cases exhibiting such features after the first operation active treatment was resorted to and the immediate change in the general condition of the patients was so striking as to encourage the belief that probably such a line of treatment had averted a fatal issue. In all these cases after an anæsthetic had been given again the surface wound was excised, the interpleural cavity was well sprayed out with hot saline solution, then dried by means of sterilised gauze mops, and finally the opening in the chest wall was entirely closed by stitches. In all cases healing occurred by first intention and the children made uninterrupted recoveries. The following notes give a brief account of one of these cases.

A child, aged 18 months, who had suffered from whooping-cough for the five weeks immediately preceding the date of operation, was admitted to the hospital on Dec. 6th with signs of a right-sided empyema. A rib was resected on that date and the usual routine treatment applied. On the 13th an empyema was detected on the left side and similar treatment adopted. Both cavities became quite clean as the result of drainage but showed no signs of filling up. The patient became profoundly emaciated and on Jan. 1st of the following year was in a marasmic condition and able to take only a slight amount of liquid nourishment. His weight was only 19 pounds. No cause for this general and progressive asthenia could be discovered. Chloroform was administered, the cavities in the interpleural space were cleaned, and the wounds excised and closed as already described. Immediate improvement followed. Both wounds healed by first intention. By the end of a week the child had gained one pound in weight and on Feb. 27th he was discharged as quite well, having gained four pounds in weight since the date of the second operation. Six months later he was seen and was a well-nourished healthy child having had no further trouble. The histories of the other two cases are very similar except that each patient only suffered from a single empyema. It is as difficult to give an explanation of the recovery in such cases as it is of the death of the other referred to above. The result of the method of treatment adopted, however, is encouraging and appears to be worthy of further trial. Of the remaining 44 cases which recovered one had a double empyema and was not completely healed until 73 days from the date of the first operation, the convalescence being interrupted by an attack of broncho-pneumonia. Six cases took 41 days to heal; six cases took 30 days to heal; seven cases took from 21 to 28 days to heal; 15 cases were healed in less than 21 days; whilst nine cases were healed within 14 days from the date of operation. (By "healed" is implied that the wound was entirely covered by skin and that the patient in other respects was quite well.)

I must express my indebtedness to my colleagues at Great Ormond-street for placing so much clinical material at my disposal during my tenure of the post of resident medical superintendent and for their permission to make use of the notes on the cases.

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SINGLE AND SUCCESSIVE EXTRA-SYSTOLES.

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THE patient, a seaman, was first seen in the out-patients' department of the Seamen's Hospital Society, Greenwich, in August, 1908. The following details of his history and state may be placed on record. The family history contained nothing relevant. He stated that he had suffered from "gout" 12 years previously and that at that time he had had swelling of his great toes with considerable pain and tenderness. He also said that he had had one or two mild attacks since. About 12 years ago he had "influenza" which laid him up for some weeks. Otherwise his health had been good. Venereal disease was denied; and there was no statement of value which might incline one to the view that he had ever suffered from rheumatic infection. His present trouble began in July, 1906, when a heavy case fell on his leg and he was laid up in an infirmary for six

weeks. He stated that he had since suffered, from time to time, from pain or uneasiness in the chest and that he had been short of breath on exertion.

The patient was admitted as an in-patient at the Seamen's Hospital on August 27th, 1906, complaining of pain in the limbs and shortness of breath. The notes taken at this time show that the chest moved well and that there were no abnormal physical signs on percussion or auscultation of the lungs. The cardiac dulness is described as "not increased." There were no murmurs. The pulse was markedly irregular. The abdomen was full and the liver was palpable. He was discharged on Sept. 30th. In the interval he had several attacks of shortness of breath, some of which were nocturnal. On one occasion a systolic murmur was noted at the apex. The pulse-rate is recorded as 44, 48, 50, 52, 48, 60, 72, and 96, the last figures being given shortly before the date of discharge, when the pulse is said to have been regular. The respiratory rates are given as 28, 20, 24, 20, 16, 18, 29, &c. The temperature was normal throughout.

