by noting the level at which the liquid stands in the burette.

There is no one alkali in the blood which we can hold responsible for its alkaline reaction. It is therefore necessary to measure this alkalinity by taking a known alkali, say NaHO, as the unit. By ascertaining the amount of a $\frac{1}{75}$ normal tartaric acid solution required to neutralize a known quantity of blood, and then ascertaining the amount of sodium hydrate neutralized by this amount of a $\frac{1}{75}$ tartaric acid solution, we learn in terms of NaHO the amount of tartaric acid required to neutralize a known quantity of blood. Things which are equal to the same are equal to one another.

Thus by experiment we find that 0.5 c.cm. of $\frac{1}{75}$ normal tartaric acid solution neutralizes 0.05 c.cm. of blood; *then* 1,000 c.cm. of $\frac{1}{75}$ normal tartaric acid solution neutralizes 100 c.cm. of blood.

Again, by experiment, we find that 75 gm. of tartaric acid neutralizes 40 gm. NaHO ($23+1+16=40$). 1 gm. of tartaric acid neutralizes ($\frac{1}{75}$ of 40) 533 mgm. of NaHO.

Since 1,000 c.cm. of $\frac{1}{75}$ tartaric acid solution neutralizes 100 c.cm. of blood, 100 c.cm. of blood has an alkalinity of 533 mgm. of NaHO.

0.5 c.cm. of $\frac{1}{75}$ normal tartaric acid solution neutralizes 0.05 c.cm. of blood. 1,000 c.cm. of $\frac{1}{75}$ normal tartaric acid solution neutralizes 100 c.cm. of blood. 75 gm. of tartaric acid solution neutralizes 40 gm. of NaHO.

$$C_4H_6O_6 = \frac{48+6+96}{2} = 75 \text{ neutralizes } NaHO = 23 + 1 + 16 = 40.$$

Then 1 gm. of tartaric acid solution neutralizes ($\frac{1}{75}$ of 40) 0.533 NaHO.

This is the quantity of tartaric acid in the $\frac{1}{75}$ normal solution (1 gm. in 1,000 c.c. of water). This, therefore, is the value in alkalinity—so to speak, in terms of NaHO—of the tartaric acid solution employed.

Now on titration it is found that from 9 to 10 drops of such a solution are required to neutralize 0.05 c.cm. of blood.

10 drops equal 0.5 c.cm., which equal 0.5 gm.
0.5 gm. equals 0.266 NaHO.
Therefore 10 drops equal an alkalinity of 0.266 NaHO.
1 drop = 0.0266 NaHO.

It is perhaps better to bear in mind that 9 or 10 drops represent the normal, and to report examinations accordingly. For example, "6 drops required to neutralize," "12 drops required to neutralize," etc. It would also simplify the proceeding to use a solution of litmus in the blood solution instead of the papers.

The Eyepiece Micrometer (Fig. 600) is of so simple construction and mechanism that its employment is to be recommended for more accurate clinical reports on the size of the blood corpuscles.

The following explanation is taken from the Leitz advertisement of the instrument:

Micrometric Measurements.—The scale of the eyepiece micrometer is divided into $\frac{1}{10}$ mm. Each of these divisions represents, according to the objective used, a certain absolute linear measure of the object, as shown in the following table:

Number of objective.	Absolute length of object represented by one division of the eyepiece-micrometer scale. Millimetres.	Number of objective.	Absolute length of object represented by one division of the eyepiece-micrometer scale. Millimetres.
1	0.054	7	0.0026
2	.028	8	.0020
3	.015	9	.0017
4	.012	Immersion $\frac{1}{10}$	.0022
5	.0048	" $\frac{1}{12}$	.0018
6	.0034	" $\frac{1}{18}$	.0014

When making micrometer measurements it is absolutely necessary accurately to maintain the tube length at 170 mm. If this is neglected the measurements become unreliable or even worthless.

The above micrometer values are measured with eyepiece II.; in the other eyepieces they differ in an inappreciable degree.

Example: Let a scale of *Hipparchia Janira*, as seen with objective 6, cover 54 divisions of the scale longitudinally and 20 divisions transversely. Its actual length will then be $54 \times 0.0034 = 0.184$ mm., and its breadth $20 \times 0.0034 = 0.068$ mm.

