possibly not until after the lapse of some years, the venous chambers become overtaxed and the auricular muscle, following the protracted period of stress and overstrain, capitulates completely, its wall ceases to contract co-ordinately, and frequently passes into a condition of fibrillation, which, though implying intrinsic activity, is to all intents and purposes useless for the onward propulsion of the blood stream.

FIG. 3.

Fig. 3. is a tracing typical of this advanced stage in the history of tricuspid incompetence; we notice in it—

1. A complete absence of the auricular waves.
2. A fusion of the c and v waves.
3. A similarity between the arterial and venous tracings in that in both one observes a systolic filling and a diastolic emptying, a state of affairs entirely different from that observed at all ordinary times.

Bearing these observations in mind, and admitting that they are by no means comprehensive, but, rather, isolated facts which tend towards and amply warrant a careful study of the varied and widely differing phases which the great veins may assume, one would recommend their careful examination as a matter of routine, especially in cardio-vascular disorders, and, in conclusion, suggest that venous auscultation be not forgotten, for by its aid one gains additional advantages, abnormal sounds become audible—for instance, the well-known *bruit de diable*, characteristic of anaemic states, which, caused by loss of tone in the vein walls, is heard best when the patient is in the standing position, also the upwardly conducted venacaval murmur, the sounds resulting from the closure of the venous valves, and, lastly, the clicking sounds to which the rapidly-contracting auricle of auricular flutter gives rise and which are aptly referred to by Morrison as jugular embryocardia.

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¹ Bard, *Archives des maladies du coeur*, etc., May, 1915. ² Chapman, *Medical Society's Transactions*, vol. xxx, 386. ³ Parkinson *Heart*, vol. vi, No. 1.

THE HEART'S ACTION IN JAUNDICE.

BY

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THE belief is prevalent that the pulse becomes unusually infrequent and at times irregular in rhythm in jaundiced patients. These changes in the pulse are said to occur commonly in catarrhal jaundice, although met with occasionally in jaundice from other causes. It is curious why there should be this difference if, as is stated, the slowing of the heart is due to the action of bile salts on the heart muscle and intrinsic inhibitory mechanism of the heart.

I have investigated the heart's action in a number of jaundiced patients; in some I have found the pulse infrequent, in some irregular, in others both infrequent and irregular, but I have not been satisfied in any case that the jaundice was responsible for the infrequency or the irregularity. It is said the pulse may fall as low as 40 a minute; if by "pulse" is meant rate of ventricle, this rate, then, must be rare. I have not met with an instance in over 100 cases of jaundice. Slowing of the ventricle to 40 or below, whether occasioned by disease or poison, is, with rare exception, due to partial or complete heart-block, and so far as I know heart-block in the course of jaundice has not yet been illustrated.

A pulse-rate about 50 and 55 a minute is not uncommon in patients with jaundice when free from fever and the patient is kept in bed, but this is not proof that the jaundice is the cause of the slow pulse; the patient's normal pulse-rate must be known; and how it behaves in

other conditions, because the pulse has a tendency to become infrequent in many non-febrile illnesses when patients are confined to bed. The slowest pulse-rate I have met with due to total bradycardia, in an adult with jaundice, was 50 a minute. The patient was a man aged 65, with severe jaundice from gall stone disease; his normal pulse-rate was about 72 a minute. A year after this attack of jaundice he had severe bronchitis with fever and a fast pulse. When he was getting better the pulse fell to 50 to 52 and kept at this rate until he got about again. I could relate many similar examples; on the other hand, in the vast majority of cases of jaundice in adults I have found the frequency of the heart about or above the normal.

In a number of cases I have found a pulse-rate of 40 and below; but the heart-rate has been double the pulse-rate, the infrequent pulse being due to an alternate premature beat of the ventricle too feeble to send a wave to the wrist. This is shown in Fig. 1.

FIG. 1.—Showing two beats of the left ventricle to one of the pulse. A. Apex.

Cases of jaundice with this form of irregularity of the heart and pulse slowing have been published to illustrate the action of the bile salts on the heart, the assumption being that they increase the excitability of the heart muscle, and thus provoke the premature contractions; but there is no other proof advanced, and information is wanting as to the rhythm of the heart before the jaundice occurred and after it had passed off. My own experience indicates no proof that patients with jaundice are more liable to develop extra-systoles than are patients suffering from other toxic conditions. All the cases of jaundice with premature beats I have observed have occurred in persons past middle age; I have not met with any example in a child or young adult, whereas poisons—notably the digitalis group—which in very large doses may produce extra-systoles, do not show this selective action as regards age. In most of my cases of jaundice showing premature beats I know extra systoles were present in health. In some, in which premature beats were noted for the first time during jaundice, I found the extra-systoles persisted long after the patients were free of jaundice, and although this fact does not disprove the provocative action of the bile salts, nevertheless experience has shown that extra-systolic irregularity due to poisons ceases within a few days after the cause is removed. I do not contend that irregularity due to extra-systoles may not be favoured during jaundice—it may be; but I submit it is not because of any action of the bile salts on the cardiac muscle, but because the illness keeps the patient resting. This slows the heart, and premature beats, perhaps only occasional in health, tend to become more frequent with the slower heart action.

