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SPHYGMOGRAPHIC OBSERVATIONS

ON THE

PULSE OF TYPHUS.

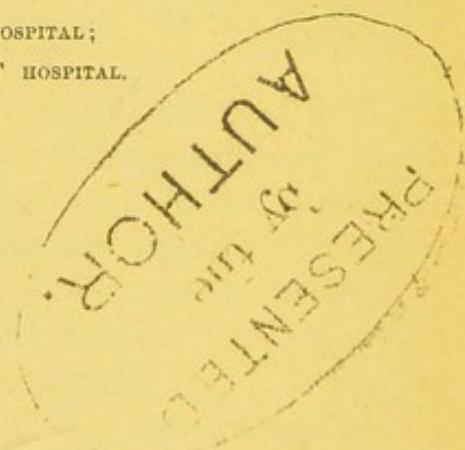
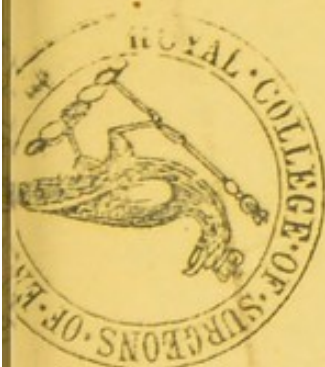
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SPHYGMOGRAPHIC OBSERVATIONS

ON THE

PULSE OF TYPHUS.

THE pulse of typhus is too familiar, and its variations too well known to the experienced physician, to require any notice from me as to its value as a means of diagnosis, or the guide it affords with regard to the treatment to be followed, especially in the administration of stimulants.

The object of this paper, however, is to draw attention to the results obtained from an extensive series of observations on the typhus pulse conducted in Cork-street Hospital, by the aid of the sphygmograph of Marey.^a

The physician now daily experiences the benefits derived from the use of instrumental aid in the formation of diagnoses, and in many cases where the information obtained by his unaided senses is quite sufficient for the formation of a correct opinion, these instruments confirm his opinion, and often show results which, although perhaps not of much immediate importance, yet are of considerable scientific value and pathological interest.

It has been with a view of comparing the sphygmograms obtained with Marey's instrument with the sensations conveyed by the pulse to the finger, and of seeing what practical and scientific knowledge may be derived therefrom, that these observations have been undertaken.

The pulse, at the commencement of typhus, is generally found to be quick, without, perhaps, any other change; weakness is then added to the quickness. The pulse is often full and bounding; but

^a *Physiologie Médicale de la Circulation du Sang.* Paris, 1863.

a full and bounding pulse is not *always* strong. As to the relation of the pulse to temperature, it will be found that the pulse becomes quicker and weaker, or full and bounding (in certain cases), and of lower tension as the temperature increases; and becomes stronger, less compressible, and frequent, and of higher tension, as the temperature falls. With respect to the eruption of typhus, the variations and state of the pulse have usually a direct connexion with the number and darkness of the spots—*i.e.*, the more numerous and dark the spots, the quicker, weaker, and of lower tension the pulse. Of course there are exceptions to these statements, but as a rule these are the conditions found.

If we look at Figs. 16 and 17, Plate II., we shall see examples of the sphygmogram of health; there may be slight variations from these forms consistent with health, but they are unimportant and easily explained by peculiar conditions of the individual. It will be seen, by taking one of the elevations of the line which represents a single beat of the pulse, that it consists of a nearly vertical up-stroke, and a longer and more oblique down-stroke, interrupted by a small rise, called the dicrotism, or second beat. The up-stroke represents the force of the ventricle in driving the blood into the arteries, diminished by the amount of resistance to its onward flow. This resistance depends upon—first, the conditions of the aortic valves, which, if healthy, will not offer much obstruction; second, the resistance in the arteries themselves, depending upon the size of the vessels, the quantity of blood contained in them, and the state of their coats; thirdly, the condition of the capillaries as to whether they are dilated or contracted. One of the chief causes which influence the condition of the capillaries is temperature, and it is of special importance to recollect this when investigating the pulse of fevers. The down-stroke represents the time occupied by the flowing away of the blood through the capillaries and veins before the second stroke of the ventricle takes place. The dicrotism is produced by the rebound of the blood from the obstructions produced by the conditions of the arteries and capillaries. It follows, therefore, that the more elastic the arteries the stronger will be the rebound and the better marked the dicrotism. This elasticity can be destroyed in two ways—either by great flaccidity of the coats of the arteries and capillaries, or by increase of tension in the former, depending upon the rigidity of the arterial walls, the fulness of the arteries, and the resistance of the capillaries. We find both these conditions developed during the course of typhus fever.

