

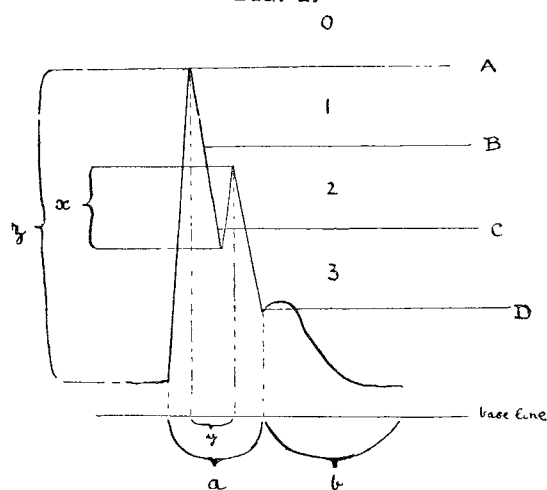
THE PULSE IN AORTIC DISEASE; THE RELATION OF PULSE CURVES TO BLOOD PRESSURE.

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An analysis of the pulse curves of 20 cases of aortic regurgitation.—Careful notes were taken of 20 cases of aortic insufficiency. The cases were not selected, but were taken in rotation as they were admitted to hospital. They were examined and the pulse tracings were taken in the majority of cases within two days of admission, when the patients were settled, but before they were under the influence of drugs other than diuretics and purgatives. Most of the physical signs were checked by competent observers; the blood pressures given are average pressures of six or more observations taken for the most part between the hours of 10 A.M. and 12 noon, and at the same time as the tracings. The figures of the pulse analysis are the result of careful measurements and are each an average of five or more analyses from one or more tracings from each radial artery. The chief clinical features are given on the left of the accompanying table. It will be seen that in the majority of the cases they were those of considerable aortic incompetence, that two cases associated had mitral stenosis, and that ten others had mitral regurgitation to a lesser or greater extent. Cases presenting marked signs of aortic stenosis do not occur in the list. Some, no doubt, had a certain degree of stenosis but in no case did the physical signs indicate that it was a prominent feature of the case. Post-mortem examinations were obtained in Cases 6 and 17. Certain lettering and figuring in the table require explanation. Under "sclerosis of arteries," the signs, 0, S, S+, and S++, indicate normal, slightly sclerosed, sclerosed, and extremely sclerosed vessels respectively. Under "pulsus bisferiens" + signifies its recognition by palpation, ⊙ indicates its presence in marked degree. Under the instrumental analysis the description is divided into systolic and diastolic phases. Referring to Fig. 1, the intervals *a* and

FIG. 1.



b are the lengths of systolic and diastolic phases respectively. The "depth of the first notch," *x*, is given in its relation to the height of the primary wave *z*. The "second peak position" is given in the table, according to the position of its apex in relation to the equidistant lines A, B, C, and D, where A is drawn through the apex of the primary wave and D through the bottom of the diastolic notch. In the figure given it falls in the position 2. When the apex falls in the position 0 the pulse is anacrotic. When it falls on one of the lines A, B, C, or D it is indicated thus, $\frac{1}{2}$ or $\frac{2}{3}$. The distance separating primary and first secondary wave is given as the distance *y*, in seconds.

The chief points of interest in the table are as follows: 1. 14 cases, of an average age 36.8 years, showed an average systolic blood pressure of 132 mm. Hg (cp. Janeway, p. 195). These were cases unassociated with signs of granular kidney.

