

TACHYCARDIA:

OBSERVATIONS UPON ITS OCCURRENCE IN THE ENTERIC AND OTHER FEVERS.

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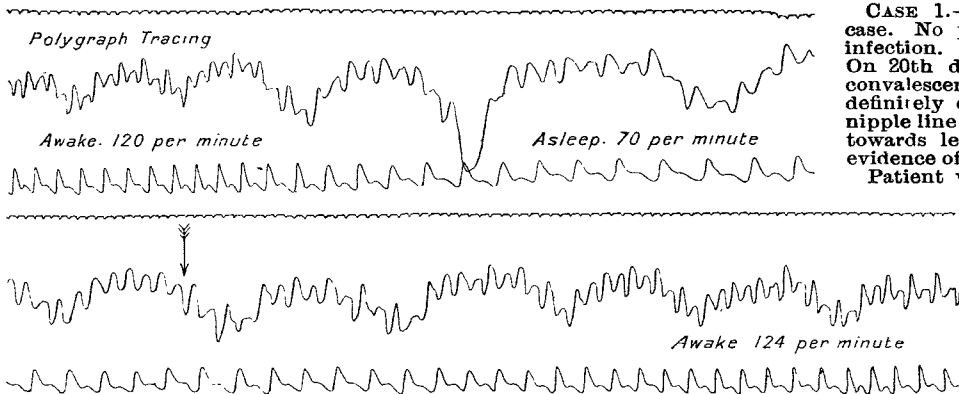
TACHYCARDIA occurring during the convalescence from the enteric fevers falls into three classes; each of these can be readily recognised by bedside observation, and thus appropriately treated.

During the last two years I have examined a large number of cases belonging to the enteric group of fevers, in many cases paying special attention to the heart-rate. The majority of these cases was characterised during the febrile period by a relatively slow heart-rate; some developed tachycardia *gradually* during convalescence, a few *abruptly*, whilst the minority were conspicuous by the presence of rapid heart action *throughout the disease*.

Scope of Investigation.

With a view to determining the nature of the tachycardia present the usual signs and symptoms of heart failure were

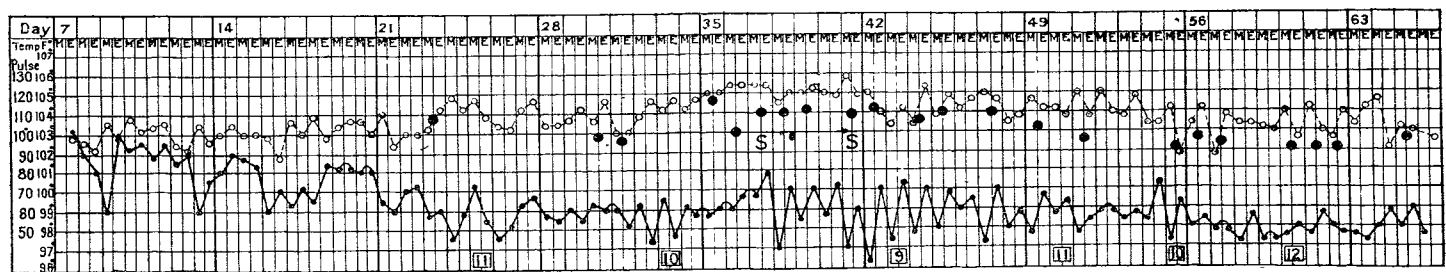
CASE 1.—Polygraph Record Awake and Asleep.



frequently sought for, the cardio-vascular system was repeatedly examined, and in addition further observations were made which appear to throw light upon this problem. These further observations will now be described, and the reasons given which led to their application. Briefly they are: the sleeping pulse-rate, arrest of respiration, localisation of apex beat of heart, and effect of posture upon heart-rate.

Sleeping pulse-rate.—A case under the care of one of my colleagues had been notified as having a persistent heart-rate of between 130 and

CASE 1.—Composite Chart of Temperature, Pulse, and Respiration.



Key to Symbols. Temperature — Pulse rate ... Sleeping pulse ● S—Strophanthin gr $\frac{1}{200}$ Intravenously. Arrest of respiration in seconds eg 11

140 beats per minute after an apparently mild attack of paratyphoid. Had been kept to bed for a month after commencement of convalescence; no diminution in heart-rate.

Careful examination failed to reveal any abnormality in size, sounds, or rhythm of heart; bases of lungs clear. Attempts were made to slow heart by compression over carotid artery and by draught of cold water with view to stimulate vagus nerve, but without avail.

