A PLEA FOR A MORE DETAILED STUDY OF THE SOLDIER’S HEART.

By LIEUTENANT-COLONEL H. E. DEANE (R.).
Royal Army Medical Corps.

A PLEA for a more detailed study of the soldier’s heart, in a wide, comprehensive sense, under conditions of work and play, mild and arduous, and not only under the conditions appertaining to the at present unexplained symptoms of what is called the “soldier’s heart” in a more morbid sense.

This paper is no attempt at being didactic, but is intended to be suggestive of the need of prolonged observation of a very large number of healthy individuals, working and playing under the ordinary conditions of daily life. No members of the profession are so favourably situated for doing this as the Army Medical Service, with the whole of the British Forces at their disposal.

I must first fulfil the pleasant duty of offering my thanks to Colonel Rolt, Inspector of Gymnasia, and to the Army Gymnastic Staff, for the ready and courteous help they have always afforded me in making these observations at Aldershot, and to Sir Alfred Keogh for facilities granted me at Netley and Millbank.

I have extended these observations beyond the Army, as I wished to ascertain the course of respiratory pulse curves in professional gymnasts, acrobats and dancers. The observations are the outcome of a paper published in the Journal of the Royal Institute of Preventive Medicine in May and June, 1906, dealing with the military position of “Attention,” its absurdities and possible evils, and with the pulse-rate of recruits after gymnastic exercises. Further consideration impressed me with the necessity of knowing more of the subject of the pulse-rate of healthy individuals after exercises of various kinds and severity, before deciding that a recruit’s pulse was necessarily unduly quickened. I think some facts which I observed, and which I am not prepared to explain, are worth bringing before the Services, with a view to further observations on a large scale being made. The information given in the books, that exercise quickens the pulse, was not very helpful. To begin at the starting point, there is a table laying down the average pulse-rate for different ages. Is
that average based on pulse-rates when the subjects are lying, sitting, or standing, or on the average of all these positions? It is stated that tall men have, as a rule, slower rates than short men. I had the pulse of fifty men of the 2nd Life Guards counted during their ordinary duties one morning, and the average was exactly 75. In Schäfer's text-book of physiology, observations of Dr. Guy, of King's College Hospital, published in the "Cyclopædia of Anatomy," 1852, are quoted, stating that the pulse-rate of 100 men, averaging 27 years of age, was 78 standing, 70 sitting, and 66 lying. Dr. Guy also says that extreme results are very wide of the average, which they always are, by the way; for the difference between standing and sitting ranges from 0 to 24; between sitting and lying from 0 to 11; and between standing and lying from 0 to 28; and he only refers to healthy people. I have made observations on men and women after games, gymnastics on apparatus, free gymnastics, and after performing particular exercises: the variations are great, even in the same individual. For instance, in the case of a lady in her second year of training for a physical instructress under the Swedish system, on four different occasions the following pulse-rates were taken at the same hour, before and after the same kind of work, which lasted one hour: 104 increasing to 128 after the work; 120 decreasing to 112; 108 to 156; 92 to 124. And the work included deep breathing, which I understand had for its object a steadying of the pulse and circulation, whatever that may mean. I have been much struck by the little change in pulse-rate of the N.C.O.'s undergoing gymnastic instruction at Aldershot under the old system, of which I will give one instance. Forty-two men who had been twelve days under instruction were examined at 11 a.m., when they had already done gymnastics for an hour and a half; again at noon after another hour's gymnastics, and again at 2 p.m. after their dinners. The average at these times was respectively 89, 92 and 90; the range being respectively from 60 to 128, from 60 to 112, and from 60 to 104. Another squad of fourteen men, three days under instruction, had an average pulse-rate of 88 at 11 a.m., and of 110 at 3.30 p.m.—at the end of the day's work. I will give one instance of the result of short, sharp exercise: A senior member of the gymnastic staff had a pulse-rate of 68, and then engaged in a few minutes' bayonet work, at the end of which his pulse-rate was 152, falling in two to three minutes to 84. On one occasion I asked a recruit, who had been attending a gymnastic
course for two months, to climb a rope without using his legs; he could only make an attempt at the exercise, and his pulse-rate rose from 84 to 128; I let him stand and walk about, and in about ten minutes the rate was 88. On the same occasion I asked another recruit to go over the bridge ladder, and his pulse-rate rose from 92 to 148, and in about five minutes was 104. Time will not permit of continuing this branch of the subject, and I will close it by saying that in counting the pulse of a number of men after exercise, the pulse of the men counted later will have had time to slow down; but the fact of their slowing down within such a short time is a healthy sign, and I think it advisable to count the pulse also with the man sitting in a case where it seems unduly fast when standing.