2. Four cases, with signs of chronic interstitial nephritis and of average age 46 years, showed an average systolic blood pressure of 163 mm. Hg (cp. Janeway, pp. 195 and 169). 3. There was no definite relationship between the height of blood pressure and the amount of arterio-sclerosis (cp. Janeway, p. 185). 4. There was no relationship between the height of blood pressure and the state of compensation (cp. Janeway, p. 199). 5. There were, as would be expected, definite relationships between the amount of sclerosis and the age of the individual and etiology of the case. (Rr = recent rheumatism, So = syphilis of old standing.) 6. With careful palpation a pulsus bisferiens was palpable in 13 cases out of 20, and easily palpable in three cases. It was not palpable where the interval between primary and first secondary waves was less than one-tenth of a second, and not palpable when this interval exceeded one tenth of a second, if the depth of the first notch was limited. 7. There was a definite relationship between the height of the first secondary wave and the amount of arterio-sclerosis. The greater the sclerosis the higher the wave. There was no relationship between the height of the wave and the height of blood pressure and state of compensation. (When the wave occupied position 0 or 1 the pulse felt flat topped; when it occupied position 3 it felt collapsing.) 8. As a rule, though not invariably, the better the compensation the closer were the primary and first secondary wave, and the more shallow was the bisferiens notch (cp. Steell). 9. The average duration of systole¹ was 0.38 second, the average duration of diastole was 0.48 second; there was no definite relationship between the two and the relationship was of no prognostic significance (cp. Chapman and Allbutt). 10. A diastolic notch was present in all cases; in nine cases it appeared normal, in six cases exaggerated, in five cases diminished. In height it showed no definite relationship to the amount of regurgitation (Case 17 in particular), to the height of blood pressure, to the amount of arterio-sclerosis, or the degree of compensation. Neither did it demonstrate any relation to the length of systole, but there was some relation between it and the depth of the bisferiens notch, though this was not constant. 11. In 18 out of 20 cases the two pulse tracings were identical. Of the remaining two, one (Case 6) showed a more prominent pulsus bisferiens on the left side; the other (Case 15) showed it more prominently on the right.² 12. One case out of 20 showed an anacrotic pulse (Case 2), but only on admission, and on admission compensation was poor; the patient's age was 68 years and he presented signs of extreme arterio-sclerosis and granular kidney.

Types of pulse curves in aortic disease.—The types of tracing met with in aortic stenosis have been fully discussed by many writers, notably by Marey, Mahomed, and Steell. Originally anacrotism was considered to be pathognomonic of the condition; later this type was found in association with numerous other conditions. The pulsus bisferiens was also found in stenotic cases. More observations led to the conclusion that neither type is pathognomonic, for both may be found apart from stenosis (cp. Steell, &c.). The more recent observers associate anacrotism, combined with low blood pressure, with marked stenosis, and this combination has been confirmed in these investigations by two cases in which the signs were definite; the blood pressures were 110 and 115 respectively.

Sansom describes three types of curve met with in cases of regurgitation: (1) curves with large amplitude of upstroke, usually having the diastolic small and situated low down; (2) anacrotic types, associated with stenosis or renal disease; and (3) normal tracings. The second, he states, is of unfavourable prognostic significance, the third of good. It is impossible to divide, and indeed it appears inadvisable to attempt to divide, the types into classes. Every intermediate type exists and every combination of them. It seems better to describe the main features of these curves and the conclusions which can be drawn from them. In a paper by Galabin on the "water-hammer" pulse emphasis

¹ It must not be forgotten that this figure does not include the pre-sphygmic interval (cp. Keyt).

² W. Broadbent attempted to show that these differences on the two sides are due to the arrangement of the aorta and its branches; in his experience the pulsus bisferiens is generally more marked on the one side. This is not the experience of other writers. Morison attributes the difference to a difference in longitudinal tension in the vessel investigated, due to the position of the limb. The view is not confirmed by these investigations, though it is true that the pulsus bisferiens is better marked with the wrist extended. (Cp. Lewis, Practitioner, 1906.)

CLINICAL FEATURES.