The polygraph tracing was continued for a considerable time, when suddenly the heart-rate was observed to drop from 120 to 70 beats a minute. Respiration likewise slowed. *The man had gone to sleep.* (See tracing of Case 1.) The tracing was continued for a considerable time; then patient was quietly awakened, tachycardia and increased rate of respiration *immediately returned*.

In consequence of this observation, all cases showing rapid heart action frequently had the pulse-rate determined when asleep, and in this paper this observation will be referred to as the "sleeping pulse." A series of observations upon healthy men of between 20 and 30 years of age with an average waking pulse of 72, showed a sleeping pulse of 65 per minute.

Arrest of respiration.—Breathlessness has long been recognised as evidence of cardiac weakness, when such causes as morbid blood states and physical conditions or diseases of the lungs themselves have been excluded.

With a view to measuring breathlessness of patients the following method was employed. The period of time was accurately measured by the polygraph, during which the subject could suspend his respiration, beginning at end of quiet *expiration* and ending with next *inspiration*. This observation will be referred to as "*Arrest of Respiration*." Similar observations upon healthy controls showed this period to vary between 20 and 80 seconds.

Localisation of apex beat of heart.—The frequent difficulty in localising the apex beat of the heart in cases of the enteric group was quickly realised, and this observation will be fully dealt with in Case 3.

Effect of posture.—The effect of posture upon heart-rate was studied likewise the effects of a tight abdominal binder upon heart-rate, when in upright position. In health the assumption of the upright position usually causes a 10 per cent. increase in rate above that of recumbent position.

Description and Discussion of Cases.

Four types of cases showing tachycardia, upon which these observations have been made repeatedly, will now shortly be described and then discussed. In Case 1 the tachycardia is observed to arise in a permanently damaged heart; in Case 2 the tachycardia remains only while the heart is poisoned; in Cases 3 and 4 the tachycardia will be seen to be secondary to other causes.

Tachycardia Cardiac in Origin.

CASE 1.—True typhoid (*B. typhosus* in urine). Severe case. No previous history of cardiac disease or rheumatic infection. Rapid heart action was noted throughout disease. On 20th day soft mitral systolic bruit was first heard; as convalescence was established area of cardiac dullness was definitely enlarged. Apex beat in 5th space 1 inch beyond nipple line; bruit became more marked and was propagated towards left axilla. Examination of lungs invariably gave evidence of oedema, more marked at left base.

Patient was discharged as stretcher case on 70th day from onset of illness. Three months later I was informed he was suffering from mitral regurgitation.

The points to be noticed in this case are:—

1. Occurrence of valvular disease and of necessity a damaged myocardium in case of true typhoid.
2. Throughout illness heart-rate was observed to be rapid.
3. Pulse-rate was rapid when observed during sleep.
4. Breathlessness was always present and arrest of respiration never exceeded 12 seconds.

Comment.—In above case of valvular and myocardial disease arising in a case of typhoid fever the heart-rate was observed to be unduly rapid in waking and sleeping states throughout. The arrest of respiration is less than that observed in healthy hearts. *The tachycardia is cardiac in origin.*

This type of tachycardia is due to toxic irritation or degeneration and consequent weakness of the myocardium, which necessitates an increased heart rate in order to maintain an efficient circulation; in addition there is considerable evidence that the heart muscle has been permanently damaged by the infection.

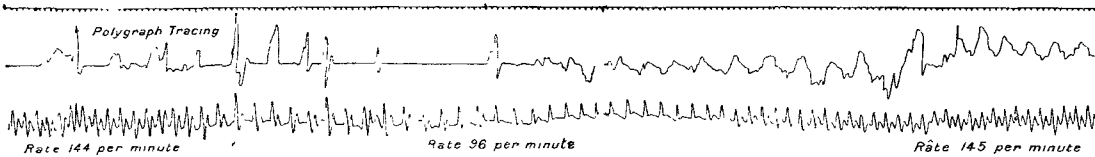
Tachycardia Toxic in Origin.

CASE 2.—Severe case of paratyphoid B (*B. paratyphosus B* in faeces). Pneumonic type, rapid heart action and rapid respiration were observed for a considerable time (4 weeks). On 15th day of illness tachycardia present might have been termed phasic as shown in polygraph tracing. A rate of 144 per minute alternated with a slower rate of 96 per minute, each phase occupying some 20 seconds. During this time patient was in critical condition, being semi-conscious for following week.

