bruit at the impulse; at the same time the heart is clearly enlarged, and it may be beating rapidly and irregularly; there may be a history of syphilis or of chronic alcoholism; the patient may be very stout in the fatty, though generally not so in the fibroid, cases. There may be a history either of an extremely sedentary life upon the one hand, or of overuse of the heart by strenuous hard physical work—as a blacksmith, an athlete, and so forth—on the other. Needless to say, the exact nature of the cardiac lesion remains obscure or uncertain in many of these cases, many a patient who really has mitral stenosis being regarded during life as suffering from chronic bronchitis and emphysema, and so on.

3. "Physiological" Albuminuria.

Finally, we come to that large group of cases of albuminuria in apparently healthy males between the ages of 15 and 30. The condition was unknown until medical examinations at schools or for life insurance, for the army, navy, and civil services became common; and it has received a large number of different names, of which the following are some: "Accidental," "essential," "postural," "cyclic," "orthostatic," "intermittent," "physiological," "functional," "orthotic" albuminuria, Pavy's disease, albuminuria "of adolescence" or "of puberty." It derives its chief importance from the fact that young males who suffer from it are looked at askance by the older examiners for life insurance or for the "services," and are very liable to be rejected altogether. The reason for this was the fear that they were sufferers from some form of nephritis.

Collier and others have thrown much light upon the nature of the affection by their investigations upon the urines of rowing men. It is found that the urine voided just before a boat race being free from albumen, that voided immediately afterwards is generally loaded with it. A few hours later this albuminuria is gone again. Now, university oarsmen are, upon the whole, long-lived; hence this recurrent albuminuria cannot matter in them, and the same applies to the albuminuria of many adolescents. A prominent feature of such a case is that the urine first voided in the morning is quite normal, whilst that passed later in the day may contain anything from a trace to five parts per thousand of albumen, or more; the more the youth has exerted himself physically by walking or otherwise, and the more he has exposed himself to cold, for instance, during a train journey to the city on a winter's day, or in a cold bath, and so on, the greater is the liability to this unimportant, but possibly alarming, albuminuria. Some youths are so liable to it that they may pass albumen for days together before an interval of freedom from it occurs. Sometimes they appear to be in robust health, sometimes they look a little pale, as though they had been overworking at an indoor occupation; they may be nervous, but often they are not. A natural nocturnal emission is supposed to predispose to albuminuria next day. The point is that these individuals have to be differentiated from sufferers from Bright's disease. The method of diagnosis is as follows: A complete routine examination is carried out, and no obvious affection of the heart or other viscera can be detected; the blood pressure is normal; the albumen having been discovered, the patient is directed to supply a series of samples at intervals of a few days, and preferably passed immediately after rising in the morning. If all samples contain albumen it will be very difficult to exclude organic disease; if some contain albumen in abundance, however, and others none at all, the presumption will be that it is "functional"; before being finally satisfied, however, it is important that a careful microscopical examination of the centrifugized deposit from a specimen containing albumen should be made, no casts or other abnormal constituents being found. The administration of calcium chloride greatly diminishes the tendency to this form of albuminuria. In an adolescent male who has no symptoms of albuminuria discovered accidentally, present after exertion or after exposure to cold but absent after rest in bed, and, when present, not associated with renal tube casts or with signs of arterial, cardiac, or other diseases that should be detected by physical examination, is almost certainly a "physiological" albuminuria, which needs no treatment and is not indicative of any underlying disease.

Clinical Observations

ON THE

USE OF DIGITALIS IN HEART DISEASE AND DROPSY WITH FIBRILLATION OF THE AURICLES (NODAL RHYTHM).

BY

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IN the present paper I purpose to illustrate the use of digitalis in cases of heart disease with dropsy, in which the auricles are in a state of "fibrillation" and functionally inactive—a condition present in a large proportion of cases of severe heart failure, whatever the nature of the underlying lesion may be. Cases of this kind constitute a definite group, and their diagnosis is of great clinical importance both for treatment and prognosis.

It has always been recognized that benefit from the administration of digitalis in cases of severe heart failure is variable, even when classical indications for its use are present. In some patients improvement is rapid and maintained—the heart decreases in size, and dropsy quickly disappears; in others its power for good is limited—improvement occurs to a certain extent, and then comes to a standstill; in others again, particularly cases of mitral stenosis with regular pulse, and those resulting from arterial disease, digitalis is often impotent or even harmful—the heart continues to dilate, and dropsy increases under its use.

An example of such a case is the following:

CASE I.

A girl, aged 13, under my observation for some time with a compensated double mitral lesion of rheumatic origin. In August, 1909, severe dyspnoea with marked cyanosis came on after exertion and persisted for several days. The attack was quite recovered from, but later compensation gradually failed, and at the end of October severe dropsy set in. The pulse was quick but regular; heart enlarged to right and left; mitral presystolic, systolic, and diastolic murmurs were present. Although digitalis was well tolerated and given for over a month in full doses, with occasional remissions of a day or two, it had very little influence on the rate of pulse (Fig. 1). For a time

Fig. 1. - Tracing of radial and jugular pulses from Case I after continued full doses of digitalis; rhythm is regular, rate 84 per minute. The jugular tracing shows two pulses, *a* and *v*, to each beat of the carotid artery *c*. The wave *a*, due to contraction of the auricle, precedes the carotid beat by one-fifth of a second (normal, or auricular type of venous pulse).

there was some improvement in the general condition; but subsequently the heart further enlarged, dropsy manifestly increased, the amount of urine diminished, and eventually the lungs became oedematous before death, which occurred two months after the onset of dropsy.