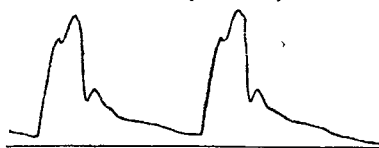
Case.	Sex and age.	Etiology.	H.A.B.			Epigastric pulsation.	Sclerosis of arteries.	Kidneys.	Blood pressure.	Aortic signs.					Mitral murmurs.	Compensation.	Pulse.										
			Rib space.	Inches from mid line.	Character.					Basal murmurs.	Second sound.	Duroisiez murmur.	Thrill.	Aneurysm.			Palpation.	Arterial systole.	Arterial diastole.	Difference in right and left pulse.							
																					Water-hammer.	Pulsus bisferiens.					
Upstroke, sudden or normal.	Second peak position, 0, 1, 2, 3.	Distance between first and second wave in seconds.	Depth of first notch.	Length of systole in seconds.	Length of diastole in seconds.	Amount of diastole.	Pulsus bisferiens more marked on right side. Identical.																				
1	F., 64	?	6	5½	Heaving.	+		S+	Nil.	135	D.	0	0	0	+	Nil.	Good.	+	+	S	1	0.14	1/8	0.46	0.48	N	Identical.
2	M., 68	So	5	5½	Forcible.	+		S++	Alb. Poly. U	150	S.D.	0	+	Cap. pulse.	0	S slight.	Fair.	+	+	S	(0 on admission)	0.14	1/5	0.46	1.2	N	"
3	M., 29	S & R	5	3	Indistinct.	+		S	Nil.	130	S.D.	0	+	Cap. pulse.	0	S	Poor.	+	+	S	2	0.14	1/10	0.42	0.33	-	"
4	M., 40	So ?	6	6	Wavy.		S+	Alb. Poly. U.	165	S.D.	0	0	0	0	Nil.	"			S	2	0.18	1.5	0.41	0.41	N	"	
5	F., 26	Rr	5	6	Forcible.	+	S	Nil.	130	S.D.	0	+	Cap. pulse.	0	S	"			S	2.3	0.18	1/6	0.42	0.48	+	"	
6	M., 36	Strain ?	5-7	6	Wavy but strong.	+	S+	"	130	D.	0	+	Cap. pulse.	0	S	Bad.			S	L. 1, R. 2	0.24	1.3	0.42	0.33	+	Pulsus bisferiens more marked on left side.	
7	M., 57	So	5	4½	Heaving.	+	S++	"	135	S.D.	Present.	+	Cap. pulse.	0	Nil.	Good.			S	1	0.14	1/15	0.33	0.52	N	Identical.	
8	M., 50	So	8	6½	"	+	S+	"	140	S.D.	0	+	Cap. pulse.	0	S	Poor.			S	½	0.09	1/8	0.18	0.29	-	"	
9	M., 51	Ro	6	4	"	0	S+	?	?	S.D.	0	+	Cap. pulse.	0	Nil.	Fair.			S	1	0.09	1/8	0.24	0.52	N	"	
10	M., 51	S & Ro	6-7	6	Forcible	+	S+	Alb. Poly. U.	180	S.D.	0	+	Cap. pulse.	0	S slight.	Poor.			S	1	0.14	1/10	0.52	0.58	Very slight	"	
11	F., 11	Rr	7	6	Heaving.	+	0	Nil.	130	S.D.	0	0	Cap. pulse.	0	D. & S.	Good.			S	3	0.14	1/10	0.37	0.33	N	"	
12	M., 21	Rr	6	6	Feeble.	0	0	"	130	S.D.	0	+	Cap. pulse.	0	S	Poor.			S	3	0.18	1.5	0.38	0.46	N	"	
13	M., 50	Ro	4-7	7	Wavy.	+	S	"	135	S.D.	0	+	Cap. pulse.	0	D. & S.	"			S	2	0.14	1.5	0.37	0.46	+	"	
14	M., 26	So	6-7	5	Forcible.	+	S+	Alb. Poly. U.	160	S.D.	0	0	Cap. pulse.	0	S	Fair.			S	2.	0.14	1/10	0.42	0.62	-	"	
15	M., 48	? injury.	5	4	Heaving	+	S+	?	?	S.D.	0	0	Cap. pulse.	0	S	"			S	2	0.14	1/5	0.36	0.33	+	Pulsus bisferiens more marked on right side.	
16	M., 28	?	5	4	Heaving	0	S	Nil.	130	S.D.	Present.	0	Cap. pulse.	0	Nil.	"			N	2	0.14	1/6	0.37	0.46	+	Identical.	
17	F., 37	R Malignant.	5	4½	Feeble.	0	S	"	140	S.D.	0	0	Cap. pulse.	0	"	Bad.			S	2	0.18	1/6	0.37	0.42	+	"	
18	M., 14	R	5	4	Heaving.	0	0	"	115	S.D.	0	0	Cap. pulse.	0	S. & (?) D.	Good.			S	3	0.14	1/10	0.38	0.24	N	"	
19	M., 61	Ro	7	6	"	+	S	"	140	S.D.	0	0	Cap. pulse.	0	Nil.	Fair.			S	2	0.14	1/4	0.42	0.62	N	"	
20	M., 30	Ro	6	5	"	0	S	"	130	S.D.	0	0	Cap. pulse.	0	S slight.	Good.			S	3	0.09	1/20	0.36	0.58	-	"	

REMARKS.

