be subjected to deep kneading, with the object of softening and stretching the scar tissue and, if possible, getting rid of it altogether. The patient must be warned that this process will be painful, but at the same time encouraged to expect the benefit which results from successful treatment. Massage must be supplemented by active and passive movements, persistent but never sudden, the degree of stretching the adhesions at any one time being guided by the patient's feeling of pain. As has been said above, it is better to progress slowly than risk any actual tearing of these fibrous bands, which may give rise to bleeding and subsequent formation of fresh adhesions. By these methods deformities may be reduced, and scar tissue dispersed at the same time.

Periarticular bursitis is common in the neighbourhood of all joints, and is characterized by tense swollen bursae which may be hot and red. These are tender to palpation and painful when the joint is moved in such a way as to stretch or press on the inflamed synovial walls. The condition is apparently due to the infection settling in a bursa irritated by a constant strain on the surrounding tendons and ligaments. This is well illustrated by the clinical picture of subacromial bursitis as described by Buckley. With the arm at rest by the side there is a point of extreme tenderness if the bursa is palpated under the tip of the acromion. As the arm is abducted there is severe pain while the wall is stretched by the action of the supraspinatus whose tendon crosses the floor of the bursa. With abduction beyond a right angle, however, both pain and tenderness disappear as the bursa passes in below the protecting acromial process. As these conditions are due to strain or trauma in conjunction with infection, the joint must be protected from the strain or trauma, whether the swing of a golf-club, the use of a tennis-racket, or other such movement, until the inflammation has subsided. For hastening this end, ionization is the method of choice; it combines counter-irritation with the direct increased blood supply to the part from the passage of the current. Once the inflammation in the bursa has subsided there is no difficulty in restoring mobility and full function.

Osteo-arthritis.

In this condition rarefaction and absorption of the bone occurs with compensatory formation of osteophytes and overgrowths. The joint surfaces become eroded, and with the destruction of the synovial linings the sensitive cartilaginous surfaces come into contact with each other, causing intense pain and inducing protective muscular spasms. These spasms may result in considerable deformities, and the formation of osteophytes may take place in such a way that restoration of the opposing bones to their normal alignment is impossible. Cases which have progressed to this stage cannot be helped to any great extent by physiotherapy, and indeed any treatment short of active surgical intervention to immobilize the painful joint gives little promise. Moreover, since the condition is most frequently met with in old debilitated persons, little able to stand a major operation, even this method is not often applicable. Every effort should therefore be made to arrest the condition in the early stages, or prevent deformity of joints. Since strain and pressure favour the formation of osteophytes, as soon as the joint can be got into the best orthopaedic position by extension apparatus, weight-bearing splints must be applied to prevent the direct apposition of joint surfaces and convey the stress of the body weight past the affected joint. In order to achieve the object of relieving muscular spasm and restoring good position and at all times to relieve pain, radiant heat is of the greatest service. Massage to muscles is of use in maintaining tone, but care must be exercised that the hypertonia existing in those muscles already in spasm is not increased by injudicious treatment.

I do not suggest for a moment that other methods of treatment of the various forms of arthritis referred to in this paper are not of the greatest use, and in some cases almost essential; but it is useful to indicate that much may be done for these troublesome and all too common afflictions by methods that are within the scope of the available therapeutic armamentarium of most practitioners and within reach of the pockets of most patients.

END-RESULTS OF ARTIFICIAL PNEUMOTHORAX.*

BY

S. VERE PEARSON, M.D., M.R.C.P.,

PHYSICIAN, MUNDESLY SANATORIUM.

THE following results are based upon a series of 78 patients whose treatment was commenced fifteen to three years ago. Of those who recovered, only 4 were started later than December, 1921, and only one later than June, 1922. All the patients were in the third stage of pulmonary tuberculosis and were sputum-positive. They were patients who had failed or who were failing to respond to the ordinary sanatorium régime.

Table Summarizing Results.

	Operation Practicable.	Operation not Practicable.
Able to work	29+4=42.3 per cent.	2
Dead	34+5=50.0 ..	9 (64.3%)
Dead from other cause	1	—
Ill with tuberculosis... ..	3	—
Lost sight of	2	3
Total	69+9	14

The 9 patients put separately were some who were largely under my care during the period mentioned, but artificial pneumothorax was not started originally at the Mundesley Sanatorium. During the same period there were 17 patients in whom only a partial pneumothorax could be produced; 8 of these are dead, 4 are well and working, 1 is ill, and 4 I have lost sight of.

