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Mr. LENNOX BROWNE in the Chair.

"THE ART OF BREATHING AS APPLIED TO PHYSICAL DEVELOPMENT."

By A. L. HOPER DIXON, Surgeon-Captain, A.M.S.

MR. CHAIRMAN AND GENTLEMEN,

The purport of my paper is to show the relationship which exists between the correct process of respiration and the physical development of the chest. But prior to discussing this question I must briefly occupy your attention in demonstrating, from an elementary point of view, the anatomical and physiological aspects of the parts concerned.

The trunk of the body consists of two cavities, an upper thoracic—the chest—and a lower abdominal—the belly. The higher chamber contains the lungs, heart, and great blood-vessels, that is the circulatory and respiratory apparatus, and the lower the stomach, liver, kidneys, and intestines, in other words the organs of digestion, nutrition, and elimination. Interposed between these is the diaphragm, which is by a long way the most important muscle concerned in respiration.

This muscle forms a contractile curtain and separates the chest above from the abdomen below.

The chest is conical in shape, narrow and immobilo at its upper part, broad and expansile below.

Above, in addition to supporting the neck, it provides passage for the large blood-vessels, the wind-pipe, and gullet. In front, is the upper portion of the breast-bone, laterally the first ribs, and behind is the spine. The middle portion of the chest has the breast-bone in front, ribs on either side, and the back-bone posteriorly. The floor of this cavity is formed by the diaphragm. There are twelve ribs on either side, which, with the breast-bone in front and spine behind, serve to form the bony framework of the chest. These ribs are elastic in action, on account of the cartilage interposed between them and the breast-bone, and are arched in form. Behind they are attached to the back-bone.

The ribs increase in length from the first to the seventh, after this they diminish. The seventh rib would probably be the most mobilo

and the first the most immobile. Their direction is oblique, and the interposing spaces are termed "intercostal."

I now come to the diaphragm. This is a muscle whose importance cannot be overestimated.

It forms a floor for the chest, supporting the lungs and heart, and a roof for the abdomen. It is like a dome in shape and undergoes changes in form during respiration, which I will describe later on.

It is attached to the internal circumference of the chest, to the lower portion of the breast-bone in front (ensiform cartilage), to the six or seven lower ribs on the sides, and to the back-bone behind.

So far as the muscles of the chest are concerned it would have no bearing on this paper to discuss them in detail; suffice it to say that the ribs are laced together by two sets of muscles termed "intercostal" which severally play their parts in the process of respiration.

I now come to the physiology of these parts. The lungs are the most important structure and fill up for the most part the cavity of the chest, of which they take the shape, that is, roughly, pyramidal or sugar-loaf, with the narrow portions above and the bases below.

They are united by the wind-pipe which bifurcates a little below the root of the neck.

They consist for the most part of air-cells, with a rich supply of small blood-vessels. The amount of air-cells is calculated as about 725 millions. The right lung is larger than the left on account of the latter having to make room for the heart.

For the sake of analogy the lungs may be compared to two large sponges capable of absorbing atmospheric air, as sponges would water, and then discharging, by virtue of their elasticity, the impure carbonic acid gas. This alternate expansion and filling with pure air, and contraction with emptying of impure air, constitutes the process of "respiration," and the extension to which it is done is termed the vital capacity.

The effects of respiration are twofold:—Firstly, to introduce oxygen, which is necessary for the maintenance of life, and, secondly, to get rid of substances, the products of combustion, which, if allowed to be retained, would poison the system. Inspiration fulfils the first requirement and expiration the second. So far as inspiration is concerned, the enlargement of the chest is entirely muscular, and the diaphragm is the most important muscle which provides for this increase of dimension. Every time we breathe, the diaphragm contracts, has a tendency to become flat, pushes down on the abdominal organs, and thereby elongates the vertical diameter of the chest. The increase in the transverse diameter of the chest is due to rib expansion, and the antero-posterior diameter of the chest is increased by the ribs pushing the breast-bone forward. Expiration, on the other hand, is not a muscular act. For when the inspiratory act is over, everything flies back to its original position. This is due to elastic recoil, aided by the weight of the chest; and at the same time the pressure on the abdominal organs is relieved by the withdrawal of the diaphragm.