Suppose a valve of *Pleurosigma angulatum*, measured with objectives 4, 6, and 7, to cover 21, 74, and 98 divisions respectively; then the measurements of its length represent the following absolute dimensions:

Objective 4: $21 \times 0.012 = 0.252$ mm.
" 6: $74 \times 0.3004 = 0.252$ "
" 7: $98 \times 0.0026 = 0.255$ "

Tables of Magnifications.—The image seen in the microscope produces upon the eye the same effect as an object seen at the normal distance of distinct vision, *i.e.*, 10 inches.

If, therefore, a rule be placed at the foot of the microscope at a distance of 10 inches from the eye, it can be compared with the microscopical image of a scale divided into $\frac{1}{100}$ mm. The quotient is the magnification of the objective and the eyepiece combined.

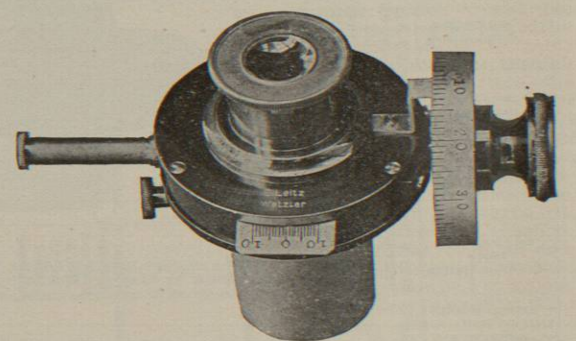

FIG. 600.—The Eyepiece Micrometer.

If, *e.g.*, 92 mm. of the rule are found to cover $\frac{7}{10}$ of the image of the micrometer scale, it follows that the magnification is $\frac{92}{0.7} = 130$. The tables of magnification have been compiled in this manner and are sufficiently accurate for practical purposes.

Thus, supposing the same specimen of *Pleurosigma angulatum* to be measured—

(1) with objective 7 and eyepiece 0,
(2) with objective 4 and eyepiece II.,

and supposing the length of its image to be 67 mm. in the first and 22 mm. in the second case, then, since the actual size of the object is found by dividing the length of the image, as seen at a distance of 10 inches from the eye, by the magnification of the objective and eyepiece combined, the length of our specimen of *Pleurosigma angulatum* is:

(1) $\frac{67}{270} = 0.248$ mm.
(2) $\frac{22}{90} = 0.244$ mm.

In all these measurements a tube length of 170 mm. must be strictly adhered to.

(NOTE.—As this article goes to press I learn that Jolles's ferrometer has undergone such simplification as to place it among those instruments useful for clinical work.

The eyepiece spectroscope is also a valuable addition to our clinical apparatus.

Both of these instruments are as yet untested, but their simple construction and application commend them to the clinician.)

BIBLIOGRAPHY.

As space does not permit of a long list being introduced, the reader is referred to the very full bibliographical note in von Jaksch's "Clinical Diagnosis" and to the writings of the observers who are quoted throughout the article.

Charles N. B. Camac.

BLOOD-LETTING.—This title includes all methods of abstracting blood for therapeutic purposes, whether they are for a general or for a local effect. The terms *venesection* and *phlebotomy* are restricted to bleeding from the larger veins, for the purpose of influencing the system generally; whilst *leeching*, *wet-cupping*, and *scarification* are means of abstracting blood from the capillaries, the effect of which is almost entirely local.

General blood-letting, or venesection, is of very ancient origin. References to it have been found in history prior to the time of Hippocrates, and in the writings of this early authority it occupies an acknowledged position as a valuable therapeutic agent. During the many years that it has been employed it has been viewed with a varying degree of favor, and at times its advocates have employed it in all forms of disease and in a most extravagant manner. The seventeenth century and the early part of the present century mark the periods of its greatest use, during which excessive and repeated bleedings were constantly employed. The amounts of blood removed seem astounding at the present day. For a pleurisy 5,520 gm. were abstracted during a period of several days; in a case of pericarditis it was found necessary to abstract, on different occasions, 721, 720, 960, 1,200, and then 1,440 gm. before the patient was relieved; and, in a case of inflammatory rheumatism, twenty pounds of blood were taken during the progress of the attack. In the early part of the century, medical opinion went to the other extreme; the practice fell into disrepute and was almost entirely abandoned. During the last twenty-five years its use has been revived. Many of the older practitioners who had never forsaken its use have been more outspoken in advocating its therapeutic powers. At medical gatherings, many papers have been read and numerous discussions have followed, in which venesection has been very generally supported. Its employment has now assumed a more rational character. The advance in our knowledge of physiology and a closer clinical observation have made clearer what its effects are upon the system, and we now employ it with a definite object in view and restrict its use to a much more narrow sphere.