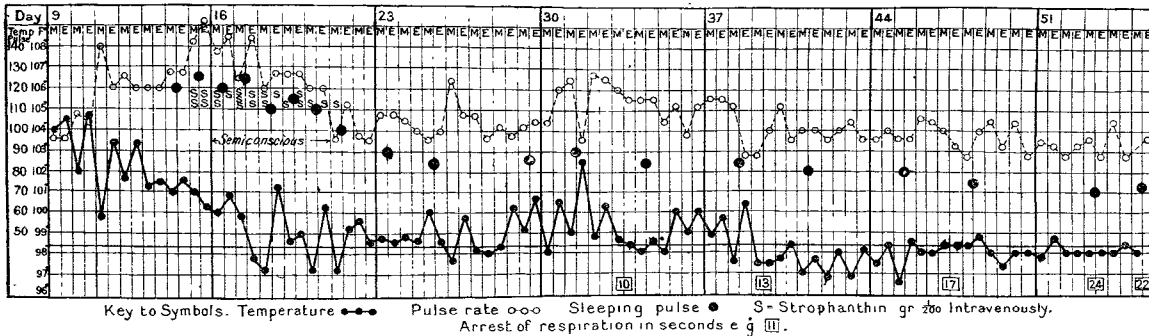
With a view to arresting the tachycardia 1/250 gr. of strophanthin was injected intravenously and within 1 hour the higher rate was obliterated, but was observed to return 3 or 4 hours later; successive injections of strophanthin were given. Invariably the higher pulse-rate disappeared for a time. (Extreme difficulty was experienced in taking records, the rhythm is uncertain.)

By 22nd day the phasic tachycardia had vanished and with return of consciousness, convalescence was speedily gained, the lung condition cleared up, and an excellent recovery ensued.

CASE 2.—Polygraph Record on Fifteenth Day of Illness.



CASE 2.—Composite Chart of Temperature, Pulse, and Respiration.



The sleeping pulse throughout illness is shown on chart. During critical period a rate of 120 a minute was frequently recorded, whereas during convalescence this had fallen to 70 per minute. The arrest of respiration increased from 10 to 24 seconds before discharge. In upright position the rate was observed to be 82 per minute.

Comment.—In the early stages the tachycardia present is observed both during waking and sleeping states. The arrest of respiration is unduly curtailed. The tachycardia is toxic in origin.

This type of tachycardia is due to the poisoning of the heart muscle by toxins generated by the infection. The action of these toxins may be either by reflexly stimulating the nervous mechanisms of the heart or by increasing the irritability of the heart muscle, which is seen to regain its normal function with the termination of the infection. As convalescence is established the heart-rate both during waking and sleeping states, also in erect posture, is that seen in healthy hearts. The cardiovascular system has completely recovered. The man was discharged quite well ten weeks from the onset of his illness.

Vaso-motor Tachycardia.

CASE 3.—Moderately severe case of paratyphoid A (bacillus isolated from blood). Polygraphic records were taken daily throughout the disease. The apex tracing was always taken from a fixed point, over fifth space and just below and internal to left nipple. A brief description of the case is as follows:—

1st day of disease: Frontal headache, languid. 2nd: Severe headache, general aches and pains. Flushed, eyes suffused, sweating, offensive breath, tongue furred, lungs clear, heart sounds clear. Pulse big volume, good tension; by evening pulse dicrotic. Polygraphic records showed a normal rhythm, positive apex beat; arrest of respiration 10 seconds in morning, only 6½ by evening. Few rose-coloured spots on abdomen. 3rd: Very ill, many spots, abdomen tender, especially over splenic area, little diarrhoea, heart sounds soft, apex beat gone. 4th: Abdomen distended, spleen felt, photophobia. 5th: Abdomen distended, systolic bruit.

6th day: Epigastric pulsation recorded, apex beat absent, diarrhoea stopped, few fine crepitations at base of left lung, systolic bruit. 7th: Pulse very dicrotic, oedema both lungs, no apex beat, systolic bruit. 8th: General improvement, abdomen less distended and tender, spots gone, spleen palpable, no apex beat. 9th: Improvement maintained, heart slow, no apex beat. 10th: Epigastric pulsation less, no apex beat. 11th: Epigastric pulsation gone, no apex beat.