So much for the anatomy and physiology. I now pass on to the

pith of my paper, which professes to show how breathing, properly applied, may affect the physical development of the chest.

I have shown how the chest may be increased in three diameters, namely, from above downwards, from before backwards, and sideways, and I now intend to give you a practical demonstration of correct and incorrect methods of taking one's breath. These may be easily observed from the exterior. (1) Upper chest or collar-bone and shoulder breathing, (2) mid-chest or rib breathing, and (3) abdominal or diaphragmatic breathing.

These movements are to some extent dependent on each other.

I will first take the incorrect mode of breathing. This consists in filling the upper and middle portions of the lungs with air partially at the expense of the lower.

I take an inspiration, my collar-bone and shoulders are raised, so also are the upper chest and top of the breast-bone; there is a slight movement upwards and outwards of the ribs, whilst the lower portion of the lungs remain passive. The diaphragm is only exercised to a feeble extent, and the abdomen, released from diaphragmatic pressure, shows a concave surface instead of convex. This mode of breathing is practised by the majority of people, both male and female, when asked to do a respiratory gymnastic, but is never practised during sleep. I have no hesitation in stating it to be entirely wrong. I have already described to you the narrow limits and immobility of the upper portion of the chest, where the lungs in that quarter are imprisoned in a bony, inelastic box, in close apposition to the wind-pipe, gullet, and large arteries and veins, so it is not inconsistent to suppose that this form of breathing must not only exercise undue pressure on the subjacent parts, but also cause imperfect aeration of the blood.

I have frequently seen both amateur and professional singers grow scarlet in the face whilst singing, owing to their employing this upper chest form of breathing and thereby causing congestion of the vessels already referred to.

So far as my experience of the recruit goes, he does the same thing. He has not the slightest notion of filling his lungs. He is told to take a deep breath and replies by raising his collar-bones and hunching up his shoulders. In other words, he makes an exaggerated effort of his usual mode of breathing.

The result is that his chest expansion must be very small. I have frequently met recruits with less than one inch chest expansion, and some only half an inch.

I now come to the second mode of breathing—mid-chest or rib. This consists in the expansion of the middle and lower portions of the chest, principally in the transverse and antero-posterior diameters, which is accomplished through the medium of the ribs. The latter are drawn forwards, outwards, and slightly upwards, and the breast-bone is pushed forwards. This mode of breathing does not stand out separately by itself as an independent act, but coexists either with the incorrect method of upper chest breathing, or the correct style of abdominal or diaphragmatic

breathing. On the other hand, this costal respiration may be practised in a perfectly independent manner, without encroaching on the upper chest above or the abdomen below, only by people who have made a practical study of the subject.

I will now show you the middle chest or rib form of breathing, and you will notice that it occurs quite independently of the collar-bones above and the abdomen below. But this act, as an independent one, is a physical impossibility to those who have not trained their respiratory muscles.

The third and last method of breathing is the abdominal or diaphragmatic. This is the correct form of breathing, and is assisted by the ribs.

I have already explained to you that the diaphragm forms a dome-shaped partition between the chest above and the abdomen below, and resembles in a quiescent state an expanded parachute.

The convexity is towards the chest and the concavity to the abdomen. Directly we take a deep breath the diaphragm descends and flattens out at the sides, so pressing down the abdominal organs below; and, as a consequence of this, the exterior surface of the abdomen naturally assumes a rotund convex appearance. Then, when expiration occurs, the pressure on the abdomen is released and its surface loses its roundness of outline as the result of the diaphragm flying back to its original position.

I wish to lay great stress on the shape of the abdomen during respiration, as it is a common occurrence to see people take an inspiration, hunch their shoulders up, draw in their abdomen, and then expire and puff their belly out, and they are under the impression that they are breathing correctly, whereas it is the exact opposite that should take place. In correct breathing there should be no movement of the collar-bones or shoulders, but merely a forward and upward movement of the breast-bone, more especially the lower part, combined with the rib movement already described and the alternate enlargement and diminution of the abdominal walls.