The fact that digitalis often fails to do good in the later stages of heart failure, when the pulse is rapid and regular, was known in the early days of its use. It was recognized that the drug slowed the pulse in some cases more than others, and that to a great extent improvement was proportionate to the degree of slowing which ensued; and, further, that the most marked slowing and rapid response to treatment usually occurred when the pulse was irregular, but it was also recognized that these results were not constant in all cases with irregular pulse.

There was no explanation of this discrepancy forthcoming until Mackenzie differentiated the various forms and causes of irregularity of the heart by means of the venous pulse. He established the fact that in cases which

respond most promptly and certainly to digitalis the pulse was not only irregular, but the irregularity was persistent and very characteristic, consisting of an indiscriminate mixture of strong and weak beats, scarcely ever two being alike in duration and force (absolute irregularity of the heart). He observed further that in this form of irregularity the character of the jugular pulsation was abnormal, and that all signs of contraction of the auricles were absent.

The clinical value of these facts cannot be over-estimated; the determination of the presence or absence of absolute irregularity of the pulse in a given case of severe heart failure furnishes indications for the use of digitalis which can be obtained in no other way. Mackenzie established the fact that it is to its action in cases of this kind that digitalis owes its great reputation in heart failure.

In cases of rheumatic origin with completely irregular pulse, the heart in most cases slows under full doses to a degree which rarely occurs in any other form of heart action, and concurrently there is a rapid diminution in

Fig. 2.—Shows ventricular form of venous pulse; the rhythm is completely irregular; the venous tracing shows a single wave, *v*, synchronous with ventricular systole. The space *E* represents that portion of ventricular systole during which the semilunar valves are open.

size of the heart and liver, together with copious diuresis and disappearance of dropsy.

In order to explain the mechanism of this form of heart action, and make clear the meaning of the terms "ventricular form of venous pulse," "auricular paralysis," "nodal rhythm," and "auricular fibrillation," which are as yet used indifferently to designate it, the events of the normal heart beat must be outlined.

Under normal circumstances the stimulus provoking the contraction of the heart arises at the junction of the great veins with the auricle; from here it travels to the walls of the auricles, which contract in response to it; the stimulus is then propagated downwards to the ventricles; the only means of transmission being along the auriculo-ventricular bundle (the bundle of His); the ventricles contract about one-fifth of a second later than the auricles. These events can be determined by observing the movements of the jugular pulse, and timing them with the heart beat, or carotid pulse. The jugular vein fills and collapses twice to each beat of the ventricle; a pulse due to contraction of the auricle immediately precedes the carotid beat, the second wave follows immediately after the carotid pulse, and is ascribed to diastolic filling of the auricle. These movements are shown in Fig. 1.

In absolute irregularity of the heart the entire character of the jugular pulse is altered; instead of two waves—one immediately preceding and one following systole—there is a single large wave synchronous with contraction of the ventricle—*ventricular form of venous pulse* (Fig. 2). In most cases the venous pulsation in the neck is well marked and can be readily timed; occurring with systole, it closely resembles pulsation of the carotid, for which it is frequently mistaken. The venous origin of the pulse explains the seeming paradox so frequent in these cases of a forcible carotid pulse with a feeble radial beat. Mackenzie concluded that this synchronism of arterial and venous pulsation was due to tricuspid regurgitation; further, that the auricle must be so overdistended as to

be incapable of effective contraction. He reasoned that tricuspid regurgitation could not give rise to jugular pulsation unless the right auricle was full of blood at the time in the normal cardiac cycle when it should be empty—that is, at the beginning of ventricular systole—otherwise the blood regurgitated by the ventricle would serve only to fill the empty auricle, and in consequence its wave would not be transmitted through the jugular vein. He found "auricular paralysis" commonly ensued in patients with rheumatic mitral stenosis, and that the onset of absolute irregularity of the heart in such cases was always associated with disappearance of the presystolic murmur and thrill, and *post mortem* the auricle was found enormously distended and the muscle fibres greatly atrophied.

Further experience, however, showed that tricuspid regurgitation was not an invariable concomitant of the ventricular form of pulse; moreover, cases were met with having this form of pulse in which *post mortem* the auricles were found hypertrophied, thus evidencing that they contracted during life. To explain the absence of

Fig. 3.—From Case II before increasing the dose of digitalis. Pulse is absolutely irregular, rate 95 per minute. The venous pulse is of the ventricular form, with two waves, *a'* and *v*. The wave *a'* occurs at the time of the carotid pulse (down stroke on radial tracing), and is probably due to the auricle contracting at the same time as the ventricle. Tincture of digitalis 5 minims t.d.s. had been given for six weeks up to the time this tracing was taken.

signs of contraction of the auricle in these cases the inference arose that the auricles and ventricles contracted simultaneously. Support was lent to this view by the fact that in these cases two movements could be seen in the jugular vein during ventricular systole. (These are shown in Figs. 3 and 4, *a'* and *v*.) The time of the appearance of *a'* was exactly that of the carotid pulse; there was never any sign of the auricular wave before the wave of the carotid pulse (compare Fig. 1). He suggested that the wave *a'* must be due to auricular