Of the patients who died, one lived twelve years, another seven and a half years, both enjoying good health for the greater part of these periods. Others lived six, five, five, and four years respectively; others, again, lived only a few weeks or months. The average duration of life of the 47 patients who died (including the cases of partial pneumothorax) was two and one-third years; and the duration is the same if only the 34 of the first group are taken into account. By comparing this duration to the duration of life of sputum-positive cases of all types treated by other means than artificial pneumothorax (as illustrated, for example, in Dr. James Watt's article in *Tubercle*, August, 1924), it can be seen that life was prolonged appreciably by means of this treatment, even in the cases who eventually died of tuberculosis. From a study of the above statistics it can be said that in any case of moderately advanced pulmonary tuberculosis which is fairly unilateral, the prognosis is best if compression treatment be undertaken and prove feasible.

The comparison in the table also makes clear that artificial pneumothorax is successful when the results are compared with similar cases for whom this treatment has not been possible on account of generally adherent pleura. It will be seen from the table that the death rate with these patients is much heavier. Yet the conditions which lead to the choice of a trial of compression were the same in both cases. No one can say beforehand which patients have general adhesions.

I always advise maintaining the pneumothorax for at least three years. Often four, four and a half, or five years are found advisable. But this is not a hardship, for, even on the day of the refill, the patient's workaday life need not be seriously interfered with. The average duration of the period of refills in those of my patients (34) who have recovered is four years and four months; and the average duration of life since commencing treatment is six years and ten months.

The question of how far the recovery goes, how far the working capacity is restored, is of interest. To what extent does the lung re-expand after the treatment has been stopped? Since the patients dealt with in this series are

* Summary of a paper read before the Assurance Medical Society, November 5th, 1925.

third stage, sputum-positive cases not progressing well under the ordinary régime, restoration to a quite full working capacity cannot be expected in all cases, or in the first few years. Occasionally patients soon make a complete recovery. This is especially likely to occur in young persons with sound contralateral lungs. The expectoration of sputum containing tubercle bacilli is usually an early symptom to cease.

The extent of re-expansion of the compressed lung varies, and cannot easily be predicted. In rather more than one-third the re-expansion is fairly complete. The scarring in the lung shows chiefly through cardiac, and, if on the left side, stomach displacement. The heart is pulled over to the affected side. There are no adventitious sounds, but the breath sounds may remain permanently a little weak. When much destruction with excavation of the lung has taken place, a considerable opening up of the lung is usually neither desirable nor often found.

Other figures giving the end-results of pneumothorax treatment can be found in a recent paper by Dr. R. C. Matson and others in *Tubercle* for October, 1925, and in Dr. Gravesen's *Surgical Treatment of Pulmonary Tuberculosis*, 1925, Table I (p. 52). These statistics show from 30 to 40 per cent. of cures.

THE NATURE AND USES OF REFRACTOMETRIC AND VISCOSIMETRIC TESTS.

BY

CHARLES A. H. FRANKLIN, M.D., B.S.,
M.R.C.S., L.R.C.P.

DURING the last twenty-five years a great amount of work has been done on viscosity of the blood and serum, most of it since the introduction in 1906 of Hess's viscosimeter. In clinical work, it is the *relative viscosity* which is measured (of blood, serum, oedema fluid, etc.), compared with distilled water. Refractometry gives us the protein content of serum, oedema fluid, etc.—that is, the degree of concentration of the protein.

Viscosity plays an important part in the circulation. That the blood pressure itself is dependent upon the state of the heart and the vessel walls has long been recognized, but it is only recently that the part played by viscosity has received attention, and its importance in pathological conditions has been realized. Allbutt recognized this in his review in 1911,¹ the viscosity of the blood increasing the heart work many times, compared with what it would be if it were water.

Viscosity is a property of the blood, and is subject to variations, slight daily, marked in pathological conditions. The blood carries cells in suspension, salts in solution, and a viscous protein. Viscosimetry and refractometry help to throw light upon the changes in the tissues and the alterations in the water content of the blood in varying conditions.