Venesection exercises what may be termed a mechanical effect upon the circulation, as well as a general effect upon the system. When a certain proportion of the blood is removed the tension of the blood-vessels is at once lessened, the degree depending upon the amount withdrawn. The effect is but temporary, as that which is lost is rapidly renewed; but, if any disturbance of the circulation exists, it is sufficient to allow the equilibrium to be regained, the heart beating more easily and the blood flowing more freely through the vessels.

The general effect upon the system is of the utmost importance. Accompanying the lowering of blood pressure and loss of blood cells, there is a diminished activity of the various functions. The heart's action is quieter, respiration goes on more slowly, tissue changes are less active, and there is a lowering of body heat. This depression is but temporary. In a few hours there begins a renewal of the blood, tissue changes are accelerated, the nervous system is improved by a stimulation of the nerve centres, and general bodily improvement is the result. At the International Medical Congress for 1900, in the discussion upon this subject, M. A. Robin stated, as the result of many years' observation, he was satisfied that after moderate bleeding of 150 to 250 gm., polyuria is regularly observed, and the excretion of solids is increased. A greater amount of air is taken into the lungs, as much as sixty-one per cent., and the proportion of oxygen consumed by the tissues is correspondingly increased. When the bleedings are renewed the reaction is slower, and when they are frequently repeated, a state of anæmia ensues, with a tendency to degenerative changes.

INDICATIONS.—The indications for bleeding may be summed up under three heads: (*a*) when there is excessive vascular tension; (*b*) when it is desired to obtain the benefit of its physiological action upon the various tissues and organs; (*c*) when it is believed that good may result from removing a definite amount of blood, and with it a certain proportion of toxic material, from the system.

There is no difference of opinion as to the value of venesection in all conditions in which there is venous engorgement. It may be thought desirable to try the nitrites and allied drugs for the purpose of "bleeding into the arteries," or to employ hydragogue cathartics or diuretics to unload the congested vessels; but if these measures fail, all are in favor of bleeding. The cause of the obstructed circulation may lie in the heart or in the pulmonary tissue. The effect of either of these causes is an overfilled and possibly a dilated right heart, distended veins, and more or less congestion of the various organs. In this condition the removal of blood from the venous system affords prompt relief. The laboring heart beats more freely, the arteries become filled, and the congested veins and organs return to the normal. The dyspnœa disappears, the dusky hue of the skin fades, and the general condition of the patient is at once improved. Mitral disease, when compensation is failing, and a feeble heart that is suddenly overtaxed, are the two conditions that most frequently give rise to these distressing symptoms. In such cases, when the dilatation is extreme and the force of the heart very low, venesection must be prompt to be of service. Among these cases may be included many instances of cardiac failure that occur during the administration of a general anæsthetic, when the dilated heart becomes suddenly overfilled and unable to empty its cavities. A sudden blow over the heart may suffice to cause a powerful contraction, or the withdrawal of blood will relieve the pressure and allow regular contractions to be re-established. Of the pulmonary causes of venous congestion, emphysema is the most common, and in this condition marked benefit will follow the withdrawal of blood. Cases of bronchitis and those in which there is a tendency to pulmonary œdema afford favorable conditions for this treatment.

Venesection is also of service when the arteries show a condition of increased tension, when the pulse is full and bounding, and when a condition of general plethora prevails. In these cases the relief afforded by the withdrawal of blood is also very marked, the reduced blood pressure relieving the congested organs and often preventing cerebral hemorrhage. In the convulsions of uræmia, and especially in puerperal eclampsia, when there is the same arterial tension, the value of venesection is unquestionable. The relief is immediate, and the severity of subsequent attacks is likely to be lessened. In puerperal states there should be no hesitation in resorting to it, if the arterial tension is abnormally high; and the fact that a free loss of blood has occurred during labor does not warrant the belief that venesection will be any less effective in relieving the tension. In these cases much of the benefit is due to the reduction of blood pressure, and much also may be explained by the favorable influence exerted on the tissue changes and by the increased oxidization. In addition, it is also suggested that the increased nutritive changes neutralize the poisons circulating in the blood and convert them into harmless products.