Fig. 4.—From the same case as Fig. 3, taken twelve days later. The rhythm of the pulse is almost quite regular; rate 43 per minute. The heart's sounds and impulse correspond with the radial beats; the jugular pulse is of the ventricular form. Regular slowing of the heart to this degree under digitalis does not occur when the auricular form of pulse is present.

systole, and that the auricle and ventricle contracted simultaneously; he concluded that this rhythm was brought about by the stimulus for contraction starting from a place other than the mouths of the great veins; it was assumed that it had its origin in a part of the junctional fibres between the auricle and ventricle (the auriculo-ventricular node) and from thence spread simultaneously up to the auricles and down to the ventricles. Hence the term "nodal rhythm" came to be applied to this condition. The truth of Mackenzie's main conclusions—that absolute irregularity of the heart, ventricular venous pulse, and functional inactivity of the auricle, are causally associated—has been fully established by the researches of Lewis, who has moreover made clear the mechanism by which the association is brought about. He has conclusively demonstrated by means of electro-cardiograms taken from a large number of clinical cases of absolute irregularity with ventricular venous pulse, that in this condition there is an

entire absence of normal contraction of the auricle; its musculature is in a state of unceasing tremulous movement ("fibrillation"). He found further in animal experiments that when the auricles were thrown into a state of fibrillation they became distended and remained in a state of diastole; synchronously, the contraction of the ventricle became absolutely irregular in rate and force, which rhythm is assumed to be due to the disorderly transmission of impulses.

The mode of action of digitalis in fibrillation is as yet imperfectly understood. The question is fully discussed in Dr. Lewis's recent article.¹ It suffices here to say that there are good reasons for the supposition that digitalis acts by depressing the conductivity of the *a-v* bundle; its full effect is to block the passage of stimuli from auricle to ventricle; cut off from the influence of the auricle, the ventricle beats with an independent rhythm of its own. However this may be, the fact remains that the character of the heart's action under the full influence of digitalis in this condition is comparable in every way to that occurring in complete heart-block. The rhythm of the heart at times becomes regular with a rate of 40 or thereabouts (Fig. 4); further, a frequent effect of continued full doses is the occurrence of "coupled heart beats" (Fig. 10). Lewis has shown by galvanometric curves that the weaker beat of this coupled rhythm, which occurs with notable regularity, arises in response to a ventricular stimulus, and it is supposed that a condition of complete heart-block is present.

While the majority of cases of fibrillation respond in a marked manner to digitalis, it is found as a matter of experience that reaction varies under different circumstances of etiology and rate of pulse. Cases which respond most certainly and rapidly are those resulting from old rheumatic lesions, in which the rate of pulse is not greatly above normal, and symptoms of failure arise gradually (Case II).

There is another type of case, also of rheumatic origin, in which fibrillation occurs suddenly, and heart failure soon becomes extreme; in these cases the pulse is usually rapid and reaction is uncertain (Cases III and V). Fibrillation not uncommonly ensues in course of arterio-cardiosclerosis; generally reaction is slight or absent, occasionally the heart slows to some extent, but improvement in the general symptoms is not proportionate. Exceptionally typical reaction occurs (Case V).

Common Form of Heart Failure and Dropsy, with Auricular Fibrillation.

CASE II.

Male, aged 23 years. History of three attacks of acute rheumatism. In 1906-7 he was under my care for hæmoptysis and shortness of breath; at that time the pulse was regular; heart slightly enlarged; double mitral murmur, and a marked presystolic thrill and reduplicated second sound were present. The patient was lost sight of until October 3rd, 1909; in the interim he had been attending different hospitals as an out-patient. For six weeks prior to this date he had been almost continuously in bed, and during this time had taken 5 minims of tincture of digitalis three times a day. He was very dropsical, short of breath, and unable to lie down; the radial pulse was 95 per minute and absolutely irregular in rate and force. The heart was greatly enlarged, extending 7 in. to the left and 2 in. to the right of the middle line. No precordial thrill was detected; on auscultation, a systolic murmur was heard in the mitral and tricuspid areas, but the presystolic murmur and doubled first sound present during 1906-7 were no longer heard; the jugular pulse was large and synchronous with the heart beat, the liver was enlarged and pulsating; there was no ascites or hydrothorax; cough was troublesome, with copious expectoration; moist sounds were heard over both bases; the urine was very scanty and contained albumen. The clinical evidence of auricular fibrillation is corroborated by the character of the radial and jugular tracing (Fig. 2) taken at this time. From this date he took 15 minims of tincture of digitalis, at first four-hourly, and then three times a day up to the fifteenth, when Fig. 4 was taken. My note on this date is: "He can lie down comfortably, breathes easily, dropsy much less, and is in every way improved; heart and liver diminished in size." In a fortnight he was downstairs and getting about quietly, and a month later was fit for light work. During this time the digitalis was taken in the same dose three times a day.