CASE 2.—Pulse anacrotic on admission; lost this character in two days.
CASE 4.—Some doubt as to condition of this man's kidneys.
CASE 5.—? Mitral stenosis also.
CASE 6.—Post mortem heart weighed 32 ounces; aorta dilated; muscle substance firm; aorta, chiefly regurg.
CASE 8.—Died shortly after leaving hospital. No necropsy.
CASE 17.—Necropsy. Malignant endocarditis. No trace of aortic valves. Heart weighed 18 ounces.
CASE 18.—? Mitral stenosis also.

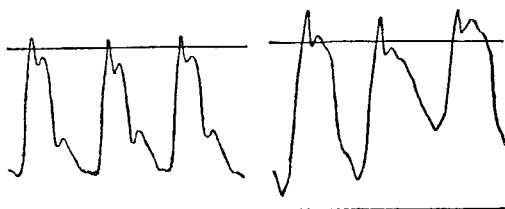
was laid on the abrupt primary upstroke (cp. Corrigan). It was shown by him that this feature is the most constant in curves of aortic incompetence and it is referred to by all writers. The abruptness of the upstroke is due to the sudden change from a low diastolic to a high systolic pressure, but it is probable that this character is present in many other conditions, notably high tension of cardiac origin with rapid outflow. Anacrotism has been mentioned already; apart from stenosis it is not commonly met with in aortic disease. In the one case (No. 2) of the 20 tabulated it was only temporary and associated with poor compensation, high blood pressure, and granular kidney (Fig. 2). It was also a

FIG. 2 (CASE 2).



feature in the tracings of Case 13 on his second admission, but was present for one day only. The evidence is consequently in support of Sansom's view that it is a sign of failing compensation and has a bad prognostic significance. The height of the first secondary wave has been shown to depend on the condition of the vessel wall. For this reason the anacrotic type should be found where sclerosis is marked (as in Case 2). Four tracings (Figs. 2, 3, 6, and 8) are given,

FIG. 3 (CASE 1).



illustrating the height of the second wave, and two others (Figs. 5 and 7) illustrating varying depth of the bisferiens notch. Tracings shown in Figs. 5 and 8 are from the same patient; the type shown in Fig. 5 remained for two days only, during which period the patient showed some heart irregularity.

In Fig. 3 a tracing from a thoracic aneurysm (of Case 1) is given (to the right); that to the left is from the radial. The change in the type of pulse during transmission is very slight. In Fig. 4 (Case 2) a very flat-topped type is shown, with the corresponding cardiogram to the right; the change in type during transmission is in this case remarkably small. Pulses of this type never feel collapsing to the finger, though they may be empty between the beats. A collapsing water-hammer pulse is shown in Fig. 8.

In the 20 cases referred to a somewhat inconstant relationship was found between the length of interval between the first and second waves and the prognosis. From these

FIG. 4 (CASE 2).

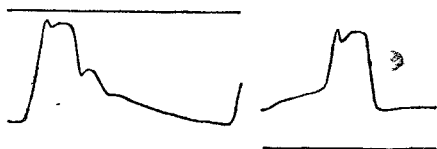


FIG. 5 (CASE 12).

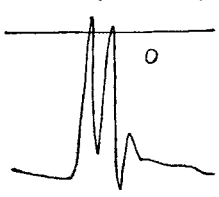


FIG. 6.



20 cases and numerous other cases investigated I am inclined to associate the length of this interval with dilatation of the heart; it has never been found of any great length, except in patients with very large hearts (Fig. 7 is from Case 6 and Fig. 5 from Case 12.) As a rule, it is associated with depth of the bisferiens notch but by no means invariably (Fig. 8).

The subject will be referred to later at greater length. The prominence of the dicrotic in the 20 cases investigated is not in accord with the views of earlier writers (cp. Broadbent, Steell, Mahomed, &c.). A partial explanation of this may be due to the fact that the tracings upon which these observations were made were taken at light pressures, for a heavy pressure tends to obliterate the dicrotic or to place it low in the tracing in these cases. It is probable that the dicrotic is present to a normal extent in most aortic cases and it would appear, contrary to the opinion of most writers, that it is of little value

FIG. 7 (CASE 6).