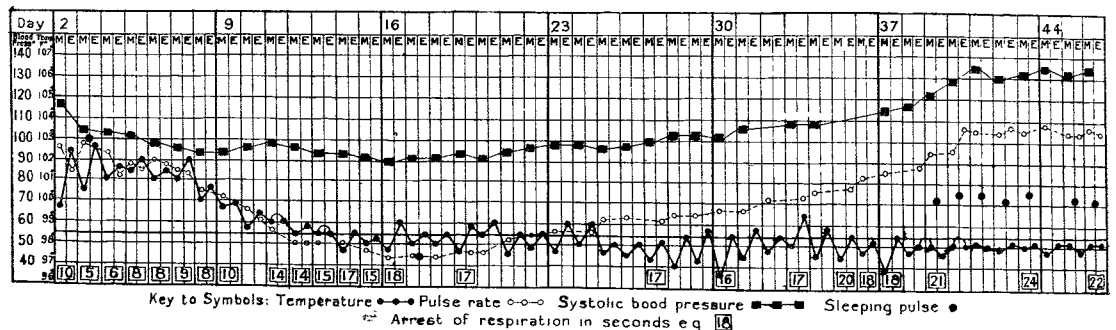
12th day: Return of apex beat, arrest of respiration 14 seconds, bradycardia, lungs quite resonant, systolic bruit gone. 13th, 14th, 15th: Rapid improvement, apex beat well marked. Convalescent. 16th-29th: Bradycardia passing off, apex beat normal. 30th-40th: Pulse-rate and blood pressure rising, sleeping pulse slow. 41st-46th: Up, "nervous," tremor, sweats, cold clammy hands, dermatographia like a D.A.H., blood pressure 130-140 mm. Hg, tachycardia absent during sleep.

47th: Discharged. Heart: Size, sounds, rhythm, normal; tachycardia when awake.

The following points were noted:—

The apex beat, which in the early days of the disease was felt and recorded in normal position, had disappeared by 5th day, and examination of heart at this time showed a faint systolic bruit at point from which apex beat had disappeared. Synchronously with this disappearance of apex beat, epigastric pulsation was observed and recorded, all signs pointing to dilatation of right heart. Towards end of second week epigastric pulsation had disappeared and synchronously

CASE 3.—Composite Chart of Temperature, Pulse, Respiration, and Blood Pressure.



with this disappearance the apex beat reappeared in normal situation, both these signs pointing to restoration of healthy tone to heart muscle.

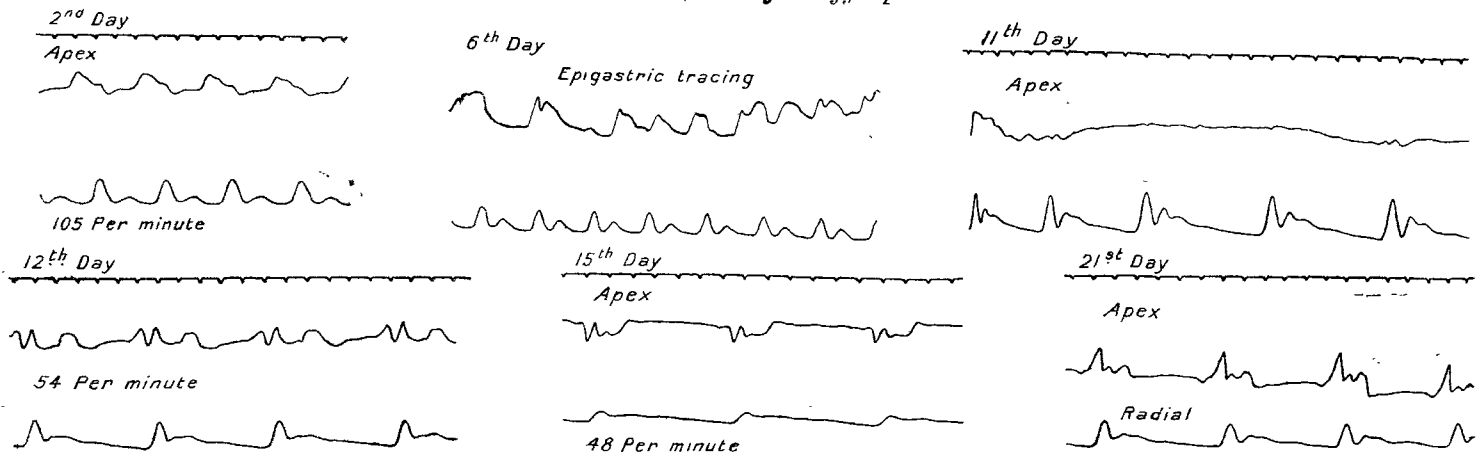
Examination of lungs during period when heart was observed to be dilated revealed signs of oedema at bases, more marked on left side.

The pulse-rate showed the usual rapid action at onset, gradually giving way to relatively slow rate so characteristic in enteric group of fevers, and as convalescence was approached, tachycardia supervening step by step. By time convalescence was established pulse-rate in erect posture was 120 to 125 per minute. The application of tight abdominal binder slightly increased rate and added to patient's discomfort. The sleeping pulse during period when tachycardia was observed is seen to be slow. The arrest of respiration at time of discharge is seen to have gradually approached the normal. By this time lungs were free from oedema.

A study of the blood-pressure curve throughout the disease shows the characteristic fall during the early stages of the disease and a return to normal by end of fifth week; later, with onset of tachycardia a height of 130 to 140 is reached.