This patient is an example of the form of heart disease and dropsy which constitutes perhaps 50 per cent. of cases as met with in general practice. It serves well to illustrate that the presence of fibrillation can be diagnosed by ordinary clinical methods of examination. In most cases graphic records are unnecessary; with the finger on the

apex beat, and a close scrutiny of the jugular pulse, the persisting disorderly action of the heart, with synchronous venous pulse, is readily detected. It shows, also, how at times, in cases treated with small doses of digitalis without benefit, prompt and continued improvement results when adequate doses are given. Five minims of tincture of digitalis had been taken three times a day for six weeks continuously, with but little effect on the pulse or symptoms. On trebling the dose and giving it 4-hourly, improvement was rapid and maintained. It is largely to cases of this kind that digitalis owes both its good and bad repute; in small doses it has little or no effect, the heart keeps quick and irregular, and if the true nature of the condition is not recognized the quick pulse may be erroneously ascribed to increased excitability from a "cumulative effect," whereas the case urgently requires more, not less, of the drug. Generally speaking, improvement in cases of this kind is proportionate to the degree of slowing of the heart; and digitalis must be given in sufficient doses to reduce the rate at least to the normal, and in most cases considerably lower, to get the best results. On commencing treatment 15 minims of the tincture should be given four times a day until the pulse slows to 50-60 per minute, which it will do as a rule within a week. In most patients the improvement with this rate of pulse is maintained, when the same dose should be given three times a day and its effect watched. In others the case hangs fire; the drug should then be pushed until its full physiological effect on the pulse is produced. The evidence of this is either a regular slowing of the heart to about 40 a minute (Fig. 4), or the occurrence of coupled heart beats (Figs. 6 and 10). A pulse of 50 or over is always characteristically irregular; when the rate falls below 50 it exceptionally becomes regular, the number of heart beats being the same as the pulse. More frequently the full effect is shown by the occurrence of coupled beats; these are readily recognized on auscultation—two heart beats follow quickly on each other succeeded by a long pause, the first beat is strong, the second short and feeble. The rhythm is phonetically represented thus:

lub-dup tutup—lub-dup tutup.
1 2 1.2 1 2 1.2

Usually the feeble beat fails, to reach the wrist, so that the pulse-rate is half that of the heart as shown in Fig. 10. During the pause a long murmur is often heard in the mitral area, due to diastolic inflow to the ventricle. From a large number of observations I have found that the total amount of tincture of digitalis required to produce runs of coupled beats or regular slowing is on the average 450 minims—that is in about ten days with doses of 15 minims. There is, however, no constancy in this respect; at times the full effect occurs with 300 minims, but only very rarely with less. In some patients larger doses and a longer time is required, and in others the characteristic reaction cannot be induced, but this is exceptional and usually only in very advanced cases.

Digitalis should be stopped when long runs of coupled beats or regular slowing occur; no further good can follow its continued use; the full effect is transient, within two or three days the pulse quickens and is again characteristically irregular. The drug should now be given again in increasing doses from 10 to 15 minims three times a day until the pulse slows to a rate approximating that at which the double beats previously occurred; it is with this rate of pulse that the patient will generally be at his best. We thus see that the guide for dosage during treatment is the effect on the heart, and that this can be determined by auscultation, the rate and rhythm of the beats furnishing the necessary indications. There are, however, associated circumstances which have to be considered of which vomiting and the amount of urine passed are the most important. When digitalis is well tolerated—which it generally is—nausea or vomiting does not occur as a rule until the full slowing effect on the heart is reached; then vomiting is almost invariable, and its significance obvious. But this symptom may arise in some patients before the pulse is affected to any appreciable extent or signs of improvement are manifest, and gives rise to doubt as to whether digitalis should be continued or not. In arriving at a decision the rate and character of the pulse, the size of the heart, the amount of dropsy present, and the quantity of urine passed have to be considered. Generally speaking, if the

pulse continues irregular and above normal in rate, digitalis may be pushed with confidence, always providing that the amount of urine passed is not diminishing; under these circumstances vomiting probably signifies no more than gastric disturbance from the direct action of the drug on the stomach. To obviate this the form of preparation should be changed, or strophanthin or digalen given hypodermically. If, on the other hand, together with vomiting dropsy is stationary or increasing and the amount of urine passed is less, as not uncommonly happens in advanced cases with extreme dropsy, the drug should be stopped. Withering pointed out in 1775 that when "the limbs in anasarca are solid and resisting we have but little to hope" from digitalis. These are the cases which fail to react to digitalis, and its continued use may be harmful until the dropsy is relieved by other means—drainage or purgation—then it will usually act like a charm.

It may be questioned whether the doses of digitalis advocated may not produce injurious effects from its "cumulative action." I have not found that the effects of the drug last much longer than the period of its administration; on the other hand, heart-block, extra-systoles, and coupled beats induced by digitalis usually disappear within two or three days; and I have never found any of these conditions arise subsequently to leaving off digitalis, even after it has been given in large doses over long periods.

The Necessity for the Continued Use of Digitalis.

An important question is the subsequent history of these patients after treatment is suspended. In my experience they break down very quickly on leaving off digitalis, more readily than cases in which the rhythm of the heart is normal. After compensation is established in mitral regurgitation, for instance, the patient may go on indefinitely without further symptoms of failure, providing he lives quietly.