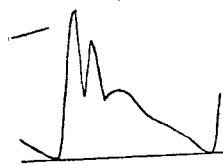
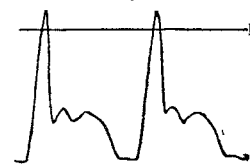


FIG. 8 (CASE 12).



in estimating the amount of the regurgitation or the nature of the aortic lesions. That dicrotism depends to some extent on rebound from the aortic valves may be admitted, but, as has been pointed out by Sanderson, Sansom, Galabin, and others, it may be marked where there is free regurgitation (cp. Lewis, *Journal of Physiology* 1906). If further proof of this is required it is to be found in Fig. 10. The dicrotic is well marked, yet post mortem no trace of aortic valves could be found; the case (No. 17) was one of malignant endocarditis. It has been suggested by Galabin that the rebound may in these cases take place from the blood entering the ventricle from the auricle. This is possible, but given a negative pressure in the ventricle during diastole it is somewhat difficult to realise. Moreover, a greater delay might be expected in its appearance at the wrist. By the side of this tracing is another (Fig. 9), showing a feeble dicrotic in a case (No. 10) of free regurgitation.

FIG. 9 (CASE 10).

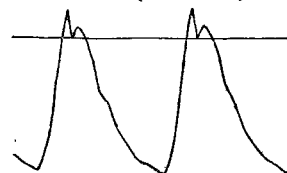


FIG. 10 (CASE 17).

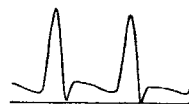


The relation of the height of the first secondary wave to the height of blood pressure.—The difficulty of estimating the height of systolic blood pressure by palpation has only recently been recognised, with the advent of the later and more accurate instruments devised for this purpose.³ Many prominent writers on the subject of pulse tracings, notably Mahomed, insisted that there is a definite relationship between the height of the first secondary wave and the blood pressure; he estimated it by drawing a line from the apex of the primary wave to the base of the dicrotic notch. He stated that if the first secondary wave was raised above this line abnormal arterial tension was indicated. The methods employed for estimating tension

FIG. 12.



FIG. 11.



Left pulse, B.P. 160.

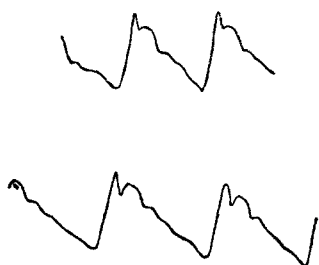
A, Cardiogram. B, Left pulse, B.P. 115.

were palpation and the pressure of the sphygmograph pad necessary to obliterate the pulse tracing. Inaccurate method never led to a greater error; it will suffice if a few tracings are given. The first (Fig. 12) a flat-topped pulse in a patient with systolic blood pressure of 115 mm. Hg, and another (Fig. 11) a collapsing pulse from a patient with a systolic pressure of 160 mm. Hg. They are examples

³ The instruments used in these investigations have been the Dudgeon sphygmograph and C. J. Martin's modified Riva-Rocci sphygmomanometer.

of over 20 observations on each of these patients. In the table of aortic cases there is evidence to show this absence of relation, and evidence showing the presence of a relation between arterio-sclerosis and the height of the secondary wave. The patient whose tracing is shown in Fig. 11 suffered from chronic emphysema and presented little arterio-sclerosis. The subject of the tracing in Fig. 12 had marked sclerosis. The want of relation between arterial disease and high blood pressure has already been referred to. The general fall of the writing style from the apex of the pulse curve depends on two factors—the condition of the arterial wall and the rate of outflow. The two

FIG. 13.



tracings shown in Fig. 13 were taken from cases of generalised arterio-sclerosis, the first with a blood pressure of 130 millimetres, the second associated with granular kidney and a pressure of 250 millimetres—yet the two tracings are practically identical.

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Taff's Well, Cardiff.

THE RASH IN CEREBRO-SPINAL MENINGITIS.