The principal changes in the form of the typhus pulse seem to depend upon the variations in arterial tension; this will be best explained by reference to Plate III. Fig. 1 may be taken to represent, diagrammatically, the pulse of typhus if the actual tension were at its lowest—so low, that there appears to be no obstruction to the onward flow of the blood. Here we find that the tension of the arteries is so much diminished before the recurrence of the stroke of the ventricle that it offers no resistance to the refilling of the vessels, and the down line of the sphygmogram falls to its lowest. If, however, the tension is increased, as in Fig. 2, which represents the amount of Fig. 1, between lines *a* and *d*, with the elevation joined by horizontal lines, the arteries having still sufficient tension to obstruct the onward flow of the blood until the occurrence of the next ventricular contraction, the first beat is, as it were, caught up by the second; Fig. 3 represents a pulse of still higher tension. A pulse similar to Fig. 1 is comparatively seldom found in typhus (Fig. 5, Plate I.; and Fig. 6, Plate II.), but the form represented in Fig. 2 may be looked upon as that characteristic of the disease during its height. These explanations are necessary as the sphygmograph has not yet come into such general use as to be familiar to the profession at large.

I have already pointed out that the characteristic pulse of typhus is (as shown by the sphygmograph) that of very low tension, with arteries reduced to the lowest state of flaccidity—and that is just what we might expect from the great weakness and high temperature of the patient during the disease. The weakness of the muscular system, as shown by the patient's loss of power, and the diminution of the first sound of the heart, of course, affects the fibres of the muscular coat of the arteries in the same way as those in other situations, thus diminishing the arterial tension. Again, the high temperature is accompanied by an increase in the calibre of the capillaries, thus also diminishing the arterial tension. In Marey's book, although a great number of pulse writings are delineated, we do not find any showing such a state of flaccidity and utter loss of arterial tension as found in the pulse of typhus. The nearest approach to this condition which Marey has delineated, is that found in puerperal fever.^a An approach to the typhus form is also delineated by him for erysipelas (*erysipele grave*), and for pyemia (*infection purulente*) after amputation. The resemblance

^a Marey—*Circulation du Sang*, p. 390, Figs. 102, 103, and 104.

between these diseases and typhus as to their adynamic conditions is well known.

In fever practice the physician may usually divide his cases into two classes, the one following a short, the other a long course to recovery. The former are the less, the latter the more severe. In making thermometric observations on typhus, it will be found that the cases may be divided into two classes: those corresponding with the cases following the short course, which attain their maximum temperature on the sixth and seventh day—and those which follow the long course, which attain their maximum on the eighth or ninth day. My attention was first directed to these two classes of cases by Dr. J. Southey Warter, in a private communication. He has since made his observations on this point public in the *St. Bartholomew's Hospital Reports*.^a I have examined all my notes of temperature, and found that they corresponded to a great extent with Dr. Warter's observations, though differing in some respects; he finds the seventh and ninth days are the periods of maximum temperature in the classes of cases I have just mentioned; whereas I should rather say the sixth and seventh for the one, and the ninth and tenth days for the other class. In fact, I find the seventh and tenth days are the common days of maxima.^b Dr. Warter also considers that the ninth day is the commonest for maximum temperature in his cases; now, in mine, I find the maximum is usually attained before the ninth day. This is what might have been expected, as I have remarked elsewhere,^c that typhus seems to run a more severe course in London than in Dublin; and as the maximum temperature occurring late in the disease corresponds (in my experience, at least) with the more severe cases, we might expect that this difference in results between Dr. Warter's observations and my own would appear, his observations having been all taken in London, and mine in Dublin.

I may also remark, when upon this interesting subject, that when typhus was less fatal in the commencement of last year (1866), the

^a Remarks on the use of the Thermometer in Acute Disease. *St. Bartholomew's Hospital Reports*, Vol. ii. London, 1866.

^b While the author was writing the above Dr. Warter was lying ill of typhus, which disease he had contracted while pursuing further his thermometric observations. In a few days he passed from this world, a martyr to medical science. His loss will be mourned by all who take an interest in the application of exact science to practical medicine.