There is a very marked difference in the behaviour of the heart in nodal rhythm; on leaving off digitalis the pulse quickens and symptoms speedily recur. Digitalis has no action on the fibrillation of the auricle; this persists when the heart is fully under the influence of the drug (see Fig. 9). Compensation results not only from restoration of tonic, but largely from the cutting off of the rapid irregular impulses from auricle to ventricle—that is, by causing heart-block; this effect, as already indicated, speedily passes off, when the auricular impulses are again transmitted to the ventricle, with the result that within a few days the heart becomes quick and irregular, and symptoms of failure recur. This will happen even with the patient at rest in bed; bodily rest appears to have no influence on the fibrillary movements of the auricle or the conductivity of the *a-v* bundle. Drugs of the digitalis group are imperative; it is the one form of heart action which requires the drug to be given almost indefinitely in order to maintain a condition of slight heart-block. The patient whose case is cited at page 425 serves to illustrate this; he has been taking digitalis in 15-minim doses for fourteen months; it has occasionally been left off for some reason or other, and invariably within a week or so he gets short of breath, and the feet begin to swell. The longest time he has been without the drug is three weeks, then the pulse quickened to 100; he was very breathless and dropsical; on resuming digitalis these symptoms cleared up almost at once. He is at his best with a pulse-rate of 50-55, and this rate can only be maintained by taking the drug. He has observed this fact for himself and he regulates the amount of his medicine accordingly. I could cite many similar cases. It is surprising how well most of these cases keep after a breakdown, providing they continue taking digitalis. I have several patients under observation who have passed through severe breakdown, but are able to do fairly laborious work without distress, and I am convinced from repeated trials that their well being is entirely due to the continued use of the drug; without it they would speedily break down. It is a necessary part of treatment to teach these patients how to regulate the amount of medicine in accordance with their symptoms and rate of pulse. There comes a time, however, in the course of these cases when digitalis and all other drugs

are impotent. I have at present such a case under my care.

CASE III.

The patient had been the subject of mitral disease, with absolutely irregular pulse, for eighteen years to my knowledge. I have attended her in many attacks of severe failure, but until recently the response to digitalis has been prompt and complete. In December, 1909, a severe breakdown occurred, the face, lips, and extremities were very cyanosed, feet and legs much swollen, breathing continuously laboured, inspiratory crackles at both bases, liver enlarged and pulsating, heart 7 in.

Fig 5.—From a case of rheumatic mitral disease, in which the pulse was continuously irregular for eighteen years. Taken before digitalis was given, during a severe breakdown. (Case III.)

to the left, and 3 in. to the right of the middle line. The character of the pulse is shown in Fig. 5. Digitalis was given night and day for nine days in 15 minim doses four-hourly; coincidently with the slowing shown in Fig. 6 there was

Fig. 6.—From the same case as Fig. 5. Simultaneous record of apex beat and radial pulse, after tincture of digitalis 15 minims four-hourly for nine days. Pulse-rate 30 per minute; rate of heart 60 per minute. Coupled digitalis beats are shown in apex tracing, the second of the linked beats being too weak to transmit a wave to the radial artery.

marked improvement and she was soon able to go about again. She continued comparatively well up to September, 1910, when severe failure again occurred; no form of treatment had any effect, the pulse kept quick and irregular, dropsy increased, and the fatal issue, three months later, was preceded by oedema of the lungs.

In the majority of cases of heart failure the onset of fibrillation is insidious, and, apart from the increasing degree of heart failure to which it inevitably leads, its occurrence is not usually marked by any special symptoms; in some cases, however, the patient suffers from temporary attacks of rapid irregular heart action which are associated with various subjective symptoms. The attacks tend to become more frequent and last longer, until ultimately permanent absolute irregularity is established. This was probably the sequence of events in the following case:

CASE IV.

A female, aged 39, first seen in December, 1909, for giddiness, vomiting, and palpitation. She has been known to me for some years as the subject of mitral stenosis, but has never had any heart trouble. She had rheumatic fever at 13 years of age; since then she has not had to keep in bed for illness. For the past month the breathing has been a little short on exertion, and she has had attacks of palpitation and giddiness, coming on and passing off quite suddenly. At times two or three attacks occur in a day, or there may be an interval of two or three days between. During the attacks she has been short of breath, and experienced an uneasy fluttering feeling at the chest; the attacks come on quite suddenly and last for about a quarter of an hour, rarely longer, and often only two or three minutes. Giddiness has been the most pronounced symptom; the attacks have lately been more frequent and lasted longer, but she has been able to do her housework as usual up to three days ago, when quite suddenly severe palpitation, giddiness, and vomiting came on, and she had to take to bed. These symptoms have continued up to the present.

Condition.—Cyanosis of face and lips, breathing quick, superficial veins of neck distended and pulsating; heart extremely rapid and absolutely irregular, enlarged to right and left; no thrill or friction present. Systolic mitral murmur; soreness and tenderness over the liver, which is just palpable; some

oedema of feet; temperature normal. Fig. 7 taken at this time is a tracing of radial and jugular pulses; the radial pulse shows complete irregularity, and the jugular pulse is of the ventricular type; 15 minims of tincture of digitalis were given every four hours with 20 grains of bismuth carbonate. The symptoms rapidly subsided; vomiting ceased almost at once. By the

Fig. 7.—From Case IV before digitalis. The pulse is absolutely irregular; rate about 130 per minute. The jugular pulse is of ventricular form.

fourth day the patient was so much better that she was out of bed. On the sixth day the pulse had slowed to 66 per minute, and occasionally the rhythm reverted to normal (Fig. 8). At this time the patient was free from symptoms and able to get about the house without discomfort.

Digitalis was continued in 15-minim doses t.i.d. from this time up to the tenth day, when long runs of coupled

Fig. 8.—From the same case as Fig. 7 on the sixth day. Pulse-rate 66 per minute. In the middle of tracing the rhythm of the heart reverts to normal. Oscillations due to fibrillation of the auricle are shown at fib.

beats were present. Oscillations due to fibrillary movements of the auricle are well shown in the venous tracing during the long pauses (Figs. 9 and 10).