The general condition of patient during convalescence might be described as "nervous." Generalised tremor present, sweats common,

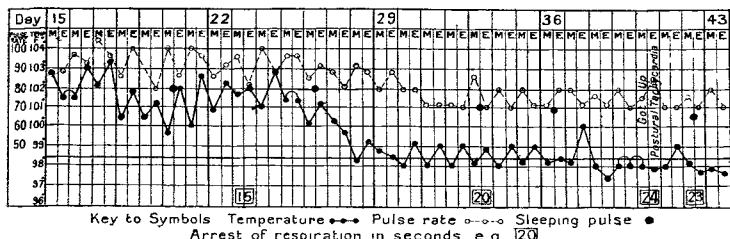
CASE 3.—A Series of Daily Polygraph Records.



extremities cold and clammy, dermatographia marked. All the signs point to a disordered vaso-motor mechanism.

Comment.—In the early stages of the disease the heart is poisoned, as shown by evidence of dilatation given above. This is especially seen in right heart, and signs of its failure were shown by oedema of lungs. All signs of this had passed away by end of second week. During convalescence heart was normal in size, sound, and rhythm. The sleeping pulse during this period was that witnessed in healthy

CASE 4.—Composite Chart of Temperature, Pulse, and Respiration.



hearts. The effect of posture upon heart-rate was not abnormal. The arrest of respiration likewise was that seen in sound folk. The tachycardia is not cardiac in origin.

The interpretation of this type of tachycardia is uncertain. The rhythm apparently originates in the normal manner. The high rate is hardly likely to be due to excitement, understood as emotion, as I have recorded this type for hours at a time without observing any change except when the patient slept. Hyperthyroidism may be ruled out, as in this condition the heart is unchanged during sleep. The phenomenon of sleep is so little understood that no explanation can be offered of the cessation of tachycardia during this condition. The tachycardia observed during convalescence is part and parcel of a condition associated with a disordered vaso-motor mechanism and may be conveniently described as vaso-motor tachycardia.

Postural or Atonic Variety of Tachycardia.

CASE 4.—Moderately severe case of paratyphoid B fever (bacillus isolated from blood), characterised by considerable abdominal distension during acute stages. Examination of heart in early days of disease showed evidence of dilatation similar to that described in Case 3. From 33rd day onwards sleeping pulse and arrest of respiration were observed to be normal, and the heart appeared to be sound in all respects. Despite this, on leaving his bed for the first time on 40th day and assuming upright position patient at once complained of feeling giddy and faint and pulse rate was observed to be 150 a minute. A tight abdominal bandage was applied and pulse-rate quickly fell to 120 per minute; patient then expressed himself as feeling more comfortable, but on releasing bandage former high rate of pulse returned, together with previous feelings of discomfort. On resuming recumbent position pulse-rate immediately fell to 90 per minute. This condition was observed to be present in a lessening degree during next three weeks, at end of which time convalescence was established and the tachycardia had vanished.

Comment.—A case of tachycardia occurring after moderately severe attack of paratyphoid fever in which a considerable amount of abdominal distension was present. The heart itself was normal in size, sound, and rhythm; pulse-rate always slow during sleep. The tachycardia was only observed when patient was in upright posture, and could be controlled by applying tight bandage to abdomen—that is, the region of body seen to be atonic during acute stages of disease. The tachycardia is not cardiac in origin.

The tachycardia may be described as the postural or atonic variety. This type of tachycardia is induced by the temporary dilatation of the great abdominal veins, leading to a depletion of the blood-supply to heart and brain. The symptoms, both subjective and objective, are materially reduced when firm support is given to the abdominal contents by a firm binder. The polygraph records give no certain evidence as to whether or not the rhythm of the heart is originated in the normal manner.¹

¹ In civilian practice I have examined a few patients wearing belts for enteroptosis, movable kidney, &c. In all some degree of tachycardia was present when the belt was removed. In addition the various subjective phenomena from which they suffered were in abeyance when wearing their belts. The question arises whether in such cases the relief of symptoms occasioned by a suitably adjusted belt is not in part due to the improvement in the circulation usually observed.

Classification of Cases.

The foregoing observations justify a classification of the tachycardias occurring during the convalescence of the enteric group of fevers into the following three groups: (1) Due to cardiac lesions; (2) postural or atonic; (3) due to general instability of the vaso-motor nervous system.

In a series of 650 cases of the enteric group of fevers tachycardia of sufficient degree to attract attention was observed in 75 cases: 5 of these were judged to be cardiac in origin, 40 were due to vaso-motor instability, 10 were of the postural variety, and the remainder presented features suggestive of Groups 2 and 3.