^c Temperature of the Body in Fever. *Medical Press and Circular*, Feb. 21st, 1866.

maximum temperature of the cases was attained sooner than when more fatal during the Autumn months. I make these remarks upon the temperature here, because I have found that the variations in the pulse correspond, in the majority of cases, with those in temperature, the higher the temperature, *cæteris paribus*, the lower the tension, and the less marked the dirotism of the pulse, and *vice versâ*, as before stated.

The pulse characteristic of typhus is, as a rule, best marked in proportion to the darkness of the spots; as the spots appear the pulse gradually loses its natural form, showing a low tension and want of dirotism; as the spots vanish the tension increases and the dirotism returns; but after its return, and as the patient approaches convalescence, the dirotism, in most cases I have observed, again disappears, but from a different cause, which seems to be a contracted and pinched state of the muscular fibres of the arteries, similar to that of the other muscles, which is only too evident, in the appearance of fever convalescents. In Plate I. are delineated the various forms of pulse found in typhus cases running the short course to recovery. Fig. 1 represents the pulse of the second day of the disease (of course observations on typhus so early in the disease are not easily obtained). I have only been able to observe two, the result being the form given in Fig. 1, which does not deviate much, except in frequency, from a natural pulse. Fig. 2 represents the state on the third day, showing a greater deviation from the natural form. Fig. 3, the fourth day; Fig. 4, the fifth day; Figs. 5, 6, 7, and 8, represent various forms found on the sixth day, the more common being Figs. 6 and 8; the forms 5 and 7 being found in the more severe cases. Figs. 9, 10, and 11, represent the pulse of the 7th day; Fig. 9 being the most common form. The similarity of the forms on the sixth and seventh days will at once be remarked, as also that of the eighth day, Fig. 12. On the ninth day we usually notice a return of the dirotism (Fig. 13), as the temperature falls, and the spots begin to disappear, but the low tension still remains; the tension now begins to rise, as seen in Fig. 14, tenth day; Fig. 15, eleventh day; and Fig. 16, twelfth day; the amplitude of the pulse tracing is not always so great on the eleventh day as seen in Fig. 15. In Fig. 17, which corresponds with the thirteenth day, we see the dirotism again becoming indistinct until the fourteenth day. In Figs. 18 and 19 we find it completely gone; from this time the dirotism again appears, and the pulse returns gradually to its natural form, as seen in Figs. 20, 21, and

22 (Fig. 22, which is marked in the Plate for day seventeen, does not, I think, exactly represent what probably will be found on further observations to be the average tracing for that day; I think it should be more like Fig. 21). The representations in the Plate are, as nearly as possible, fac-similes of tracings selected as being most typical of the days to which they are stated to correspond. I consider this a preferable mode of drawing up a series of daily sphygmograms to constructing average diagrams for each day. The vertical lines in the Plate are drawn at intervals corresponding with half a second, and are equal to the half-second divisions of my transparent sphygmographic scale.*

In Plate III., Figs. 1 to 15 represent a series of sphygmograms taken from a case of typhus belonging to the classes which run the long course, having their maximum temperature on the ninth or tenth day. Fig. 1 corresponds with day eight of the disease; Figs. 2, 3, 4, &c., up to 15, with days 9, 10, 11, &c., up to day 22 respectively. It will be observed that the character of low tension and absence of dicrotism is present in this series for a much greater number of days than in that corresponding with the short course cases represented in Plate I. At Fig. 4, a peculiar form of pulse occurs, which I have usually found accompanying head symptoms, chiefly violent headache, which is generally relieved by leeches to the temples, and cold applications. In Fig. 20, Plate II., a specimen is given of a sphygmogram, also accompanying head symptoms, which occurred in a large, heavy, plethoric man, with full bounding pulse, who was in a very peculiar and nearly comatose condition; this case was relieved by the application of leeches to the temples. We sometimes meet with pulses characterised by low tension and but slightly marked dicrotism, in smart cases of simple continued fever, as in Figs. 18 and 19, Plate II. In cases of typhus with *subsultus tendinum*, it is impossible to get a clear sphygmogram; sometimes only a slight effect of the beat of the artery can be discovered, as shown in Fig. 22, Plate II.; or it is quite obscured by the action of the tendons, as shown in Fig. 21, Plate II. In cases of well-marked typhus, without spots, we shall sometimes find that the sphygmogram never loses its dicrotism during the whole course of the disease. I have not yet observed a similar occurrence in a maculated case. Does this resemblance between the pulse of unmaculated typhus and febricula (Figs. 18 and 19, Plate II.) tend to prove any closer