A prominent idea as to the causation of the irritable heart of soldiers has been and is, that it depends on interference with the free rhythmic performance of the respiratory act, and that such interference throws a strain on the right side of the heart. Now, how does it do so, what evidence is there of it, and how does it upset any or all of the functions of the heart, the rhythmicity, excitability, conductivity, contractility and tonicity; and can the disordered condition be rectified by amending the presumed faulty respiratory acts? These are questions awaiting solution.

In connection with interference with natural respiration reacting on the heart, I invite special attention to an article on the "Human Mechanism of Respiration," in the Proceedings of the Anatomical Society for May, 1903, and to an article on "Why does Phthisis attack the Apex of the Lung," both by Dr. Arthur Keith. He shows that expansion of the chest and expansion of the lungs are not synonymous terms. The expanding lungs not only open out the air spaces, but also the blood spaces, which, by drawing blood in, relieve the right heart. These blood spaces are not opened out unless the lungs are expanded in their more important diameter, the vertical, by means of the diaphragm; and unless they are opened out, the respiratory movement does not assist the heart, which has to pump against increased resistance. When a man keeps his chest expanded with sinking in of the epigastrium, the lungs are increased in a transverse diameter, and not at all or very little in a vertical diameter, and the venous spaces and capillaries are indifferently or not at all expanded; only the superficial parts of the lungs are expanded, the deep parts being unaffected. Further, if a man maintains a rigid posture, the burden on the heart is still greater, because the
burden of the circulation is greater in a group of muscles in a state of tonus than when freely contracting and relaxing. I have been impressed with the necessity of being familiar with the action of the heart in healthy people, under various forms and degrees of exertion and under various phases of the respiratory act, before approaching the subject of the irritable heart of soldiers. First, I will give brief quotations on the subject from the books: “The frequency of the heart is increased by inspiration by a lessening of the vagal tone.” “Inspiration causes, after a preliminary fall, a rise of blood pressure; and conversely, with expiration there is at first a slight rise of pressure, but the main effect is a fall.” “Diastole of heart is favoured by inspiration.” “Systole of heart is favoured by expiration.” “The depth of a dicrotic notch (in a sphygmographic tracing) is increased by any cause which diminishes the volume of blood thrown out by the ventricle at each contraction, and also by any cause which, ceteris paribus, raises the pressure within the systemic arteries.”

Respiratory changes in the pulse during quiet breathing may be scarcely noticeable, and I show respiratory pulse tracings of three excellent specimens of humanity, Georges Hackenschmidt, champion wrestler of the world, Tom Burrows, champion club swinger of the world, and Will Hill, the famous high wire walker, all of which show slight lengthening of the diastole during expiration, but not constantly so, and at times the expiratory diastole is shorter than the inspiratory. Tracing 4, of Bombardier W. A. Kenna, a famous swimmer and diver, holding the world’s record for walking 90 yards under water in 2 mins. 44 sec., shows better than any of the others the inspiratory shortening and expiratory lengthening. I may mention he has remained under water for 3 mins. 54 secs.

I take next, the effect on the pulse of deep breathing, and the tracings shown, except when otherwise stated, were taken in an easy sitting posture, with the arms supported. The breaths were drawn easily without any straining, and the breath was not held. I can only give a few specimens illustrative of some of the manifestations noted, but all the originals are open to the inspection of anyone wishing to see them. Tracing 5 of Tom Burrows is typical of a constant manifestation—quickening of the pulse at the commencement of a deep inspiration, marked slowing towards the end, the succeeding expiratory beats being shorter than the terminal inspiratory ones, though longer than the early inspiratory ones; and in this instance the expiratory beats progressively shorten till
the distinct quickening of the next inspiration. This lengthening of diastole at the end of inspiration is not dependent necessarily on the prolongation of the inspiration, as tracing 6 shows, in which the inspirations were drawn sharply and shortly. In some cases, as in tracing 7, though the duration of expiration is shorter than inspiration, the pulse is quicker during expiration. Tracing 8 is another example of slowing during inspiration, and in which the expiratory beats are equal in number, though the duration of expiration is considerably shorter than that of inspiration. A good example of the book statement that inspiration quickens and expiration slows the pulse is tracing 9. The effect of these alterations of pulse-rate during the separate phases of inspiration and expira-

![Graphs of pulse tracings 1 to 8 showing changes in pulse rate during inspirations and expirations.]

tion on the total pulse-rate is practically negligible, though I may say that the tendency is to slightly increase it, which is what one might expect. I have made so many of these observations that I am forced to the conclusion that the practice of interposing deep breaths, in so-called breathing exercises, into the gymnastic work of healthy men is useless for any purpose connected with the heart and lungs.