In cases with sudden onset of fibrillation, the pulse is invariably rapid, and the embarrassment to the circulation which results from the altered rhythm of the heart may be so great that extreme failure rapidly ensues unless the heart slows down under treatment. In rheumatic cases occurring in young people the response to digitalis is generally prompt, but when the condition occurs in people over middle age, even in rheumatic cases, reaction is uncertain. The following is a case in point:

CASE V.

Female, aged 52. History of several attacks of rheumatic fever; well-compensated double mitral disease; no heart trouble for many years. She was under my care for minor ailments on and off for three years prior to present attack, and I never detected any irregularity in the pulse. In June, 1908, she nursed her son during a serious illness; shortly afterwards she was taken quite suddenly with sickness and severe dyspnoea; the pulse was extremely rapid and irregular; within a few hours marked cyanosis ensued. In spite of treatment the heart rapidly dilated, the liver enlarged and dropsy set in, the pulse continued rapid and irregular, and death ensued on the tenth day after the onset of symptoms.

Fibrillation is present in a large proportion of patients with heart failure and dropsy resulting from arterial degeneration. No systematic observations on the effects of digitalis in cases of this kind have as yet been made except by Mackenzie, who found the drug was all but useless in the majority of patients. My experience of such cases is limited to eleven, which I have summarized in the accompanying table (p. 428).

During the time these patients were under treatment the effects of full doses of digitalis on the pulse were deter-

mined by polygraph tracings. Generally speaking, I found in those patients who came under treatment during the early stage of failure, when dilatation was slight and dropsy limited to the legs, that digitalis usually acted well for a time; the pulse slowed, breathing became easier, dropsy decreased, and in some cases quite disappeared; but inevitably the symptoms recurred within a short time, and usually in a more pronounced form, in spite of continued treatment. Again, digitalis was beneficial to a certain extent in some patients, but more often was badly tolerated; small doses readily induced vomiting, and in all cases the effect on the pulse was less marked, and more or less dropsy and breathlessness persisted under its use. This was the course in all the cases except Nos. 1, 4, and 8. Case 11 was extremely dropsical when first seen; within a fortnight, under full doses, the pulse slowed, and dropsy entirely disappeared; it soon recurred again as extensively as before, and digitalis had no effect whatever.

In Case 4 the response was prompt, and improvement has continued up to the present.

CASE VI.—Heart Failure from Arterio-sclerosis; Auricular Fibrillation; Typical Reaction to Digitalis.

Male, aged 83 years. Always a very healthy man; for a year has been breathless on exertion; lately this has become worse, and feet have swollen. Present illness began with pain in chest, and breathlessness when out walking, he was so ill that he had to be carried home. When seen he was propped up in bed, the expression was anxious, lips and hands cyanosed; breathing very shallow—40 a minute; pulse about 120, very irregular; arteries beaded and tortuous; no apex beat to be seen or felt, heart enlarged to right and left, no murmurs heard. Troublesome cough, with copious frothy expectoration, crackles were present in both lower lobes. Feet and legs swollen, no palpable enlargement of liver. Urine high coloured and scanty. No albumen. The pulse

tracing taken at this time is shown in Fig. 11. With continued inhalation of oxygen, and full doses of digitalis (20 minims every two hours for twelve doses), his condition was considerably better in twenty-four hours. The dose of digitalis was then reduced to 15 minims three times daily; on the tenth day the pulse had the characters shown in Fig. 13, and his general condition had so much improved that he was able to sit out of bed for a short time. He continued improving, and

Fig. 9.—From the same case as last tracing, taken four days later. Tracing of radial and jugular pulses. The radial pulse is 41 per minute. Coupled beats are shown in the jugular curve; the oscillations (fib) are due to fibrillary movements of the auricle.

within a few weeks he was able to get about the house and take short walks. This patient has been under observation for sixteen months, and has taken digitalis all this time. He regulates his medicine to keep the pulse-rate about 80, and so long as this is the case his breathing is easy and there is very little dropsy. If digitalis is left off entirely for a week—which has been done occasionally to see the effect—the pulse quickens

Fig. 10.—Taken at the same time as Fig. 9. Record of apex beat and radial pulse; shows characteristic coupling of heart beats from digitalis.

to over 100 and his symptoms are decidedly worse. On resuming the medicine improvement begins almost at once. For the past twelve months he has taken on the average from 15 to 30 minims of tincture of digitalis a day. My note on December 29th is, "Pulse 80, breathing easy, very slight swelling of feet; can walk quarter of a mile without distress."

Case.	Age.	Sex.	Arteries.	Heart.	Albumen.	Dropsy.	Effect of Digitalis on Pulse.	Effect on Degree of Dropsy.	Time under Observation.	Result.	Remarks.
1	86	M.	Hard	Enlarged	None	Feet and legs	Marked	Decreased	3 years	Fatal	Several breakdowns; always responded to treatment until fatal attack.
2	69	M.	Hard and tortuous	Enlarged	Yes	Extensive	None	None	2 months	Fatal	No improvement occurred.
3	81	M.	Hard and tortuous	Enlarged	Yes	Extensive	None	None	5 months	Fatal	Nodal rhythm ensued after an attack of angina pectoris.
4	83	M.	Hard	Slightly enlarged	None	Feet and legs	Marked	Disappears	16 months	—	Condition continues satisfactory under digitalis.
5	—	F.	Normal	Enlarged	Trace	Feet and legs	Slight at first	Slight at first	12 months	Fatal	Breathless, dropsical, and cyanosed.
6	71	F.	Normal for age	Enlarged	Yes	Extensive	None	None	15 months	Fatal	Improvement at first.
7	63	F.	Hard and tortuous	Enlarged	Yes	Extensive	Marked at first	None	4 months	Fatal	
8	52	M.	Normal	Enlarged	None	Feet	Decided	Disappears	8 months	—	Keeps well under digitalis.
9	61	F.	Normal	Enlarged	None	Feet and legs	Slight	Decreased	3 months	—	Improvement at first, symptoms recurred. Digitalis had little effect.
10	68	M.	Hard and tortuous	Enlarged	Yes	Feet and legs	None	None	10 days	Fatal	Gouty subject. Sudden onset of nodal rhythm.
11	46	F.	Hard	Enlarged	Yes	Extensive	Marked at first	Disappeared at first	3 months	Fatal	Marked improvement at first. Symptoms recurred.