On Nov. 19th, 1906, he was readmitted, with shortness of breath, præcordial pain, and slight dropsy. He had a slight cough and sputum. The pulse was described as small and irregular. The heart's limits were found in the nipple line in the fifth and sixth spaces, at the left edge of the sternum and at the fourth rib. The sounds were irregular and of triple rhythm, but no murmurs were heard. Crepitations at the bases and enlarged and tender liver are described. The spleen was not felt. The arteries were somewhat tortuous and thickened. The temperature was normal throughout; the pulse was counted at rates varying from 50 to 96. There was $\frac{1}{2}$ per 1000 of albumin in the urine upon admission, the specific gravity being 1005. The quantity varied during his stay from 14 to 47 ounces. The albumin had practically disappeared when he was discharged "much improved" on Jan. 30th, 1907.

The patient has been attending the out-patients' department off and on ever since, and the notes show in the main that his state has been the same throughout. Shortness of breath on exertion, a certain degree of præcordial uneasiness, and palpitation have been present. His cough has at times been troublesome. The pulse has varied but has usually been wildly irregular. There are no notes of any appreciable degree of cardiac dilatation. His condition when first seen by the writer, and ever since, has been the same. When he rests he is better and his chief troubles are the shortness of breath and palpitation brought on by exertion and the strain of a now almost constant cough. He has never shown cardiac dilatation while under observation, neither have there been any murmurs, except on one occasion, when he came with slight dropsy of the lower limbs, the apex beat at the nipple line (four inches from the left border of the sternum), and a short systolic bruit. The veins of the neck are always more prominent than they should be and pulsate markedly with the patient standing. The pulse irregularity has always been the chief feature of the case and his general condition varies with the degree of irregularity present. The heart-sounds correspond to the pulse—that is to say, there is a normal first and second sound with each beat transmitted to the wrist, and a first sound only upon the occasions when the beat fails to reach the periphery. The sounds at the apex and epigastrium have always shown correspondence; the first and second sounds have never been observed to reduplicate. He is at times capable of considerable exertion and usually walks a mile to the out-patients' department.¹

Numerous records of the irregularities have been taken and some of these are published as illustrative of the cardiac movements. It is obvious that the low pulse counts made during his stays in hospital were due to weak or missed beats. In brief, there are rare occasions on which the pulse is regular and it then varies between 100 and 120. Usually the beats are coupled or there is marked irregularity. Simultaneous radial and venous curves have allowed analysis of most of the irregularities and the observations have been checked and amplified by electro-cardiograms taken at Professor A. Waller's laboratory at South Kensington.

The first tracing (Fig. 1) shows two phases. In the first portion of the curve are five normal beats, each followed by an extra-systole at a definite and fixed time interval. Suddenly the pulse rhythm alters and each beat is

¹ Since this article was written the man has been an in-patient. The irregular pulse still constitutes the most important physical sign.

FIG. 1.*

* All the tracings have been reduced to about four-fifths of the original scale.

accompanied by *a*, *c*, and *v* waves. During the coupled portion of the tracing the *a* and *c* waves coincide at alternate beats and a full compensatory pause follows each extra-systole. The figure is an example of what may be termed *regular alternating ventricular extra-systole*.

Fig. 2 is an electro-cardiogram from a normal subject which may be used for comparison with those described later. This electro-cardiogram shows the usual three peaks as they occur in Einthoven's curves. The first (marked *a*) corresponds to auricular systole; the sharp peak following it (reading from right to left as opposed to the sphygmograph curves) and the succeeding wave which is thicker in outline represent ventricular systole. Such a curve is obtained, as those who are acquainted with Einthoven's work will know, by immersing two extremities (in this instance the right hand and left leg) in an electrolytic solution and connecting

FIG. 2.

the separate baths to the terminals of a sensitive galvanometer. Einthoven's instrument is sufficiently sensitive to show the electrical changes occurring in the body as a result of both auricular and ventricular contractions.

Fig. 3 is a similar electro-cardiogram taken from the patient. A time-tracing in one-fifth of a second and a radial pulse-tracing are also shown, the three movements having been synchronously photographed and corresponding points of time lying vertically above one another. It is to be noted that the electro-cardiogram is reversed in this curve, as compared to Fig. 1. This is dependent upon the fact that the commutator in the circuit was inadvertently turned between the taking of the two curves. Remembering that this reversal is present it will be seen that each radial beat corresponds to two small peaks, marked *a* and *v* respectively, and that these indicate the onset of auricular and ventricular contraction.² The third wave is present and, as is frequently the case, is somewhat anomalous in form. But in addition to

and a rounded curve (dipping downwards in this tracing). Superimposed upon these rounded waves are two *a* waves, and they occupy such a position that the *a* waves are regularly placed throughout. The electro-cardiogram is thus in full accord with the venous curve shown in Fig. 1.