The next manifestation is one of the first that I noticed when
I commenced this work—the production of a pulsus paradoxus by deep breathing in healthy men. I show a series of tracings, 10 to 21, and I invite attention to some points connected with the condition. Tracings 10, 11, 12 are of a public school boy, aged 17. The first tracing shows ordinary quiet breathing and two long breaths, and no pulsus paradoxus. The next two tracings show a pulsus paradoxus on each inspiration, and an instant return of the pulse to its usual character on resuming quiet respiration.

Tracings 13 and 14, from an N.C.O. under gymnastic instruction, show a pulsus paradoxus on each deep inspiration after quiet breathing, and tracing 14 a pulsus paradoxus on each quiet inspiration for three beats after ceasing deep breathing, and by the time I could change the paper the pulse had resumed its usual character, as in tracing 15. You will notice in tracing 14 that the pulsus paradoxus persists into the succeeding expiration. This selection need not be extended at present, but will serve to introduce the first point on which information is required, namely, why is a pulsus paradoxus present at one time and not at another, with the
man under apparently identical conditions, and moreover, present at one part of the day and not another, no matter how many deep breaths are drawn. Why is it sometimes brought out on drawing the first deep inspiration after quiet breathing, and sometimes not until several deep breaths have been drawn? Secondly, why does a pulsus paradoxus not occur on lying down? I say, why does it not occur? because I have not been able to get it, but on the contrary have found it present on sitting, disappearing, or markedly lessening on lying down, and returning on again sitting up. This seems to point to a mechanical origin of the phenomenon. Tracings 16, 17, 18, 19 illustrate the point. They were taken from Lieutenant Simson, Highland Light Infantry, a Superintendent of Gymnasia, a man of good physique. Tracing 16 was taken sitting, 17 lying, 18 sitting. The difference between the tracings taken sitting and lying is very marked, and another curious point is that in the last of the series, tracing 19, taken sitting up, the pulsus paradoxus is not noticeable. I first noticed this inability to get the manifestation on lying down when trying to find out what was happening to the venous pulse during the stoppage of the radial pulse, and tracings 20 and 21 illustrate the point. The tracings were taken...
consecutively. By kind permission of Colonel Wardrop, Dr. James Mackenzie saw a man with me at Millbank Hospital, suffering from disordered action of the heart, and I drew his attention to the difference in the pulse on inspiration when sitting and lying, and he confirmed the observation by getting the man to sit up and lie down alternately.

The next manifestation I wish to invite your attention to, is the occurrence of extra systoles. In the first case in which I took tracings of these extra systoles, they occurred when drawing deep breaths after a period of quiet breathing. Tracings 22 and 23 show a case in point, and they also show the marked lengthening of diastole that occurs during inspiration. These were taken on June 19, 1906; and on August 1, 1906, I tried again, and found a remarkable absence of any change in his pulse on deep respiration (see tracing 24). This man was trained in the Aldershot School under the old regulations. The next example is of a man undergoing training under the new regulations, and here again we find an inconstancy about the occurrence of the extra systoles. On March 10, 1908, I took tracings consecutively with 637 pulse-beats and there were 35 extra systoles, covering periods of quiet breathing, deep breathing, and after travelling along the bridge ladder, 13 occurring during inspiration and 22 during expiration. While holding his breath after an inspiration, during 38 beats of the pulse no extra systole occurred. I need only show one tracing (25) taken after travelling the bridge ladder, as an illustration. On another occasion I recorded 83 pulse-beats without the occurrence of any extra systole, and the man said he had been working harder than usual that morning. On another occasion, I recorded 165 pulse-beats without an extra systole, and then set the man to run about a quarter of a mile, and 8 extra systoles occurred in 250 pulse-beats. On another occasion I recorded 183 pulse-beats with no extra systole, and during part of the time he drew some deep breaths. He then climbed a rope with his hands only, and during 196 pulse-beats afterwards three extra systoles occurred, but only during the time he was drawing deep breaths. It is impossible at present to say anything as to the conditions under which extra systoles may occur in the way of exercise. The variations are great, and any conclusion jumped at from one set of observations will be upset by a further series of observations. This man appears to have less extra systoles the harder he works, and then, on the other hand, when he has no extra systoles, exertion like that of climbing a rope appears to bring
them out. The man himself says that the more work he does the less conscious he is of a double beat of the heart. He formed one of the gymnastic class recently performing at the Tournament at Olympia, and one day I took a long continuous tracing without an extra systole. He has felt these extra systoles for some years— I may mention he holds a five-mile championship, won the N.C.O.'s Mile Championship in 1907, and was second in the open Half-mile Championship at the Army Athletic Meeting, 1907. I have not yet been able to get further observations as to the cessation or otherwise of extra systoles during held breath, when they occur during ordinary respiration.