* Med. Press and Circular, Aug. 22nd, 1866.

relation than is usually supposed to exist between those two febrile affections? The pulse delineated in Plate III., Fig. 4, was very peculiar, and existed for one day in a case of unmaculated typhus. I am quite unable to offer an explanation of this form. I could not detect any cardiac lesion.

I have not yet had much opportunity of observing the pulse of typhoid fever; but in the few cases I have observed in this disease, the most common pulse tracing is that figured by Marey,^a the dicrotism being usually well marked. In a mixed case of typhus and typhoid I observed the forms figured in Plate III., Figs. 5, 6, and 7. Fig. 7 shows a near approach to the typhus form.

What practical use can we make of the information offered us by the sphygmograph in typhus fever? At present not *very* much, excepting the advantage we derive from a more accurate and definite knowledge of the general symptoms of the disease. As a guide in treatment, it will be found that the pulse with the lowest tension, and least developed or absent dicrotism, is the one indicating the largest requirements of stimulants. This, however, is only expressing, in other words, the fact so much relied upon, that the character of the pulse is the guide in the use of stimulants. The character of the pulse of the patient will, in the majority of cases, be as easily estimated by the *tactus eruditus* of the experienced physician as by the sphygmograph. To the inexperienced, however, the sphygmograph will prove a valuable guide in treatment, as its written indications, as observed by others, will constitute a positive standard of comparison, which described sensations cannot possibly do. Perhaps, however the most important practical point is, that the sphygmograph appears to give us more accurate perceptions of the condition of the heart than the finger does. Dr. Stokes has pointed out^b that the sensations conveyed to the finger, when applied over an artery, do not always indicate the exact condition of the heart, as determined by the stethoscope applied over the chest. From my experience, the sphygmograph gives this information more accurately than the finger.

With regard to prognosis, there is no doubt the gravity of the case is measured by the character of the pulse. I have found that the sphygmograph shows an improvement in the pulse by demon-

^a Marey—p. 389, Fig. 100.

^b Stokes on Disease of the Heart. 1854. P. 134; and Dublin Journal of Medical Science, 1839, p. 15.

strating a slight return of its dirotism, before any sensible improvement could be ascertained by the finger. In one very protracted and severe case particularly, I was able, on the twelfth day, to predict an improvement in the state of the patient from the improved sphygmogram, though all the other symptoms remained the same, and the pulse to the finger presented no appreciable alteration.

The observations upon which my remarks are founded were nearly all taken in Cork-street Hospital, the majority of the patients observed being under my own care, but many of them under that of my colleagues, Drs. Kennedy and Mason, to whom I have to return my best thanks for the facilities they have always afforded me in the pursuit of scientific enquiry. I followed about sixty cases throughout the course of their disease, the observations upon which were checked by many casual ones upon other cases. At the time the sphygmograms were taken, notes were also taken of the sensations conveyed by the pulse to the finger; the temperature in the axilla and rate of respiration were recorded as well as the other conditions of the patient. Altogether, about 3,000 observations of pulse, respiration, and temperature, have been made by me, which I think must be considered sufficient foundation for the foregoing remarks. I hope they will be of interest to the profession, and eventually add, in some degree at least, to our knowledge of the symptomatology and treatment of typhus fever.

Explanation of Plate I. Pulse of Typhus running a Short Course to Recovery.

Fig. 1.—Pulse of 2nd day of Typhus.

Fig. 2. „ 3rd „ „

Fig. 3. „ 4th „ „

Fig. 4. „ 5th „ „

Figs. 5, 6, 7 and 8.—Pulses of 7th day of Typhus.

Figs. 9, 10, 11, and 12.—Pulses of 8th day of typhus.

Fig. 13.—Pulse of 9th day of typhus.