In the late stages digitalis is badly tolerated as a rule, and even when well borne has generally but little (if any) effect on the pulse, and none on the dropsy. At times the pulse slows somewhat, but rarely to the normal rate. If

Fig. 11.—Taken from Case vi before digitalis. Pulse rate, 110 per minute.

it does so, there is no proportionate improvement in the general condition. In the following case characteristic coupled beats occurred with full doses of digitalis, but the dropsy persisted.

Fig. 12.—Taken from the same case as Fig. 11, on the fourth day. Pulse rate, 90 per minute.

CASE VII.—Heart Failure in Cardio-sclerosis with Bright's Disease: Ventricular Form of Pulse.

Female, aged 63 years. First seen February 22nd, 1910; has been more or less short of breath for some years; for the last twelve months breathlessness has been extreme on any extra

Fig. 13.—From the same case as Fig. 12 on the tenth day. Coupled digitalis beats are shown; this characteristic response to digitalis in arterio-sclerosis is very exceptional.

effort. She is now in bed and cannot lie down, breathing is very laboured, face and lips cyanosed, expression anxious, feet and legs much swollen, body dropsical. Pulse absolutely irregular, arteries hard and tortuous. No apex beat seen or

felt. The heart's dullness extends 5 in. to left and 2 in. to right of middle line. Inspiratory crepitations over both lower lobes; copious frothy expectoration. Urine: specific gravity, 1020; loaded with albumen (Fig. 14). Digitalis was given in 15-minim doses four-hourly at first; after taking it for two days it caused

Fig. 14.—From a fatal case of heart failure from cardio-sclerosis and Bright's disease (Case vii). Before digitalis. Pulse-rate 120 per minute. The jugular pulse was obscured by the respiratory movements of the sterno-mastoid.

vomiting and was left off; after a few days the same dose was given again three times a day and was well tolerated up to the twelfth day of its administration, when vomiting ensued.

Fig. 15.—From the same case as Fig. 14. After digitalis. Shows characteristic coupling of beats.

Long runs of coupled beats were present in the pulse tracing taken at this time (Fig. 15). The breathing was easier and she could lie down comfortably, but there was no decrease in the dropsy. The patient was not seen again for some weeks, when the general condition was much the same as at first; different drugs of the digitalis group were tried without any effect on the pulse or general condition.

The reason for these discrepancies in the action of digitalis when compared with its effect in rheumatic cases is not understood. The mechanism of the irregularity is the same in both types, and no explanation suggests itself why it should so commonly fail to slow the heart and influence dropsy in one class of case and not the other. So far as its effect on the heart is concerned, the explanation is rather to be sought in the associated clinical circumstances. My impression is, that reaction to digitalis in these cases not only depends upon the extent and degree of degeneration of the heart muscle, but upon the presence or absence of associated renal disease. It is well recognized that digitalis fails to act in toxic conditions of all kinds; the reason is unknown but the fact is well established

Heart disease and Bright's disease are so intimately associated with arterial degeneration that it is often impossible to say in a given case how far the condition is cardiac or renal; the absence of response is to a great extent a measure of the renal element in the case and of value for prognosis, signifying, as a rule, that the condition is terminal.

REFERENCE.

¹ BRITISH MEDICAL JOURNAL, November 26th, 1910, p. 1670.

TWO CASES OF DEATH FROM POST-ANAESTHETIC ACID INTOXICATION.

BY

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It has long been known that acetone is present in the urine of patients who have been anaesthetized.

Becker, for instance, states¹ that acetone follows anaesthesia in at least two-thirds of the cases, irrespective of the nature of the anaesthetic or the duration of the anaesthesia, "and that if it be already present it is increased thereby." This has been confirmed by Abram² in a series of cases at the Royal Infirmary, Liverpool.

The importance of this fact has been recognized by all, though some, like Wallace and Gillespie of the Prince of Wales's Hospital, London,³ fully appreciate the dangers and take suitable prophylactic measures.

The two cases I have to record both occurred at the Children's Infirmary, Liverpool, within a few weeks of one another.

CASE I.

The patient was a boy aged 6 years, suffering from a chronic intussusception which had been present for six days. On August 10th, 1910, at 11.30 a.m. he was given ethyl chloride, followed by ether by the open method. A right rectus incision was then made, and a large chronic intussusception found and reduced easily; there were no adhesions and practically no congestion. The abdomen was sutured in three layers.

The anaesthesia lasted about twenty-five minutes, and 3½ oz. of ether were used.

After-progress.

At 8 p.m. the respirations were very rapid (40), though there were no râles in the chest. He was given atropine gr. $\frac{1}{20}$ four-hourly.