Dr. James Mackenzie describes three forms of extra systole, and he suggests as a definition of the term "a premature contraction of auricle or ventricle in response to a stimulus from some other part of the heart than the remains of the sinus venosus at the mouths of the great veins, but where otherwise the fundamental or sinus rhythm of the heart is maintained." The three forms recognised are extra systoles due to premature contraction of the auricle, of the ventricle, and simultaneous premature contraction of the auricle and ventricle; and they can only be differentiated from one another by a simultaneous record of the radial and jugular pulses, and even then difficulties present themselves.
Time will not permit of a detailed analysis of the jugular pulse, but I may say that the case under reference presents apparently two different conditions—extra systoles, and a complete pause of the heart—and I show tracing 26, from the same man as tracing 25, to illustrate the varieties.

The tracing is in three sections, the first of which shows an apparent pause. The simultaneous record of the jugular pulse shows that it was not a case of extra systole failing to show itself in the radial tracing. The second section of the tracing shows what I interpret as an extra systole starting in the auricle and transmitted to the ventricle, though the transmission is delayed beyond the period noticed in the ordinary cardiac contraction, as is demonstrated by the lengthened interval between A and C, representing respectively the auricular and ventricular contractions. The third section shows what I interpret as an auricular extra systole not transmitted to the ventricle; but I am open to correction as to this interpretation. Professor Cushny first demonstrated that the duration of the period including the long pause and the preceding beat, that is, the extra systolic beat, was less than the period of two cardiac cycles in cases of auricular extra systoles. Whereas in cases of ventricular extra systole the period corresponds to two cardiac cycles, as represented by two beats of the pulse. In the present case, the duration of the period of the long pause and preceding beat is markedly shorter than two cardiac cycles in both the second and third sections of the tracing, which points to the extra systoles being auricular in origin.

Now, as these extra systoles are not uncommon in young healthy adults, an important point at once arises applicable both to military and civil surgeons—What is the actual and prognostic significance of them? It is conceivable that a medical officer inspecting a class in a gymnasium might come across one, two, or more men with an irregularity of the pulse to the finger, as I have done; and he might think the man not only unfit to continue his gymnastic course, which would be bad, but worse still, he might think it necessary to send the man "sick." The case then only requires someone to think he hears a murmur and the man's career in the Service is in risk of being unnecessarily and unjustifiably blighted. In civil life it occurs that men are perfectly unnecessarily scared by someone discovering these extra systoles, and they get warned of this, and warned of that, see this specialist and that specialist, are sent to these baths and those baths, and make themselves miserable and poorer, and the extra systoles go on. Then someone else is con-
sulted and he sends the man back to his work and play, with the advice to ignore his extra systoles and avoid the doctors, and the advice is justified; the man is once more happy and richer. Extra systoles in no way interfere with the man's capacities or capabilities, even for undergoing great exertion; they interfere with his comfort in no way, unless a consciousness of a double beat of the heart can be said to do so. Dr. Mackenzie tells me he has been watching men with extra systoles for the past twenty-five years and that they do not interfere with the men's health or efficiency.

Acting on the idea that interference with respiration was a factor in the production of irritable heart, I made observations to see what the effect of holding the breath and of straining was on the pulse, and I wish to say the straining which can be done with a sphygmograph on the wrist, and with no objective resistance against which to strain, is not at all analogous to the strain of a short or prolonged effort against resistance when every muscle of the body is at its maximum contraction. When a breath is drawn and held, there is at first a quickening, then a slowing, as in ordinary deep breathing, followed by another period of quickening, though not equal to the initial quickening; and this again is followed by another period of slowing, so that there seems to be a more or less rhythmical quickening and slowing of the pulse during a held breath. I have not been able to make out anything definite as to the number of pulse-beats occurring in each period. I show tracings 27, 28 and 29 to illustrate the condition; and in tracing 29, you will notice seven changes in the period of held breath.

Sometimes, after the initial quickening on inspiration and the usual slowing has occurred, the beats remain of the same length, but increase in length towards the end of the held breath, as in tracing 30. As regards the slowing of the pulse, the effect of holding the breath is temporary and the pulse resumes its usual rate immediately. The change occurs in men and women, and I mention that in case someone might say that the phenomenon was due to some special type of drawing the inspiration before holding the breath. For instance, tracing 27 is of Georges Hackenschmidt, tracing 28 of Bombardier Kenna, and tracing 29 of a ballet dancer.