Fig. 14. „ 10th „ „

Fig. 15. „ 11th „ „

Fig. 16. „ 12th „ „

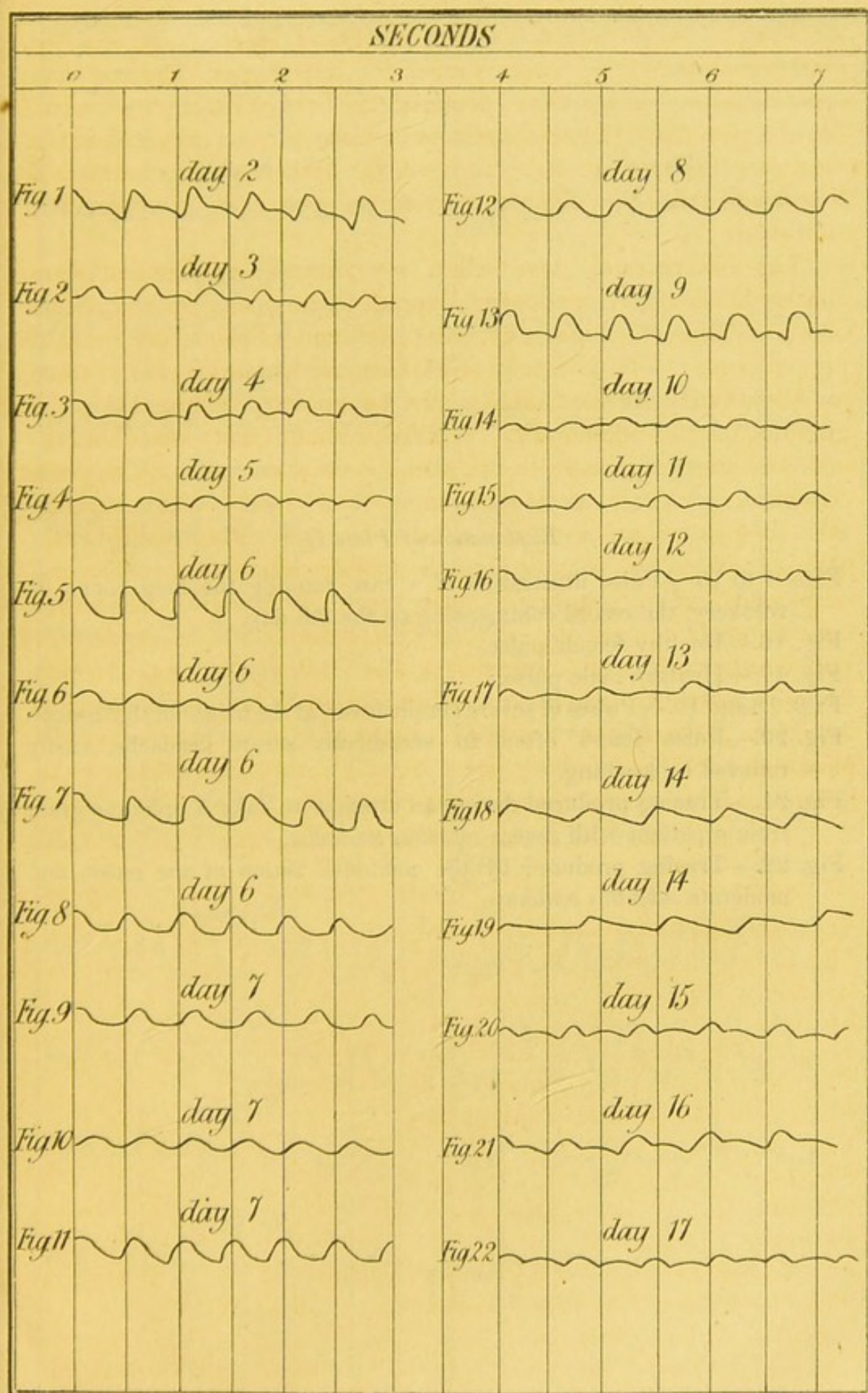
Fig. 17. „ 13th „ „

Figs. 18 and 19.—Pulse of 14th day of Typhus.

Fig. 20.—Pulse of 15th day of Typhus.