Viscosity in relation to work becomes an important factor in circulatory and cardiac disturbances. A blood examination cannot be considered complete without a viscosimetric-refractometric examination being undertaken. The value of determining the viscosity has been well summarized by Bircher,⁷ as threefold:

"1. In circulatory questions, viscosity should be considered. Red cells and viscosity are the two opposite factors which have a determining influence on the effect of heart work.

"2. The viscosimetric factor is an excellent check of the normal blood test, because it depends on the different constituents of the blood. It is a delicate indicator for changes in their relation, and on this fact is based some valuable diagnostic information.

"3. The viscosity is an accurate means of analysing the constituents of the blood; the quantity and quality of protein in

plasma may be studied as well as the exact volume of the cellular elements. On these determinations are based the diagnostic applications supported by Naegeli."

Instruments.

The viscosimeter of W. R. Hess of Zürich is used, which is not only very simple and reliable, but the only one which fulfils all the necessary conditions; it is based on the law of Poiseuille, according to which fluids at equal temperature and pressure, passing through capillary tubes of equal calibre, vary in their rate of flow in direct proportion to their internal friction—that is, to their viscosity. The clinical model shown in the diagram is the most generally useful, being compact and portable.

Method.

Only one drop of blood is required, obtained from a stab in the finger after immersing the hand in a basin of warm water for two to three minutes. The blood is collected in a short length of narrow glass tubing, E, specially supplied, which is at once brought into opposition with the end of the blood capillary tube K₂; the tube E is held in position by being pressed into a spring clip F. By means of a bulb the blood is immediately sucked up to the 0 mark. The tap H is now opened and both water and blood columns are drawn along until the blood in tube K₂ reaches the 1 mark. After reading the point reached by the column of water the blood is expelled, and the tap is turned off as soon as the water has been driven back to zero. The blood tube, K₂, is at once cleaned by sucking in and expelling ammonia, water, alcohol, and ether in succession. Although the method is not by any means free from errors, it is sufficiently accurate for clinical purposes.

Blood is then collected in a U-tube, each limb 4 inches long, no pressure being made on the finger; this is centrifuged, and when the supernatant serum is clear one limb is cut off just above the blood clot and the viscosity of the serum is measured, the other being retained for refractometric examination. (A full description of the viscosimeter is given in Bircher's review,⁷ and of the refractometer in the booklet supplied by the makers.) The refractometer of Pulfrich (Zeiss's dipping refractometer) is used, which gives the angle of refraction of the fluid; this reading is converted into grams of protein per cent. by means of E. Reiss's table.

The viscosity of the blood depends upon:

1. The mass (whole volume) of the cells. An increase raises the viscosity, and a fall in number lowers it, but the viscosity is not directly proportional. (Du Pré Denning and Watson,¹⁴ Münzer,¹⁸ Bence.⁵)
2. The haemoglobin content. (Lisbonne and Margat.¹⁶)
3. The number of

the white cells per cubic millimetre. The viscosity is increased in leukaemia, the white cells conducting more, in proportion, to the viscosity than do the reds. (Determann,¹³ Rotky.²²)

4. The carbon dioxide content. The viscosity is raised in cyanosis; venous blood is more viscous than arterial, and oxidation lowers viscosity. (Koranyi and Bence,⁶ Adam,³ Determann,¹² Austrian.⁴)

5. The protein content. Dehydration increases the viscosity, and hydraemia lowers the viscosity. After a severe haemorrhage by the rectum I have observed it to fall from 4.0 to 1.75. (Nicator-Ferro,¹⁹ Lommel.¹⁷)

6. The salt and urea contents—of small influence. (Bottazzi.¹¹)

The average viscosity of the whole blood may be taken as 4.3 to 5.3 in men, 3.9 to 4.9 in women, and of serum as 1.7 to 2.0 in both (Naegeli). The viscosity of the serum depends chiefly upon the protein content.

Considerations of space make it impossible to enter into

The essential part of the apparatus consists of two capillary tubes, K₁, K₂, connected to a single aspirator S, Gb; by the aid of a strong rubber bulb, Gb, distilled water and blood (or serum) are simultaneously drawn through the two capillary tubes K₁, K₂, respectively. If the blood is sucked up tube K₂ from 0 to 1 the column of water reaches a point in the graduated tube K₁, which indicates directly how much further the water has flown in the same time and under the same conditions. The reading is then taken at the point which the water has reached, say 4.3; this reading is the viscosity of the blood. No correction need be made for temperature between 17° and 23° C.