Now what is happening to the heart during a held breath? I show a diagram taken by means of an ortho-radiographic machine by Dr. Bruce, Physician to the X-ray and Electrical Department of Charing Cross Hospital, of Bombardier Kenna's heart while holding a breath, and it shows a marked diminution of all the diameters of the heart. The greatest decrease was in the latitudinal and left
median distances, representing respectively the right and left ventricles. The contracting process begins when the deep inspiration is drawn prior to holding the breath. I can find nothing in the effect of holding a breath to help in elucidating the cause of disordered action of the heart. When the breath is held after expiration a similar rhythmical condition obtains as in the case of inspiration, though not always so marked (see tracing 31).

My next point is the effect of straining on the pulse, and I wish to emphasise the remark that I made before, that the straining of such experiments is the poorest imitation of a real effort against resistance. The effect seems fairly constant, but one marked variation is enough to show that one explanation will not fit all cases. I show tracing 29 as a good example of what most frequently happens, the pulse becomes markedly dicrotic and slightly more rapid, and you will notice how the pulse rapidly resumes its usual character on the first inspiration after the straining ceases. Unfortunately, this could not be shown on the reproduction. Tracing 33 shows the exact converse, where dicrotism disappears during the straining and further a pulsus paradoxus is produced. As soon as quiet respiration is resumed the pulse resumes its usual character.
I got the man to draw a deep breath after one period of straining, and a pulsus paradoxus appeared. The same thing applies to the pulsus paradoxus here as to its production by deep breathing; it is not always produced, and may only appear after two or three strains. I give one more tracing (34) to show the effect of straining, and even here there is the same tendency to rhythmical shortening and lengthening of the diastoles; the tracing was taken from Georges Hackenschmidt.

Next, as to the condition of the pulse immediately after more or less violent exercise, with pulse and respiration considerably quickened. All the tracings given to illustrate this were taken immediately after cessation of the exercise. We are told that exercise raises the blood pressure, which, however, rapidly falls again. Immediately after exercise, one might expect the pulse to show signs of increased blood pressure, in whatever manner the pulse does that, and each one must decide for himself whether these tracings do indicate anything of the kind according to his own particular views of what constitutes a sign of increased blood pressure. First I show tracing 35 as a normal condition after severe exercise. It was taken from Lieutenant W. Halswelle, Highland Light Infantry, immediately after winning his heat for the Half-mile Championship at the Army Athletic Meeting, in August, 1906; and tracing 36 was taken after winning that championship the following day. Tracing 37 was taken from the Rev. Walker after winning the 100 yards in 10½ seconds at the same meeting, and tracing 38 was taken half an hour later, and after doing some gymnastic exercises in addition at my request. It shows quiet breathing and deep breathing. Tracing 32 was taken from Lieutenant Kaulbach after winning the Obstacle Race at the same meeting. I show another tracing (40) taken after a run of 100 yards, illustrating a marked lengthening of a diastole occurring at expiration during natural respiration, but occurring at inspiration, when deep breaths are drawn. The next tracing (41) shows that as the breathing quieted down this phenomenon ceased during quiet respiration, and during deep breathing the pulse shows the usual lengthening of diastole towards the end of the inspiration. As a comparison, I show tracings 42 and 43 of the pulse of a hospital porter, an ex-soldier, and an untrained man, before and after running up to the top of the hospital and down.

I need not give more tracings to illustrate the occasional occurrence of extra systoles after exercise, or of the pulsus paradoxus when the breath is sufficiently recovered to enable deeper breaths
A Plea for the Study of the Soldier's Heart

to be drawn; suffice it to say that the same thing applies to its production as during deep breathing performed not after any particular exercise. For instance, I have a series of tracings taken from an officer in a gymnastic class at Aldershot, who ran about 160 yards for me, and no change occurred in his pulse so long as natural respiration was not interfered with; but after he had drawn a few deep breaths a pulsus paradoxus appeared, and he then breathed quietly, and his pulse resumed its usual characters; then again he drew some deep breaths without any trace of a pulsus paradoxus,

and on continuing the deep breaths it appeared once, otherwise the only change in the pulse during an inspiration was the very common one of diminished primary wave. This officer had been doing no gymnastics that day prior to my taking the tracings. I may make one remark here with reference to the idea of deep breathing slowing or steadying the circulation after active exercise. In the same length of tracing taken immediately after the run, and taken after a period of quiet and deep breathing, the pulse-beats were respectively 69 and 56, the difference between which is only that not uncommonly observed between a standing and sitting posture.
independent of any active exercise. The fact becomes strongly impressed on one, that should it be thought necessary to adopt means to slow the action of the heart, the simplest, best and immediate way is to sit or lie down.

Anyone who has taken a large number of sphygmographic tracings will be familiar with the fact that the level of the tracings has a tendency to vary according to inspiration and expiration—the abscissa line, as it is called, rising and falling. In Schäfer's textbook of physiology it is stated that during a deep inspiration the line of tracing falls owing to the emptying of the radial venæ comites, and that during expiration the line of tracing rises, owing to the filling of the veins causing an elevation of the pad of the sphygmograph.