FIG. 3.

Before proceeding further it may be well to note that although the electrical change occasioned by the extra-systole is of greater extent than that produced by the physiological beat, yet the former affects the arterial system to a far less extent. Moreover, the peak of the extra-systole

FIG. 4.

is directed in a reverse direction to the peak of the physiological beat. So far as we have proceeded it has been shown that the patient is the subject of extra-systole and that at times the premature beats alternate with the regular beats. The patient not only shows single and alternating extra-systoles, but they may occur in groups, and the venous

FIG. 5.

these waves others occur. They are marked *e*, *e*, and they correspond in time to the position of the extra-systoles which have only just affected the radial pulse. Each consists of a prominent peak (directed upwards in this curve)

records produced by such groups at times become extremely complex.

Fig. 4 shows a comparatively simple irregularity. First a physiological beat occurs and this is succeeded by a single extra-systole. In the next two groups the physiological beats are separated from each other by two extra-systoles (*c*¹ and *c*²). Despite the successive extra-systoles the *a* waves

² In consequence of the reversal the waves are upside down throughout.

of the jugular curve remain regular throughout, and in each instance the compensatory pause following the last extra-systole occurs but is naturally of varying length, according to the relationship of the last extra-systole to the next physiological beat.

Fig. 5 shows similar events, but here there is some doubt as to whether the beat (No. 6) is due to an extra-systole or to the auricular impulse which occurs at a suitable instant. It will be obvious that such a coincidence must at times happen, and the reason for suspecting this beat to be an extra-systole is the appearance which it presents in the radial tracing.

Fig. 6 shows unequivocally the possibility of the occurrence of three successive extra-systoles. After the remarks

FIG. 6.

which have been made in connexion with Fig. 3 it will require little further explanation. There is, however, one noteworthy feature. If the three extra-systoles *e*, *e*, *e* are examined it will be seen that the *a* wave is absent from the central one. As in Fig. 3, the *a* waves are regularly placed throughout, but with the occurrence of two successive extra-systoles they do not necessarily coincide with all the waves due to the ventricular contraction, and in this instance the second extra-systole is uncomplicated. Again, the presence of the *a* wave preceding this extra-systole should be noted, for in the absence of the inverted type of electric curve, the second wave could not be identified from a physiological beat. In beat 6 of Fig. 5 it is impossible to state definitely whether extra-systole or physiological beat is present, in the absence of the electro-cardiogram.

We come finally to Fig. 7. It represents the irregularity which the patient most frequently presents, and those who are acquainted with venous pulse work will recognise in it a very close resemblance, both in the arterial and venous curve, to that form of irregularity which Mackenzie has termed "nodal rhythm." When first observed great difficulty was experienced in its analysis, but when subsequent curves were taken (those exemplified in Figs. 1, 4, and 5) the key to its analysis was found and received full confirmation from the subsequent electro-cardiograms. The clue to the analysis of this

The occurrence of multiple and successive extra-systoles has hitherto never been fully demonstrated. It was suggested as an explanation of certain irregularities by Mackenzie in his well-known book, "The Study of the Pulse." Wenckebach has also figured tracings in which a similar explanation was offered. But many of the curves were open to other interpretations, and there remained considerable difficulty in eliminating the possibility of the presence of interpolated extra-systoles occurring singly or in groups. The final appeal to the electro-cardiogram may be said to have placed their occurrence and recognition in man beyond question.