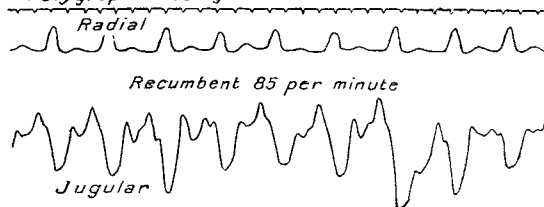
During the course of this investigation similar observations were carried out upon the cases of tachycardia occurring in other febrile disorders. In the fatal cases, such as diphtheria, cerebro-spinal meningitis, miliary tuberculosis, scarlet fever, the tachycardia was found to be of the cardiac variety. The majority of the non-fatal cases belonged to the vaso-motor group and occurred during the convalescence of such diseases as diphtheria, scarlet fever, trench fever, influenza, and pyrexias of obscure origin. A few of the postural variety were encountered in obscure febrile disorders with gastro-intestinal signs and symptoms.

Treatment.

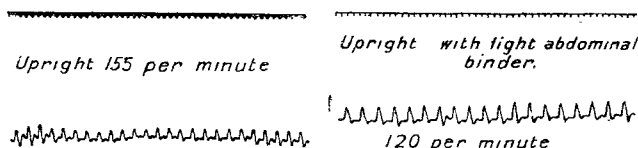
Those cases of tachycardia judged to be cardiac in origin were treated as heart cases and were transferred to England.

Case 2 can be reasonably regarded as having benefited by the use of strophanthin; a case following upon a typhoid infection, and showing what appeared to be a similar phasic character likewise responded to the drug. Out of 6 other

Polygraph Tracing



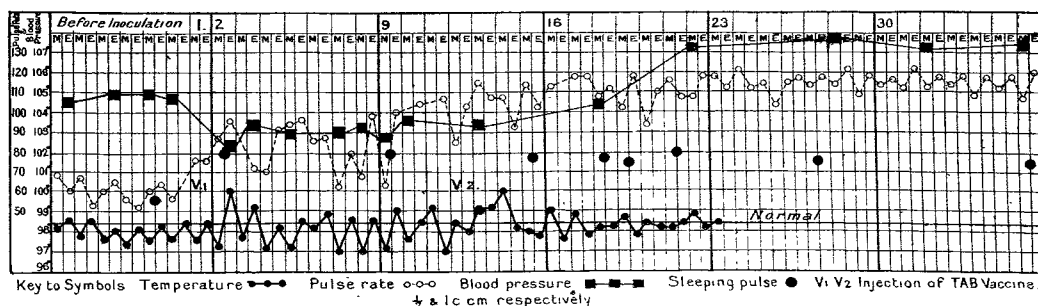
CASE 4.—Polygraph Records in Various Postures.



severe cases showing rapid heart action during the acute stages of an enteric group infection 3 responded and the heart was slowed for a time; the remaining 3 cases failed to respond and died of heart failure. In the non-typhoid cases no response was ever obtained, and so lately the drug has been abandoned.

Those cases judged to belong to the vaso-motor variety of tachycardia were not confined to bed; a gradually increasing amount of exercise, massage, and the use of ammonium bromide appeared to hasten convalescence. Those cases belonging to the postural or atonic variety were not confined to bed; a few benefited by the application of an abdominal binder. Massage and the use of tonics appeared to hasten recovery.

CASE 5.—Composite Chart of Temperature, Pulse, Respiration, and Blood Pressure.



Investigation of Cardio-vascular System after Inoculation.

Further light is thrown upon the vaso-motor variety of tachycardia by certain investigations carried out by myself upon the cardio-vascular system during the first few weeks after inoculation against the enteric fevers. Some 20 cases have been investigated, and two of these are particularly illuminating and are here described.

CASE 5.—Uninoculated man, aged 25, admitted as suspect case of typhoid. After five days' fever he was to all appearances fit and well; kept in hospital doing duty. Blood, faeces, and urine repeatedly examined; declared bacteriologically and serologically free from infection by enteric group of organisms either recently or remotely. He was then inoculated 16 days after termination of his fever.

For six days before receiving initial dose of 0.5 c.cm. of the T.A.B. vaccine he was kept to his bed, and, as seen by the chart, blood pressure, waking and sleeping pulse rates were normal. Heart

in every way sound. A severe reaction followed initial dose. The chart shows that blood pressure fell abruptly; pulse-rate rose but erratically. Eleven days later second dose of vaccine of 1 c.cm. was given. Thence onwards blood pressure curve unduly high; waking pulse-rate 110 to 120; sleeping pulse-rate normal.