The reason why this diaphragmatic form of breathing should be cultivated is not difficult to understand when I draw your attention to the accompanying diagram, with especial reference to the confines of the lungs.

I have already referred to the cramped condition of the parts above, and this is the extreme opposite of that below. Here, below, we have the broad bases of the lungs resting on and encompassed by soft and resilient structures. Here, the lungs have full play, and their movements are not hampered as they are above by close apposition to great blood-vessels and surrounded by an immobile casement of bone.

Mr. Lennox Browne, who wrote "Voice, Song, and Speech," in collaboration with the late Mr. Behnke, justly insists that the criterion of correct inspiration is an increase of size of the abdomen and of the lower part of the chest. Whoever draws in the abdomen and raises the upper part of the chest breathes wrongly.

The lungs at their bases are surrounded by soft and yielding

parts, which can be worked with the utmost ease, because Nature has not placed any obstacle in their way; but, unfortunately, many people are continually doing this themselves. This work was written for the purpose of teaching the best method of inflating the lungs with reference to song and oratory, but the facts are equally applicable to my present subject. I may here take the opportunity of tendering my thanks to the author for many valuable hints on the subject.

I now intend to give you a practical demonstration of the means I employ for developing the chest and otherwise strengthening the body. I have brought with me, from Aldershot, three recruits of the Medical Staff Corps, who recently joined the dépôt, and who have been permitted by their commanding officer to take advantage, under my tuition, of a short course of breathing drill. (In all these exercises the individual must be stripped of his upper clothing.)

Exercise No. I.—Recumbent position, head slightly raised, arms close to the side.

Gentle breathing is now practised, which is entirely confined to the ribs and diaphragm.

The extreme upper portion of the chest, together with the shoulders, remain quiescent. There must be no movement of the collar-bones. For the purpose of resistance, a lightly diffused pressure, evenly distributed, is maintained over the seat of diaphragmatic action. This covering is made of a porous plastic material, which, after being moulded to the parts concerned, is fitted with weights, the total not exceeding $3\frac{1}{2}$ lbs.

Exercises Nos. II and III consist of the same exercise, sitting and standing respectively, only without the addition of weights.

Exercise No. IV.—The same position is assumed as in No. I. A full, deep inspiration is taken, the diaphragm is then fixed—this is done by holding the breath—and suddenly released by a forcible expiration.

Exercises Nos. V and VI.—The same exercise, sitting and standing respectively, without the addition of weights.

Exercise No. VII.—Recumbent position. Take a full inspiration—when the diaphragm is well down and the abdomen protruded, fix the former—then say the first four or eight letters of the alphabet and suddenly expel the air.

Exercises Nos. VIII and IX are the same exercise, sitting and standing, without the addition of weights.

Exercise No. X.—Recumbent position. Take a full inspiration, and whilst doing so raise two light dumb-bells from each side over the head to a half-right angle with the shoulders; now complete the inspiration, then forcibly expire, and replace the dumb-bells in their original position.

Exercise No. XI.—The same as the previous exercise, only practised on a form. The head should be well raised.

Exercise No. XII.—Recumbent position. Take a quiet and prolonged inspiration through the nose, followed by a similar expiration through the mouth. During the latter place a finger close up to and

almost between the lips and endeavour to control the exit of air without warming the finger.

Exercise No. XIII.—Take a quiet, prolonged inspiration and then forcibly expire.

Exercise No. XIV.—Take a hurried inspiration and then slowly expire with the finger to the mouth as in No. XII.

Exercise No. XV.—In the standing position, arms by side, with dumb-bell in each hand. Raise the dumb-bells at arm's length over the head during inspiration and lower to side during expiration.

Exercise No. XVI.—In the recumbent, sitting, and standing positions. A series of light respirations at the rate of about 360 to the minute.