It is difficult to determine to what extent the benefit should be ascribed to the actual removal of toxic material from the body (with the blood that is drawn off), yet we find that there are many eminent authorities who lay great stress upon this explanation. To increase the usefulness of the procedure in these toxic cases, it is recommended that the bleedings should be very free and that the blood lost should be replaced by normal saline solution, either administered subcutaneously or injected directly into the veins.

The effect of venesection in lowering temperature and allaying the symptoms of inflammation would suggest the wisdom of employing it in the treatment of fevers and inflammatory diseases—a practice which was so much in vogue at the time when venesection was used empirically. This proposition, however, does not meet with favor. It is maintained that the relief afforded is but temporary, and that the tendency to fatty changes, present in pyrexia, is heightened by the repeated withdrawals of blood. The symptoms undoubtedly show marked improvement immediately after the operation, but the greater debility which results and the prolonged convalescence prevent its general acceptance. The only acute disease in which venesection receives much attention is pneumonia. In addition to the benefits derived from the lessening of the plethora and the easing of the overworked heart, the lessening of the inflammatory process and the probable limiting of the extent of the consolidation must also be considered as results of some value. At all events numerous cases have been reported in which venesection has proved serviceable, and the subject is therefore worthy of every consideration. It is evident, however, that if any benefit is to be derived from this method of treatment it must be begun early before the pathological processes have made much advance. When it is resorted to at the outset, in a plethoric patient with sthenic symptoms, a full pulse, difficult respiration, pain, and fever, the operation acts most favorably, and there is every reason to believe that it renders the attack less severe. Frequently the venesection is resorted to too late in the disease as a last resort, and although the distressing symptoms may be allayed for the moment, the ultimate result is rarely favorable.

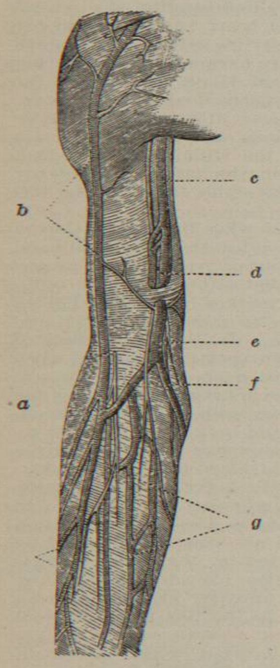

FIG. 601.—The Superficial Veins of the Forearm: Skin Removed. *a*, Median cephalic; *b*, cephalic; *c*, brachial; *e*, basilic; *f*, median basilic; *g*, anterior ulna; *d*, median nerve.

METHOD OF PROCEDURE.—Formerly, blood was withdrawn from the veins of the arm, the external jugular, the veins beneath the tongue, the scrotal veins, and the veins of the leg; but at the present time a vein on the anterior surface of the forearm is the one chosen, unless some particular reason exists why another should be selected. The veins in this region that become most prominent, when the circulation in them is arrested, are the median cephalic and the median basilic. The former is the proper one to select, as the median basilic is in close relation to the artery. The median cephalic is external to the tendon of the biceps and away from any region of danger. It will be found, however, that the size and prominence of the veins in front of the elbow vary greatly, and generally the most marked one is selected regardless of its name or position.

In performing the operation strict antiseptic precautions should be observed in the preparation of the site and in the selection of the knife and dressings. The arm is allowed to hang suspended and a firm bandage is applied above the elbow, sufficient force being employed to compress the superficial veins, and yet not enough to intercept the arterial flow. The vein is opened either longitudinally or in a direction slightly oblique to the axis of the vessel, the point of the blade being inserted directly into the vessel and withdrawn with a downward cutting motion. Before one makes the incision he should place the thumb of the left hand below the point of opening, in order to secure the vessel firmly. Care must also be observed that the skin is tense and in its proper relation to the vessel, otherwise the incision through the skin may not coincide with the opening into the vein, and instead of a free flow of blood there will be only an exudation of blood into the cellular tissue. As soon as the blood flows freely, the pulse of the other arm and the patient's face should be kept under observation to determine the effect on the circulation and to detect any symptoms of syncope. Twenty, thirty, or even forty ounces should be removed, according to the condition and temperament of the patient. The quantity taken should always be sufficient to make a decided impression upon the circulation. Frequently the amount withdrawn does not exceed a few ounces. This is too small a quantity to afford any benefit to the patient, and as a further result venesection is discredited. When sufficient blood has been removed the flow is readily checked by applying a compress over the incision, removing the constricting band, and bandaging the arm, which bandage may be removed in twenty-four hours.