By this time general condition of patient was similar to that described in Case 3—namely, tremor, sweating, clammy hands, dermatographia, and tachycardia. He was detained for a fortnight and remained much the same. The effect of exertion was then studied, and after slight effort breathlessness, palpitation, and discomfort were noted. Evacuated as case of debility.

A precisely similar series of observations was obtained in one other case of inoculation with vaccine from a different source.

The inference is that, not only active infection by organisms of enteric group, but also an emulsion of dead bacilli may give rise to a vaso-motor tachycardia. I have examined a considerable number of cases described as D.A.H., and the resemblance between these and Cases 3 and 5 is striking.

As I have shown, a similar condition of vaso-motor tachycardia has often been observed to occur after other febrile disorders, and so it appears to throw some light upon the origin of certain of these cases.

To-day all cases coming under my care showing this type of tachycardia are detained, as I believe that such a condition arising after any febrile disorder should not be regarded too lightly and returned to duty entailing the performance of arduous and sustained effort such as the conditions of active service demand. The vaso-motor mechanism must be given time to regain its normal tone, any attempt to hasten matters will only end in further prolongation of this disability.

France.

SPLINTS FOR USE IN ARM, ANKLE, AND LEG INJURIES,

WITH SOME OBSERVATIONS ON TREATMENT.

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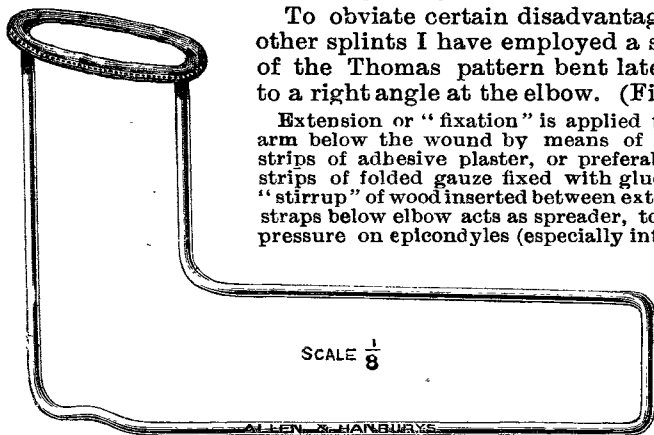
SOME apology may seem necessary for adding to the numerous splints introduced during the present war. My reason is that after an experience of over 18 months with the splints here recommended the results obtained with them are better than those from other patterns.

FIG. 1.

Right-angled Arm Splint.

To obviate certain disadvantages in other splints I have employed a splint of the Thomas pattern bent laterally to a right angle at the elbow. (Fig. 1.)

Extension or "fixation" is applied to the arm below the wound by means of lateral strips of adhesive plaster, or preferably by strips of folded gauze fixed with glue.* A "stirrups" of wood inserted between extension straps below elbow acts as spreader, to avoid pressure on epicondyles (especially internal)



Right-angled arm splint.

of humerus. In some cases extension is more convenient by a single strip applied to posterior aspect of arm below wound.

The arm and forearm (and elbow, if necessary) are supported on suitably arranged slings of flannel bandage. A taut sling is fixed beneath the hand, and on it is placed a stout roller bandage which maintains hand and fingers in best position while allowing for their gentle movements. Where the case is complicated by musculo-spiral paralysis a larger support is used to maintain fingers as well as wrist in extension. A few steadying turns of a roller bandage are passed round forearm and splint above wrist. These are dispensed with when union has begun, so that very gentle elbow movements (both active and passive) are possible without disturbing the fracture.

The splint is slung at a convenient height clear of bed and patient's body, so that dressings, &c., may be carried out without disturbance. Usually four suspension cords are employed—two from lower end, one from angle below elbow, and one from ring at upper end of splint. The cords may be fixed to suspensory framework over bed or may work over pulleys with counterpoises, so that arm and patient may be raised or lowered at will. The external bar of the splint is carried only slightly higher on the arm than the internal, and is not carried in over top of shoulder, as in Jones's splint. Consequently the degree of abduction of arm may be regulated so as to give correct alignment between upper and lower humeral fragments.

The splint is applicable, like the straight Thomas's, to both right and left arms, but it must be stocked in two, or preferably in three, sizes as regards length of upper-arm segment. Although primarily intended for fractures of humeral shaft it may also be used for many other injuries in upper limb, for example, severe flesh wounds of arm and some elbow-joint and forearm injuries.