Now the line of tracing does not always fall on inspiration, either in men or women, and as another point is also illustrated in the tracings I am showing next, I will mention it now, that is, that a deep inspiration causes increased dicrotism of the pulse, which I take to mean during the actual inspiratory phase. And further, you remember the books tell us that any cause which diminishes the volume of blood thrown out from the left ventricle increases the dicrotism. Therefore, as expiration favours the escape of blood from the left ventricle one would not expect to find a dicrotic pulse during expiration.

This increased dicrotism in inspiration is by no means always the case, and I suspect the statements have been based on experiments many in amount perhaps, but on a very limited number of individuals, and explanations devised to fit those observations may not serve to fit different phenomena brought out by extending many observations over a large number of individuals. Before going further, I may say that some authorities doubt the significance of the rise and fall of the line of tracing, and I can say myself that the degree of rise and fall varies with the instrument used. You may get a marked rise and fall, for instance, with a Dudgeon's sphygmograph, and a much less marked one or none at all with Mackenzie's ink writing instrument. A good example of the falling abscissa line and of dicrotism on inspiration is tracing 44. I give this tracing to invite attention especially to the point, which requires solution, as to what significance should be attached to this rise and fall. Conclusions are drawn as to the alteration in blood pressure during inspiration and expiration from this rise and fall, but as we know, physiological conclusions change with the moon. I wish to mention one observation that I have made about this
tracing and others of the same kind, it is this; the next consecutive tracing I took under identical conditions failed to show this rise and fall of the abscissa line, and I am not prepared with an explanation. The subject is worth further study in view of unwarrantable conclusions being drawn. Tracing 45 shows the same fall, but the absolute opposite of what is called dicrotism, during a deep inspiration. Tracing 46 shows that the dicrotism occurs during expiration. This tracing was taken from a N.C.O., under gymnastic training, and I show tracing 47 of a woman, for comparison, to show the marked dicrotism during expiration, and also you will see the line of tracing rises instead of falls during inspiration and vice versa. Now, while this tracing is before you I wish to make a short digression. A short time ago I showed a series of tracings, of which this formed one, to a man who had written a good deal on the subject of sphygmographic tracings, and he said, "There is a good instance of abdominal breathing," which came as a revelation to me, because the subject of this tracing was a ballet dancer, and the tracing was taken with her corsets on, and I was under the impression she was an excellent example of the so-called costal type of breathing. I made a further series of observations on the same lady with her corsets fastened as before, with the corsets undone and breathing only with the abdomen, and breathing with the ribs and abdomen drawn in: the results in each case were identical. See tracings 48 and 49, in the former of which abdominal breathing only took place, with the corsets undone, and in the latter of which costal breathing only took place, the abdomen being drawn in, and the respiratory bag placed over the front of the chest on the left side. I used Mackenzie's ink writing polygraph in this instance, but the dicrotism on expiration is sufficiently well marked for demonstration, and also the rise of the line of tracing during inspiration and fall during expiration, though neither phenomenon is so marked as with Dudgeon's instrument.

I pass now to a point which requires investigation and explanation, and that is, the changes that occur in the jugular pulse tracing, not only during deep respiration but often observable during quiet respiration. It may be that the changes in the tracings are partly due simply to mechanical causes referable to sucking in of the tissues of the neck, but as I am not prepared to explain the changes, and am not aware of anyone having even attempted an explanation yet, it is useless to pursue the subject at present. During a held breath there is a remarkable absence of any change
in the record of the jugular pulse as compared with that of quiet respiration, so one cannot say there is any evidence of venous congestion; and this leads to reference to another point, which is the circle of dilated venules following the outline of the costal arch, and which I have generally heard referred to as an evidence of emphysema. I have had that explanation given me by a leading consultant in London, and the explanation will not bear the slightest examination. Whatever the explanation may be, there are no grounds whatever for ascribing the phenomenon to emphysema, unless some other definition of that term be applied than that usually obtaining. I confess I accepted the explanation at one time, till I began to observe more closely for myself. Emphysema is defined as a disease of the lungs characterised by over-distension of the alveoli and atrophy of the alveolar walls, and the emphysematous lung becomes inelastic and non-collapsible, and the portions of the lung most liable to emphysema are the anterior borders. Now consider the circumstances under which this circle of venules is observed. Patients suffering from emphysema do not exhibit it; young men exhibit it, who do not work any harder physically or as hard as other men who do not exhibit it, nor do the former experience any more shortness of breath on exertion than those who do not exhibit it, and further some men who undergo great exertion with no breathlessness exhibit it, and if you percuss the hearts of such men during a deep inspiration and expiration you can follow the uncovering of the heart by the lung as expiration begins and continues, and vice versa, you can follow the covering of the heart during inspiration, clearly showing that the lung is expanding and collapsing freely. I have not been able to take a satisfactory tracing of the jugular vein during a period of straining, as it has been impossible to obviate interference with the tambour by muscular action.

