type of anemia. The pallor is usually marked and icterus may or may not be present depending upon the type of anemia.

The percentage of cases in which the liver and spleen have been found enlarged has varied in the different series of cases reported. In Balfour's⁶ series of 150 cases

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