The inverted type of curve which the ventricle yields during an extra-systole is not without interest.³ Our knowledge of the factors at work in the production of such extra beats in man is at present very meagre. A very notable feature in Fig. 7 is the absence of relationship between the strength of a particular pulse beat and the preceding pause. Assuming that the inflow to the heart is fairly steady throughout, and the venous curve leads us to believe that such is the case, the absence of this relationship can only be explained by supposing that the ventricular content is not so completely expelled in the case of an extra-systole as in the case of a physiological beat. It might be supposed that the whole of the ventricular muscle has contracted with diminished force or, on the other hand, that only a portion of the ventricular wall has contracted. Now if we are to consider the actual amount of electrical change occurring as a measure of the work accomplished by the heart, and such a view appears to be rational, it is impossible to consider a depression of contractility or the possibility of a limitation of the contraction to one portion of the ventricular wall. The explanation offered by Kraus and Nicolai, that the inverted wave is an expression of hemisystole, is not entirely acceptable; the evidence which they bring forward for such a view is by no means complete. The hypothesis suggested by Gotch in explanation of the normal triphasic ventricular curve, as the result of the passage of a contraction wave from base to apex and apex to base may help in the ultimate elucidation of the inverted curve. For if this hypothesis is well founded it would seem to follow that we must attribute the inverted wave of the extra-systole to a reversed or unusual order of ventricular contraction. It is probable that we are on fairly safe ground in assuming that the inverted curve of the extra-systole represents a relatively active ventricular contraction,⁴ and the fact that the cardiogram of an extra-systole is as a rule far larger in relation to the preceding physiological beat than the radial pulse would warrant us in expecting tends to confirm the view; we are further justified in concluding that the extra-systoles are beats which are anomalous in the highest degree, though from their close resemblance to each other we are forced to recognise their specific nature, and their probable origin in certain instances, as in the present one, from a fixed point.

In conclusion, brief reference must be made to the hypothesis of Wenckebach in regard to "true bigeminy" of the

FIG. 7.

tracing is that the *a* waves are prominent, the *x* depressions are large, and the *c* waves leave but a very small impression upon the curve. At one point the tracing shows five successive extra-systoles; at other points groups of two or three. The *a* waves can be identified throughout, but they are not quite so regularly placed as in preceding tracings. To what this irregularity may be due it is not possible to assert definitely. Retrograde contraction of the heart, or the production of an extra-auricular contraction in response to the ventricle, may possibly be the cause, but after a careful examination of the now abundant curves which have been obtained it is considered as highly improbable.

heart. It is almost certain that under this term he has described instances of irregularity of a totally distinct character. A full discussion of the subject is beyond the limits of this communication, for it involves questions of fine distinction, such as the differentiation of extra-systoles arising at the seat of stimulus production and irregular production of stimulus material in the same locality, be it

³ So far as observations have been made it would appear that ventricular extra-systoles alone yield inverted curves.

⁴ Einthoven points out that the magnitude of the electric variation in atypical beats is opposed to the generally adopted views of the relationship of contractility to the time of recovery.

in sinus or ventricle. Neither the absence of a full compensatory pause nor the presence of a fixed relationship between the first and second beat of a couple can be accepted as evidence against the presence of extra-systoles, and these two factors are the main ones by which Wenckebach attempts to isolate those cases which he considers as illustrating true bigeminy. It is felt that the introduction of the term is at present premature and that the subject cannot be further considered with profit until our knowledge of stimulus production, both in natural and unnatural situations, has advanced considerably. Wenckebach's view is dealt with because in a recent communication he has extended it, conceiving that not only a bigeminy but a tri- or poly-geminy may occur. The tracings which are given as examples of polygeminy, and notably that copied from Gibson's paper, appear to differ in no essential respect

FIG. 8.

from the curve reproduced in Fig. 8, which, from our knowledge of the case with which we are dealing, may be emphatically declared to represent groups of successive extra-systoles.

Since the patient has been under observation 11 successive extra-systoles is the largest number which have been noted.

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Nottingham-terrace, N.W.

TWO CASES OF HYPERTROPHIC PULMONARY OSTEO-ARTHROPATHY.

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CASE 1.—A married woman, aged 43 years, was admitted at the Royal Hospital for Diseases of the Chest on August 30th, 1905, complaining of cough and swelling of the arms and legs. She had lost her mother, a brother, and a sister from pulmonary tuberculosis, 22, 23, and 18 years previously respectively. There was no history of gout or rheumatism. She had lived in Wales until she was 22 years of age and since then in London. Until latterly she had enjoyed good health. The catamenia had always been scanty and irregular, but there was no history of vaginal discharge, and nothing pointing to disease of the pelvic organs. She had had two children but no miscarriages. Her general health had been good until the year 1900 when she took to bed for seven weeks with pains in the shoulders, hands, knees, and ankles. In 1901 she was laid up for eight weeks with pain after food and sickness. Her "present illness" dated back three years and began with an attack of right-sided pneumonia which confined her to bed for nine weeks. Since that time she had not been strong and had complained of occasional pain in the right side. 12 months before admission to hospital she was in bed, this time for seven weeks, with right-sided pleurisy. She had been in a poor state of health since this attack, and had suffered from increasing shortness of breath and constant sickness. She had noticed clubbing of the fingers for six months, swelling of the legs for four months, and swelling of the arms for one month. This swelling was accompanied by pain, especially on movement. On examination the patient was somewhat short of breath even when lying in bed. The thyroid was the seat of some general enlargement. The apex beat of the heart was in the fourth space in the nipple line. The cardiac action was rapid but regular and the sounds were clear. Over the right lung posteriorly there was absolute dulness below the angle of the scapula, with absence of breath sounds and diminished expansion,