At 1.30 a.m. he was worse, expiration being prolonged at both bases.

At 2.30 a.m. he vomited, so was given sod. bicarb. ʒj in ʒij of water; this was retained, and no more vomiting took place.

At 10.0 a.m. he was much worse; pulse 160, but hardly perceptible. Cyanosed; dilated pupils; he was given oxygen and brandy. Retained salines well.

At 1.30 the same day the child was just conscious, but obviously dying; the breath smelled of acetone. Respirations 72; air hunger; pulse hardly perceptible. Cyanosis not present as oxygen was given continuously.

Urine.

A catheter specimen of urine was obtained and presented the following characteristics:

Light colour, slight deposit of mucus, acetone smell just perceptible, acid, sp. gr. 1028. No albumen, bile, pus, or sugar. Phosphates precipitated on boiling. Acetone present in large amount, demonstrated by both nitro-prusside and iodoform tests. Diacetic acid was present. No microscopic examination was made.

The child died before treatment could be commenced, and no post-mortem examination was allowed.

Both the night sister and nurse noticed that the breath had a peculiar odour, but did not report it as they "thought it due to a new kind of chloroform."

CASE II.

This was a child, aged 1 year and 10 months, with inguinal hernia.

On September 17th, 1910, at 5.30 p.m., anaesthesia was commenced with equal parts of chloroform and ether given on a Schimmelbusch mask, but the child stopped breathing twice, although he was not deeply under. Artificial respiration was necessary on both occasions. A change was made to ether by the open method, and this was borne very well.

The anaesthesia lasted about forty minutes; of C.E. mixture ʒij were used, but much was wasted; of ether ʒjss.

After-progress.

Had a comfortable night, and was well till 7 p.m. on the following evening, when vomiting occurred and the pulse became 180, temperature 103.2°; ? smell of acetone on breath; respirations 44. Chest normal, child very quiet. Pupils normal.

Urine.

Specimen of urine obtained was clear and of light colour; a large amount of white urates appeared on cooling; the urine

was acid and smelt of acetone. No albumen, bile, pus, blood of sugar.

Acetone was shown in very great quantity by Legal's nitro-prusside test and Lieben's iodoform test, and diacetic acid was present.

Treatment was at once commenced as follows: (1) Rectum washed out with sod. bicarb. solution; (2) ʒj sod. bicarb. in ʒij water per rectum; (3) sod. bicarb. ʒss in water every hour by mouth.

This had no effect and the child became worse.

1.45 a.m. Much worse, respirations very rapid, pupils dilated, continuous rectal saline commenced.

4.55 a.m. Pulse much weaker, given pituitary extract miiij and sod. bicarb. ʒij in one pint of water, subcutaneously.

7 a.m. Moribund, given oxygen, and pituitary repeated.

8.5 a.m. Death.

An autopsy at 2.30 the same afternoon showed the liver slightly paler than usual, but otherwise everything was normal.

REMARKS.

In neither case was the urine tested for acetone before the operation.

Since the occurrence of these cases the urine of every child in the infirmary is tested for acetone on admission by Legal's test, and if present the operation is delayed, if possible, till the acetone has been eliminated, and treatment is continued after the operation.

Wallace and Gillespie pointed out⁴ that an individual deprived of carbohydrates excretes acetone and diacetic acid, but the exhibition of carbohydrates rapidly causes the disappearance of these substances. They therefore employ glucose as a prophylactic. So, acting on their suggestions, the following scheme has been instituted at the Children's Infirmary, Liverpool:

All patients admitted to surgical wards for operation (usually admitted 2.30 p.m.) have

1. Glucose, ʒj, at 4, 6, and 8 o'clock on day of admission and 4, 6, and 8 o'clock on following morning. If the child is 8 years or older ʒij are given.

2. Sod. bicarb. in the strength of ʒj to ʒiv of water instead of plain "wash-out" before operation.

If acetone is present in urine on admission,

1. Continue glucose two-hourly in daytime.
2. Give sod. bicarb. ʒj in ʒj of water two-hourly in day and four-hourly in night.

Liquid glucose is more satisfactory than the solid, and children take it well as a sweet. Sod. bicarb. solution is frequently only taken by children after a struggle.

Since the initiation of this measure no serious symptoms have developed in any patient; but the treatment has not been in force long enough to give a reliable comparison, though the post-anaesthetic vomiting has been less.

I am indebted to Mr. Dun for permission to publish the first case, and to Dr. McClellan for the second.

REFERENCES.

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RADIUM IN CANCER.

BY

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It is now some years since the newer method of using radium, advocated by Wickham and Degrais,¹ of Paris, and others, was introduced, but as yet there are few recorded results of cases treated in this country. I have employed the method in suitable cases during the past two years, and a description of some of the more typical may be of interest.

The method differs from the older one of enclosing the radium in glass or metal tubes. Instead, pure radium in the form of sulphate is spread on a varnished surface of metal or linen, and screens of various densities are interposed between the applicator and the tissues. In this way it is claimed that a much smaller quantity of radium is required, and the amount of the radiation can be graduated and concentrated either on the surface or on the deeper parts. The best results appear to be obtained from applicators containing 2½ mg. of pure radium to each square centimetre. I have used two applicators of this strength, one measuring 4½ and the other 9 square centimetres.

In the majority of my cases the disease has been in a very advanced stage. In two only was the cancer still in an operable condition. These were very similar cases of