Now I will briefly refer to cases of disordered action of the heart. The first desideratum, indeed necessity, seems to me to make a sharp distinction between cases displaying simply disordered action without objective signs of valvular lesions, and cases of valvular lesions, further it seems necessary to apportion a due value to cardiac bruits which may be unattended with other objective or any subjective signs; and again, cases occur where a bruit exists with signs of disordered action and subjective symptoms, which completely recover. Of course, I know the difficult question arises as to whether a man who has once broken down, even temporarily, in that way, can in the interests of the Service and of
himself be profitably retained in the Service. I wish to invite your attention to one or two points which may eventually lead to something being determined as to the causation of cases of disordered action of the heart by a more detailed study of the conditions under which the men have broken down and a more detailed study of the cardiac condition. I may mention here that it is far from uncommon, as every military surgeon here will know, for men to be ordered sick from an inspection, maybe for a gymnastic course or foreign service, and also cases occur where men have reported sick for some slight ailment, and while in hospital a bruit has been discovered. Though such cases are brought before an invaliding board they are often returned to duty from Netley. Now for an instance as to the circumstances under which some men develop symptoms necessitating them reporting sick. A man, aged 25, with over six years' service, reported sick after running drill because he could not get his breath, and before this he could run about 5 miles. The breakdown occurred at Poona, where, in the month of June, the men were sent out to run perhaps 2 or 3 miles before breakfast. On the other hand, we get a history like the following: A man, aged 22, with four years' service, felt nothing wrong during his first two years' service at home, but after being in India a few months began to suffer from shortness of breath on any exertion and from palpitation. Again, a man, aged 25, with ten years' service, was sent sick from a medical inspection. He had been a cornet player for nine years and gave it up on account of shortness of breath, and he had experienced shortness of breath on exertion for six years prior to being sent sick.

I refer now to a case I was able to see with Dr. Mackenzie at this hospital, a man, aged 22, with two years' service. Five months previous to my seeing him in March of this year he had been in hospital for impetigo, and was being discharged well, when, on carrying his kit from the pack store, he suddenly felt queer, faint, and giddy, and was conscious of his heart beating, and was readmitted. I saw him on March 17 and made the following observations: The apex of the heart was in the normal situation and not the slightest sign of any enlargement could be made out, nor could Dr. Mackenzie, on a later occasion, find any evidence of dilatation. There were tender points in the two or three upper left intercostal spaces. When lying down his pulse-rate was 88, sitting 92, standing 152, and after walking up and down the ward once, 172. Immediately on lying down it fell to 92, again on sitting rose to 124, and on standing to 148. After a short interval the pulse-rate on lying was 80, sitting 84, and standing 124. I made further
notes about a week later, and his pulse-rate when lying was 84, sitting 88, standing 164, and on sitting down immediately after that count it fell to 96, and on standing up again rose to 126. I then got him, while standing, to draw a few deep breaths, not forced ones, and after them his pulse-rate was 152. The deep breaths had no slowing effect at all; quite the contrary apparently. He then walked up the ward once, and his pulse was 164, falling immediately on lying down to 84. After an interval, his pulse, on standing, was 120, and I then got him to draw a deep breath and hold it as long as he comfortably could, and after resuming breathing the rate was 112; after a short interval I repeated the observation and the rate fell to 100, and on a third repetition of the observation it was still 100. Fortunately I am confining myself rigidly to observation of facts to the best of my ability, and scrupulously avoiding drawing any conclusions or deductions; otherwise one might jump to the conclusion that holding the breath would always slow down the rapid pulses of these cases. Perhaps it will. I do not know yet, but I do know they will slow down without it, because on a still later date his pulse-rate, when standing, was from 96 to 108, and after walking up the ward rose only to 124. In dealing with the whole subject of this paper one meets with so many variations and apparent contradictions that one might almost undertake to produce off-hand half a dozen facts to contradict any explanation that might be devised. Dr. Mackenzie and I took sphygmographic tracings of the apex beat, radial and jugular pulses, and he could detect nothing to throw any light on the condition. The excursion of the jugular pulse was large, but so it may be in other cases. One frequently observes in these cases, which, however, was not so in this man, a general nervous condition and a great susceptibility to influences which had no effect whatever on the man prior to the cardiac condition supervening.