Fig. 21. „ 16th „ „

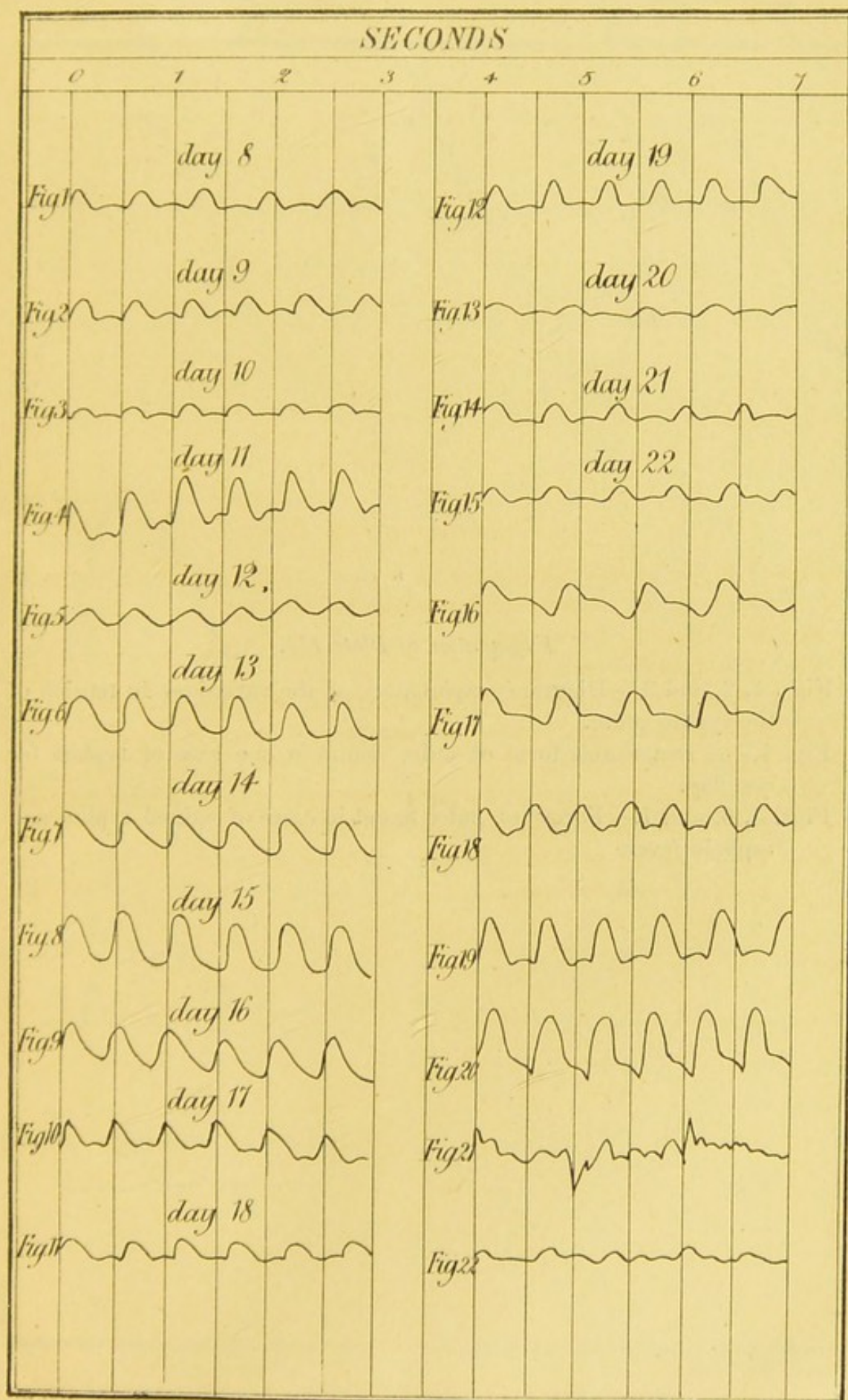
Fig. 22.—Pulse of 17th day of Typhus, running the short course, but not an average specimen; the tracing should be more like Fig. 21.



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Explanation of Plate II.

- Figs. 1 to 15.—Pulse illustrative of a case running the long course to recovery, the record commencing on the 8th day.
- Fig. 16.—Healthy female pulse.
- Fig. 17.—Healthy male pulse.
- Figs. 18 and 19.—Pulses of severe simple fever, at the height of the disease.
- Fig. 20.—Pulse found often to accompany severe headache, easily relieved by leeching.
- Fig. 21.—Tracing produced during an attempt to take a sphygmogram from a patient with severe *subsultus tendinum*.
- Fig. 22.—Tracing produced by the combined action of the pulse, and moderate *subsultus tendinum*.