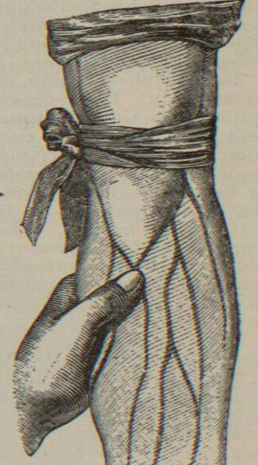
FIG. 602.—Forearm with Ligature Applied. Finger at junction of median basilic and median cephalic veins.

It is often desirable to abstract blood from some prominent part for the purpose of relieving a local hyperæmia or congestion, as in many bruises and ecchymoses, in disease about the eye, nose, ear, gums, etc., and in some forms of cellulitis. Such local blood-letting is also occasionally employed to lessen the congestion of deep organs by withdrawing blood from the surface of the body near to the affected part. In all cases the blood flows from the capillaries or superficial vessels, and the quantity is very slight in comparison with that which is abstracted in general blood-letting. To accomplish this end, leeches, scarification, and wet-cupping are the means employed.


FIG. 603.—Glass Leech Tube.

LEECHING.—This means of locally abstracting blood is still frequently employed, but not to such an extent as formerly. When any large amount of blood is required, a number of leeches must be used. A single leech will absorb from two to three drachms of blood, and this may be increased as much more by warm fomentations applied after the leech has dropped off. The leeches may be placed in a wine glass which should then be inverted over the desired spot. If the area is very limited, or if the blood is to be withdrawn from the nasal cavity, gums, or any cavity, a leech glass should always be utilized. The leech will bite more freely if removed from the water an hour or more before needed, and for the same reason the part should be thoroughly cleansed. When a leech shows no inclination to bite, rubbing the skin with sweetened water will sometimes induce it to fasten upon the spot. The peculiar bite of the leech

always leaves a permanent scar, and care must be observed in selecting a site which is not conspicuous.

SCARIFICATION AND CUPPING.—By these means blood is abstracted through small superficial incisions into the skin, the flow being augmented by the cupping glass when that instrument is employed. The incisions may be made with an ordinary knife or lancet, or by means of a scarificator. In the latter instrument the blades may be adjusted to any desired length so that the cutis vera of the part may be incised without penetrating to the deeper tissues. The cupping glass may be one of those specially constructed for this purpose, or an ordinary wine glass may be made to serve the same end. The cavity of the glass is heated over a spirit lamp, or by burning a small quantity of spirit in it, and then the glass is quickly inverted over the desired part and placed in such a way that the air will not enter. As the heated air cools its density is increased and suction force is exercised upon the incised surface. The glass should be removed as soon as it ceases to act and a fresh one applied. A cupping glass with a rubber bulb attached, on the principle of the ordinary breast pump, is also utilized.


FIG. 604.—The Scarificator.

DRY CUPPING.—Very frequently cupping glasses are applied without an incision being made for the removal of blood. This is known as "dry cupping." The application of the glasses produces a rapid flow of blood to the part, and when repeated rapidly over a small area, the withdrawal of blood from organs lying below the surface is sufficient to relieve them if inflamed and congested. A single glass may be applied and quickly reapplied, but it is more satisfactory to employ a number of glasses and apply them at the same time. They are applied after the same manner as described for wet cupping. Dry cupping has the advantage of not making any incision and not causing any scar. The therapeutic action is somewhat different from that of wet cupping, as the counter-irritation is much greater and more prolonged. Junod's boot is an instrument prepared on the same principle as that of the cupping-glass, its purpose being to withdraw blood from the body into one of the limbs, in order that relief may be afforded to congested organs without the permanent loss of any blood. It consists of a metallic vessel into which a limb may be placed and which closes so tightly that air cannot enter or escape, except by means of an exhausting syringe. As the air is withdrawn from the cavity, the blood flows into the vessels of the limb which becomes greatly swollen and congested. This appliance has never met with much favor, as the constitutional effect is not very satisfactory and the local action is often severe.