vocal fremitus, and vocal resonance. For two inches above this area the percussion note was impaired and a few râles were heard. Physical signs similar to those at the base behind were found at the axillary and anterior bases of the lung. With the exception of some dulness at the left base, which was probably caused by the enlarged spleen, the left chest presented no abnormality. There was no evidence of ascites. The liver edge was one inch below the costal margin in the nipple line and the spleen was much enlarged, reaching to the umbilicus. The blood count gave red corpuscles 4,250,000 per cubic millimetre and leucocytes 6000; of the latter 56 per cent. were polynuclear, 30 per cent. were lymphocytes, and 7 per cent. coarse eosinophile cells. The hæmoglobin value was 40 per cent. The urine was normal. There was much œdema of the legs and arms which did not pit easily. That on the legs reached to the lower abdominal wall, that on the arms to the elbows. Lumbar œdema was also present. She had marked deformity of the arms and legs in addition to the œdema. Clubbing of the terminal phalanges of the fingers was well marked, least so in the case of the little fingers, and there was fusiform swelling of the inter-phalangeal joints. At the wrist enlargement was present, with increased width and thickness at the lower ends of the forearm bones, the styloid process of the radius being especially prominent. From the wrist upwards there was a general shelving away until near the elbow, above which the swelling started again in a similar manner. The bones at the elbows seemed to be enlarged irrespective of the thickening round the joints. There was no deformity of the shoulder-joints, but movement here and at the other arm-joints was impaired and somewhat painful. The feet and ankles showed similar deformities—clubbing of the terminal phalanges, fusiform swelling of the inter-phalangeal joints, and thickening at the ankles extending half way to the knees. There was some stiffness of the knee-joints. Skiagrams taken by Dr. A. H. Greg showed the bony changes typical of pulmonary osteo-arthropathy. A well-marked deposit of new bone was present in the concavities of the shafts of the first phalanges and the metacarpal bones. The deposit was largest in amount over the metacarpal bone of the thumbs and the little fingers, and in the latter situation it had a laminated appearance. The distal half of the ulnæ and radii were encased by new bone which almost obliterated the concavities of the shafts, the amount diminishing as the elbow was approached. Over the styloid process of the radius the new bone was abundant, and, as is often the case in this situation, it presented a fluffy appearance in the skiagram. The shafts of the metatarsal bones showed a definite layer of encasing new bone which was most marked on the first and fifth. On the fifth it presented the laminated appearance previously described. The shafts of the tibiæ and fibulæ were much thickened. They looked clumsy in the skiagrams and their surfaces had a wavy outline. She complained of stiffness and pain in the temporo-maxillary joints. There was no enlargement of the nose.

A temporary improvement on admission was followed by diminution of strength and other unfavourable indications. On Oct. 14th some pus containing diplococci which stained by Gram's method was removed through an exploratory puncture in the right axilla. On the 18th Mr. W. Turner removed a piece of the seventh rib at the angle of the right scapula and evacuated about two ounces of pus from a superficial cavity. From this time the patient steadily improved and on Nov. 5th breath sounds could be heard at the right base and it was noticed that the spleen was not quite so broad. When discharged on Dec. 11th she had gained 10 pounds in weight. A fortnight later the empyema wound had healed. On March 12th the general condition had still further improved and she had put on two stones in weight. At the right pulmonary base the evidence pointed to thickened pleura, and there were no abnormal physical signs anteriorly. The spleen showed an extraordinary diminution in size, and its edge could only just be felt below the costal margin. The enlargement of the thyroid had disappeared. As to the osteo-arthropathy, the clubbing and the other manifestations so far as they affected the soft parts had markedly retrogressed. The feet looked almost normal but the hands and forearms still presented the typical deformity of the disease. There was some pain in the hands and knees.

CASE 2.—A single woman, aged 21 years, was admitted at