As already stated, the pulse is said to be affected more particularly in catarrhal jaundice. This is not a common ailment in adults, and I have notes of only four adult cases; in three of these there was nothing noteworthy in the pulse, in one case sinus irregularity was present. This patient was a woman aged 35; jaundice was marked. In the tracing (Fig. 2) is shown a waxing and waning in rate

FIG. 2.—R, Respiration; I, inspiration; E, expiration.

of pulse, which is 65 per minute on the average. The variations in length of diastoles are independent of the respiratory movements. I have frequently noticed this relation in sinus arrhythmia induced by digitalis, and the irregularity in this case may be due to the jaundice.

I knew nothing of the patient before this illness, but since, I have taken several tracings at rest without finding any irregularity and an average of pulse of 75 to 80.

Catarrhal jaundice in young people is commonly associated with a slow pulse, the rate being often no more than 50 to 60 per minute. The slow pulse is always irregular, and in my experience the irregularity is always due to sinus arrhythmia.

Fig. 3 is a tracing from a boy, aged 13, with catarrhal jaundice; the rate of the pulse is about 52 per minute; the irregularity is of sinus origin. The pulse-rate in health was usually about 80 and irregular in the same way. A year before this record was taken he had scarlet

FIG. 3.

fever, and during convalescence his pulse slowed as much and became as irregular as it did during jaundice.

Fig. 4 is from another case, a boy aged 9; the rate is about 63 and sinus irregularity is present. This boy's pulse is usually about 80 and irregular. He had a pulse of 60 after measles two years later.

These tracings are exemplary of a number I have from similar cases. Sinus irregularity is present in about 80 per cent. of healthy children; those who show it usually have a slower rate of pulse than the average for the age, and there is a curious susceptibility in this rhythm for the pulse to become unduly infrequent under conditions which tend to lower the pulse-rate; during sleep, for example,

FIG. 4.

and after any febrile illness the pulse often becomes very slow and irregular.

In catarrhal jaundice there is usually fever with a rapid pulse before the jaundice appears; when the jaundice comes out the fever goes, and often the pulse suddenly

falls in rate—may be from 100 to 120 with regular rhythm to 50 to 60 per minute in course of a few hours—and

FIG. 5.

becomes very irregular. This naturally attracts attention, and is ascribed to the jaundice; it will generally be found, however, in such cases that sinus irregularity is present in health, and the pulse will behave in the same way in the same patient after any febrile illness; such at least has been my experience.

Poisons which slow the heart have also the power of causing heart-block or hindrance to the passage of *a-v* impulse through vagus inhibition of conductivity. As already stated, no instance of heart-

FIG. 6.

block during jaundice has been illustrated. In 1911 I had a case of catarrhal jaundice under my care, in which at first there was seemingly impaired *a-v* conduction, evidenced in the jugular pulse. The patient was a boy aged 13; Fig. 5 is the record taken on the fourth day of well-marked jaundice; the pulse-rate is 75 per minute; impaired conduction is suggested by the lengthened *a-c* interval, which measures about $\frac{2}{3}$ sec. Next day the rate of the pulse had fallen to 68; in the tracing (Fig. 6) there is an additional wave marked *b* with the slower beats; careful examination of this curve will show that the lengthening of the *a-c* interval is apparent only, being brought about by fusion of the waves *b* and *a* during the quicker pulse periods. I have illustrated this fallacy more fully in a paper published in 1912.¹

REFERENCE.

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FROM THE VISIBLE TO THE GAMMA RAY SPECTRUM.

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(With Special Plate.)

In the accompanying Plate (Fig. 1) is represented a chart of the wave lengths of rays ranging from the visible part of the spectrum to x rays and the gamma rays of radium. The numbers across the top of the diagram represent the number of octaves which the rays range over; the numbers across the bottom give their respective wave lengths in tenth-metres—that is, ten thousand millionth parts of a metre.

The limit of visibility at the red end of the spectrum is 7,594 tenth-metres, and is a convenient starting-point for the purposes of this article; the visible region of the spectrum is constituted by almost exactly one octave of radiation, for the wave length of the ray corresponding to the extreme violet is very nearly one-half that of the extreme red. Passing into the ultra-violet portion of the spectrum, it will be seen that rather more than two octaves have been investigated.

A region of about six octaves, which remains at present unmapped, separates the extreme ultra-violet from the commencement of very "soft" x rays. The most easily absorbed x rays whose wave lengths have been determined are the characteristic rays from aluminium with a wave length of 8.4 tenth-metres. As we pass up through

several octaves of x rays the limit indicated by π is reached; this represents the "hardest"—that is, the most penetrating x ray which has, so far, been produced. The line π represents an x -ray beam of "medium" penetrating power.

The gamma rays from radium are represented in wave lengths as extending between the two heavily dotted lines on the diagram, and it will be seen that the most penetrating gamma rays are of appreciably smaller wave length than the "hardest" x rays so far available. On the other hand, some of the gamma rays are of longer wave length, and therefore more easily absorbed than "very hard" x rays.

The two other lines marked Ca and Ag represent the characteristic x rays emitted by calcium and silver respectively.

One of the objects of this article is to put forward a plea for a more exact specification of the different types of radiation which are used in experimental investigations and therapeutically. It is submitted that the time has passed when it sufficed to record, for example, that exposure to hard x rays caused the disappearance of a malignant growth, or that a lethal effect was observed