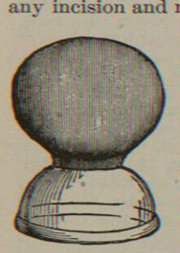
FIG. 605.—Cupping Glass, with Elastic Rubber Cap or Bulb.

Beaumont Small.

BLOODROOT.—SANGUINARIA. *Red Puccoon.* "The rhizome of *Sanguinaria Canadensis* L. (fam. *Papaveraceæ*), collected in the autumn" (U. S. P.). It is doubtful if this definition can be complied with, as the aerial portions die in early summer, and before fall all traces which would indicate the presence of the rhizome have disappeared. The plant is a low perennial, with a thick, fleshy, horizontal root-stock, from which one or two leaves and a single handsome white flower appear early in the spring, enclosed at the base by several sheathing scales. The leaves are kidney-shaped, variously lobed, and grow much larger and broader as the season goes on. The flower is about 3 cm. across (one and one-fourth inches), regular, perfect, spreading; sepals two, falling early; petals from six to twelve, rather narrow; stamens numerous, ovary and capsule one-celled, with two placentæ; ovules (and seeds) numerous, with prominent caruncles. An opaque, orange-colored juice is found in all parts of the plant, especially in the rhizome, where it is very abundant and dark. Bloodroot is a native of North America, and is occasionally cultivated as an ornamental plant both here and in Europe. The dried rhizome is about 5 cm. (two inches) long, and 1 cm. in diameter, slightly flattened, indistinctly annulated, and evidently shrunken and wrinkled. It is reddish brown externally, variously bent and twisted, and now and then branched. It breaks with a short fracture, and displays a pink surface, finely dotted with dull red points; this surface becomes dark by exposure, and finally is uniformly brownish red. Odor slight, disagreeable. Taste bitter, acrid, nauseous, and persistent. Powder sternutatory.


FIG. 606.—Bloodroot.

The principal constituent is the alkaloid *sanguinarine* ($C_{20}H_{15}NO_4$), discovered and named by Dana in 1829. When pure it is in white crystalline needles or tufts, insoluble in water, but easily dissolved by alcohol, ether, oils, etc.; it forms with the principal acids beautiful salts of brilliant orange or red color. The powder excites violent sneezing. Its taste, when dissolved, is that of the rhizome intensified. Chelerythrine ($C_{21}H_{17}NO_4$) exists in smaller amounts and yields yellow salts. Small amounts of at least two other alkaloids exist, with irritant resin, starch, citric and malic acids.

Action.—The several alkaloids of bloodroot have very dissimilar actions when used separately, but that of sanguinarine is overpowering and determines that of the drug. It is a most powerful irritant, locally and systemically. It was formerly used as a caustic for morbid growths, and has had many uses as a counter-irritant. It is powerfully irritant to the mucous membranes, and sialagogue. It is a powerful and even fatal emetic and cathartic. Systemically, it irritates both the spinal and cerebral centres, producing tetanic convulsions and intoxication or violent delirium. It depresses muscular fibre, and this at length greatly depresses both the circulation and the respiration.

These properties can be utilized, by small doses, in improving both appetite and digestion, and in producing expectorant effects, the latter either by internal administration, or by inhalation of very weak preparations, or by application to the throat. It was formerly a much-used emetic in doses of gr. xv. to lx., but this use is now considered barbarous. It is very little used at the present time, and then chiefly as an expectorant, in doses of 0.2 to 0.5 gm. (gr. iij. to viij). Its excretion is accompanied by stimulation of intestinal and renal secretion and of peristalsis. It is also a stimulating emmenagogue. A fluid extract and a fifteen per cent. tincture, each containing a little acetic acid, are official. *H. H. Rusby.*

BLOOD STAINS.—In criminal trials the medical witness is often called to determine whether stains found on weapons—as knives, clubs, or daggers—or upon the