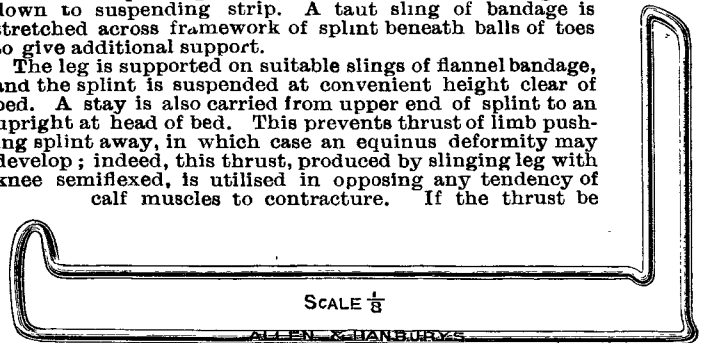
* A photographic illustration was supplied by the author and has been omitted.

Ankle and Leg Splint.

For the original idea from which I devised this splint I am indebted to my colleague, Mr. J. F. Engledue Prideaux.

The splint, of light metal framework two feet long, is shown in Fig. 2. The foot is suspended by folded strip of gauze or length of flannel bandage applied to anterior half of sole with glue. Circular turns of a bandage (see Fig. 3) are really unnecessary to fix it to foot, but if used it is well to employ cardboard (cut to suitable size) in folds of gauze under sole to prevent lateral compression in region of metatarso-phalangeal joints. The toes should not be glued down to suspending strip. A taut sling of bandage is stretched across framework of splint beneath balls of toes to give additional support.

FIG. 2.



Ankle and leg splint.

excessive and inclined to produce a calcaneus deformity it may be regulated easily by altering degree of flexion at knee or controlled by fixing upper part of leg, as is described below for cases of fracture of leg bones.

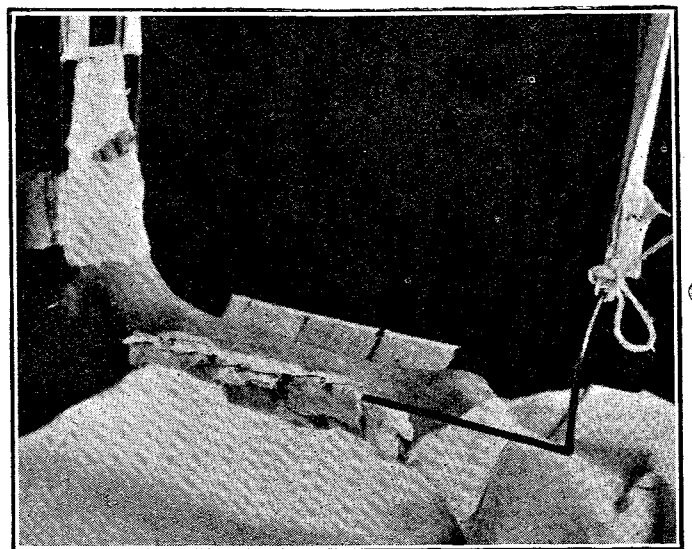
In leg fractures extension is made from ankle region to lateral bars of framework of foot-piece, and counter-extension by strips of gauze and glue applied to antero-lateral aspects of leg above wound and carried to upper end of splint, in which case the stay to head of bed is unnecessary. In practice it will be found that traction is unnecessary in many leg fractures due to gunshot injuries, as usually no tendency to overriding occurs as in ordinary oblique fractures of tibia; the "extension" and "counter-extension" straps should then merely act as "steadiers," as in fractures of humerus. In ankle injuries complicated by fractures of leg bones higher up I have employed the splint satisfactorily without any extension below.

The splint is suitable for use on any size of limb and is applicable to right and left legs alike. It may be used for wounds of the posterior tarsus and for any wound involving the calf muscles. It is much more convenient and comfortable than a Thomas or Wallace-Maybury splint in leg cases.

Both splints are readily adapted for use during transport of patient. To the arm-splint a strut or leg of malleable metal may be fixed beneath angle below elbow, the lower end of splint resting on patient's abdomen. The ankle-splint may be supported on legs fixed to upper and lower ends.

Since employing these splints I have been able to obtain better results, with much less difficulty for myself and to

FIG. 3.



Ankle and leg splint in use in case of compound fracture of ankle-joint. Wound on outer aspect, in which tendon of peroneus longus is seen exposed. Also flesh wounds beneath each sling on posterior aspect of leg, and one in upper end of popliteal space.

the greatly increased comfort of my patients. The material employed has been 1/4-inch round iron, and the splint can be made readily by any smith at very little cost. The ring at the upper end of the arm-splint may be padded and covered with leather, or it may be left uncovered altogether until required for use, when it may be suitably padded with wool and jaconet in a few minutes. Both splints may be obtained from Messrs. Allen and Hanburys, Limited, to whom I am indebted for the illustrations of the splints shown in Figs. 1 and 2.