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IN only a few of the numerous cases of the above disease which have occurred in Glasgow since the first quarter of the year has a rash appeared. This is in accordance with the reports of similar epidemics from various quarters in Britain. Herpes has been noticed in several and is usually situated at the angles of the mouth. But it is in regard to those cases in which a definite rash has appeared on the body before death that I desire to call attention. In two a decided purpuric rash, purple in colour and hæmorrhagic in character as spots, with well-demarcated edges, varying in size from a pin head to rather smaller than a lentil, were seen closely packed on the dorsum of the feet and nowhere else on the body. In another in which death took place within 16 hours from the time of onset (the first symptom being that of delirium, the child waking at 4 A.M. in this condition) a well-marked punctate hæmorrhagic rash, each spot singly of the size of a pin head, and in places in clusters of six or seven, was seen scattered all over the trunk and limbs. In another in which death took place after 24 days' illness a rash appeared on the seventh day and from the subsequent history evidently came in crops. On examination on the twenty-first day of the illness, purple and maroon spots, circular, with regular edges all the same size—i.e., that of a lentil—were seen on the dorsum of the feet, on the arms, the legs, the trunk (back and front), four below the chin, and one behind each ear. They were scattered over the body with areas of three to four inches of normal skin between each. These spots were definitely hæmorrhagic in character and so well defined as to be seen from a considerable distance, the picture presenting quite the aspect of "spotted fever." A cluster of 15 maroon spots

occupied the interscapular space and appeared on the previous day. On visiting the case the following day those spots previously maroon had changed to purple, were still of the same size, circular with regular edges, but now quite purple. Next day—i.e., the twenty-third day of the illness—they had almost disappeared and fresh maroon ones were seen in other situations. Larger pale-blue blotches with irregular edges fading into the surrounding tissues, 16 in number, were also noticed on the trunk and limbs. They occupied the cutis vera, normal skin could be seen distinctly over them, and at no time was any alteration in their colour, appearance, or position noted.

Glasgow.

A NEW METHOD OF ADMINISTERING AN ANÆSTHETIC THROUGH A TRACHEOTOMY TUBE.

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THOSE of us who are called upon to administer an anæsthetic to a patient through a tracheotomy tube, whether the operation be for laryngotomy, thyrotomy, or other operation requiring a preliminary tracheotomy, have usually adopted one or other of the following methods—namely, a small catheter attached to a Junker's apparatus, a flexible tube and funnel (Hahn's), or a Skinner's mask held over the tracheotomy tube at a suitable distance. The objection to the first two methods is that they tend more or less to obstruct the already diminished air-way, which is one of the great difficulties in the way of administering an anæsthetic in these cases. The presence of a tracheotomy tube in the trachea is already a narrowing of the passage; if anything further, as a catheter, be introduced into this it means a further narrowing; or should respiration be carried on through a long tube the case is even worse—and add to this the deleterious effect of chloroform on respiration and the danger to the patient becomes enormously increased. With regard to the Skinner's mask, the size of the thing itself and the hand of the anæsthetist, taken in conjunction with the smallness of the field for operation, must hamper the movements of the surgeon considerably. Even in the Trendelenburg position the gain in room is not sufficient entirely to counteract these objections. With respect to charging up a patient with chloroform in these cases, to my mind it is a practice to be condemned as fraught with much danger; besides, the patient keeps coming round, often at inconvenient times for the surgeon. With a view to overcoming these difficulties I have had an instrument made for me by Messrs. Hockin, Wilson, and Co. The total length of the instrument is about 15 inches and it is composed of a handle, F G, and a long arm, F E D C B to A. The latter is of flexible

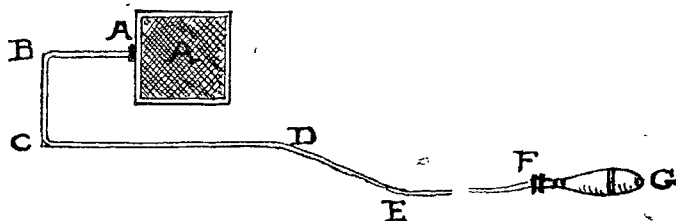


Diagram of Inhaler.

metal from D to A and is bent as illustrated. A is a one and a half inches square frame, which is to be covered with lint held in position by a safety-pin or stitching.

To use the instrument a piece of lint or similar material is stretched across the square A so as to cover it above and below and held in place by means of a safety-pin. Chloroform or C.E. is sprinkled on this from a drop-bottle and the part B C is rested on the sternum of the patient, so that A is above the tracheotomy tube. The limb C D to E is so bent as to bring the point E well down towards the operation table out of the way of the surgeon; E F gradually sloping up and bringing G to about the level of the patient's ear. The length of the instrument enables the anæsthetist to stand well back while using it. The square A