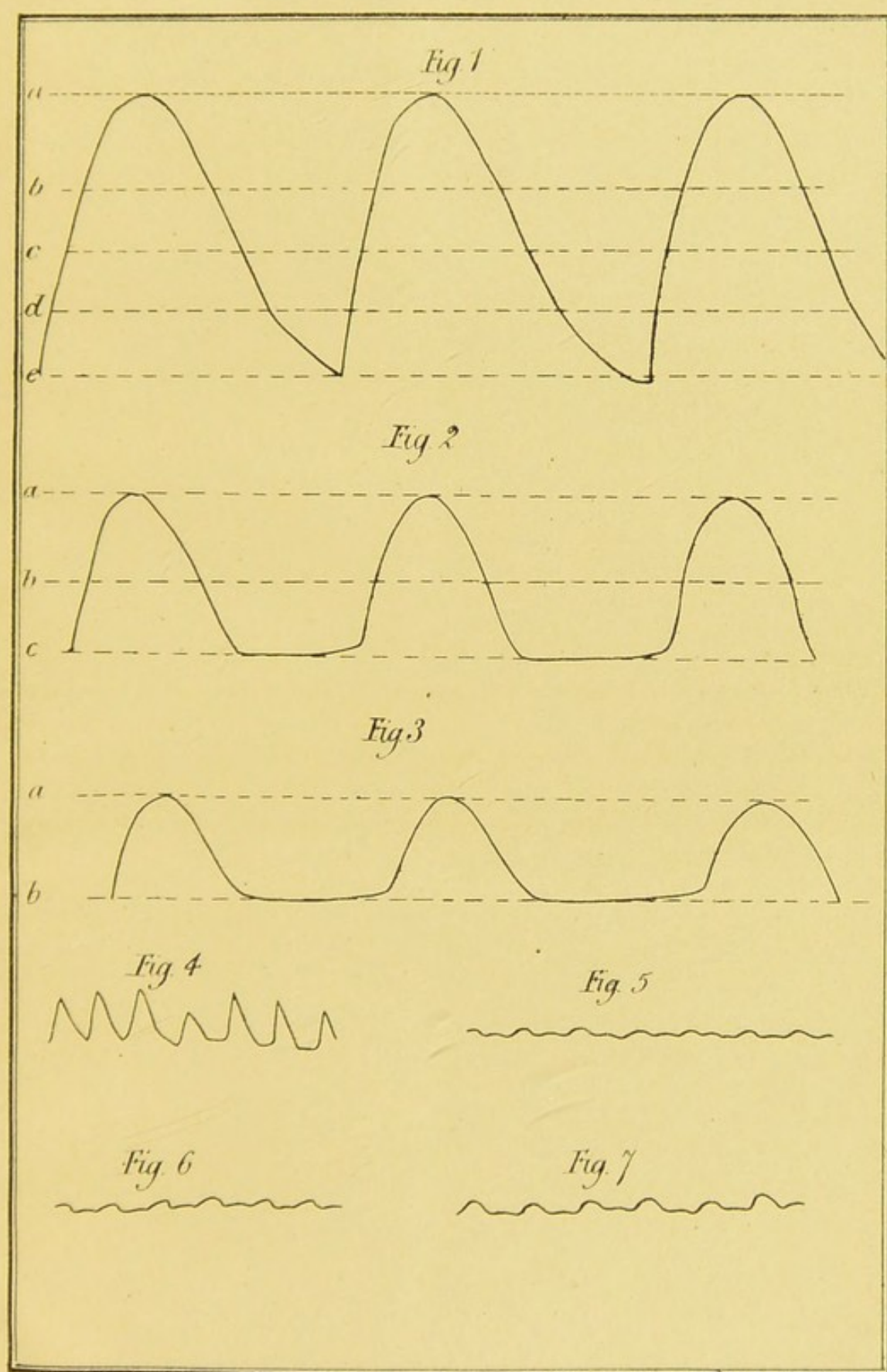
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Explanation of Plate III.

Figs. 1, 2, and 3.—Diagrams explanatory of the variations in tension of the typhus pulse.

Fig. 4.—A remarkable form of pulse found in one case of typhus for one day.

Figs. 5, 6, and 7.—Forms of pulse found in cases of mixed typhus and typhoid fever.



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