I submit, gentlemen, that the subject requires to be investigated de novo, shorn of all mere ideas, theories or suppositions, whether such have reference to cigarette smoking or anything else; detailed investigation is required as to the circumstances under which the men break down, and also a detailed graphic record of the cardiac conditions. I would ask, is it quite certain that the equipment has nothing to do with the subject? And one line of investigation I suggest, and which I cannot now pursue myself, is a detailed examination of men after marching or after a field day. As regards graphic pulse records, it requires very little practice, and Mackenzie’s polygraph attachment to a Dudgeon’s sphygmograph has the merit of being simple and cheap. His ink writing machine enables many feet of continuous tracing to be taken.
One word with reference to the idea that fixation of the chest and venous congestion are concerned in the causation of this disordered action of the heart. Now no effort of any kind, not even the simple action of carrying a chair across a room, can be performed without some fixation of the chest, and many occupations involve more fixation of the chest during efforts than is the case with the soldier. Why need fixation of the chest during an effort, which is perfectly natural, produce venous congestion sufficient to produce this cardiac condition, and, moreover, has Nature done her work so badly that not only may the ribs be fixed but also the diaphragm during an effort, and no provision be made for the temporary natural alteration in the respiratory and circulatory spheres? We know Nature does better than that though we may not know how. To say that a man is to do nothing that necessitates fixing his ribs and even his diaphragm seems nothing short of an absurdity. Constant or frequent interferences with the natural means adopted by Nature for equalizing the respiration and circulation is another thing, such as keeping men fixed in the unnatural position of "attention" or letting them march in clothing or equipment that interferes with the action of the diaphragm. As I said at the beginning I repeat at the end, this paper is simply suggestive for further and more detailed investigation of the whole subject. The field is an open one, badly calling for clearance of wild, unsubstantiated statements, contradictory theories, and explanations made to fit one observation and completely failing to fit other similar ones.

To summarise briefly: The factor or factors concerned in the production of the irritable heart of soldiers are not at all clear, though perhaps the subject can be made to appear clear on paper. The subject requires more detailed clinical study, and, moreover, prolonged investigation of large numbers of healthy men under natural conditions of work and play is required to find out normal variations, the effect of exercise, and the effect of respiration on the circulatory system, and then something definite and useful may be learnt as to the effect of respiration in cases of disease.

In view of the contradictory statements made regarding the value of artificial deep breathing and of the types of breathing, it is clear to me that the subject requires to be studied afresh from the practical and clinical sides amongst men following their ordinary daily avocations, whether that of soldier, sailor, tinker, or tailor. No body of the profession has access to sufficient material on which to study the many variations that may occur except the
Services, and this may partly account for the constant amendments, corrections, and contradictions that are met with in the literature of the subject. In carrying on the investigations one point must stand out in a lurid light, that is, rigid avoidance of being in a hurry to explain phenomena and jumping at conclusions which will only have to be altered at the next new moon, if not before.

DISCUSSION.

Inspector-General Sir Herbert Ellis thanked Lieutenant-Colonel Deane for his paper, and said he was sure they were all very pleased to have heard such a very interesting paper, and he had no doubt that they would like to hear a few remarks from Dr. Mackenzie, who took such an interest in this work.

Dr. Mackenzie stated that it had given him much pleasure to listen to such a very interesting paper. He commenced to work twenty-five years ago, and gave several instances of individuals who came to see him, suffering somewhat slightly, who were either rejected by life insurance companies, or had to pay very increased premiums if they were entertained. He pointed out that there was no subject in the history so clearly recognised, and it was in regard to this that such work as Colonel Deane's was of the greatest importance.

Sir Herbert Ellis enquired if anyone had any further remarks to make before the meeting closed. He stated that he had served on two occasions with the Marine Artillery, when he saw a larger number of men suffering with heart trouble than he did with the blue jackets during the rest of his service. He pointed out that some two years ago he was very much struck with the depot at Walmer where the present system of physical training introduced such hard work on the parade ground. He saw nine or ten young men brought down, and not fit to do the hard work on the parade ground. He was sure it was their wish that he should be the means of conveying to Colonel Deane their thanks for the very excellent paper read.

Colonel Leishman stated he had very little to say except that he had obtained certain experiences of heart trouble from the number of post mortems held, and he had got the general impression from soldiers who had died that a certain amount of heart disease was not uncommon. He stated that he had not any definite figures to show.

Colonel Deane then replied to one or two questions which were put by Colonel Leishman, and gave the price of one or two instruments, and this closed the meeting.

Sir Herbert Ellis informed them that the next meeting was an extra one, to be held on July 1st, and that Lieutenant-Colonel Macpherson would read a paper on prevention of disease in Panama and Cuba.