Exercise No. XVII.—Take the hurried respirations as in the previous exercise for about five seconds, then a deep breath, and gradually expire.

I have now illustrated how a variety of exercises which, when practised regularly and in a careful manner, serve to educate the diaphragm in the various performances of its muscular duties. In order to develop any muscle it is necessary that there must be a certain amount of resistance. No muscle can be otherwise properly developed. For this reason I employ light weights with most exercises, but more especially those which are performed in the recumbent position. I find with my pupils that a slight pressure evenly distributed over the diaphragmatic area facilitates not only the method of explanation but also the practical results. Here is a shield which I recently designed for this purpose.

The diaphragm is quite as easy to train, with proper care, as any other muscle in the body; but, strange to say, owing probably to its being out of sight, it is entirely neglected. No trainer in athletics appears to devote a thought to the subject. A man who goes in for fencing, boxing, or running, devotes his training to the muscles concerned in these respective exercises, irrespective of the diaphragm, and little dreams of the enormous benefit that may be derived from training his bellows and learning to control his wind. There are many advantages to be gained by training this most important muscle in the manner I have just demonstrated. These exercises are the means of thoroughly well airing the lungs, and therefore cause a corresponding increase of respiratory capacity. This is easily proved by means of a spirometer, when it may be seen that a man who breathes correctly will have no difficulty in outrivalling a man who hunches up his shoulders every time he inspires.

They have a most beneficial effect on the general health and digestive powers, which is in great measure due to the increased oxygenation of the blood.

In weakly subjects with poor breathing capacity and delicate lungs they may, with judicious practice, be the means of establishing a robust condition of health.

So far as stammering is concerned, and when not due to any exciting cause, which may be removed by treatment, these exercises may be the means of effecting a speedy and permanent cure.

As an instance of this, here is a case in point. A few months ago at the Cambridge Hospital, Aldershot, a recruit was brought to my notice who stammered so badly that it was deemed advisable by the medical authorities to discharge him from the service. I applied for permission to treat him, but was at first refused on account of the apparent hopelessness of the case. Ultimately, however, I gained the required permission, and having satisfied myself that there was no need for surgical or medical interference, gave him a course of the above exercises, combined with reading drill, under my personal supervision, for one hour every day. He very soon showed signs of improvement, and in a short time was able to read a paragraph from a newspaper without any difficulty. At the end of three months he was practically cured, and had no difficulty either as "challenging" when a sentry, or "numbering off" on parade.

Another advantage to be gained is the increased expansibility of the chest. The greater the descent of the diaphragm the greater is the expansion of the lungs and chest walls. The lung power is therefore increased, as also is the amount of oxygen taken into the blood. The greater control a man has over his diaphragm the greater control he has over his breathing, especially when extra demands are made upon the lungs, in the way of getting rid of noxious products of combustion. His powers of endurance must therefore be increased. On the other hand, in that form of breathing where, during respiration, the collar-bones are raised and the abdomen drawn in, there is imperfect aeration of the blood, and this may lead, as I have before pointed out, to venous congestion of the upper extremity.

This style of breathing may be seen at any time with bandsmen who play wind instruments. I have frequently noticed it at Aldershot, when on a Sunday I have watched the different regiments being played to church. Their faces are scarlet, the veins on the neck and temple are outstanding, and every time an inspiration is taken the shoulders are raised to a corresponding extent with the amount of fatigue. This condition might be easily obviated by a little attention to their uniform, so as to allow the breathing parts full play, especially at the neck and waist. A tight collar constricts the wind-pipe and a tight belt and tunic have a restraining effect on the bellows.

In addition to this every wind instrument player should be instructed in the method of being able to produce a maximum amount of sound with a minimum expenditure of power.

This, I have no hesitation in saying, can only be done by the means already described.

The same remarks would apply also to buglers.

The three recruits which I have brought with me to-day have been practising these exercises since the 10th of last January. On that date their chest measurements, which were taken by an officer of the A.M.S. at Aldershot, were as follows:—

	Min.	Max.	Expansions.
Cowland	32½	34½	+ 2 ins.
Swetland.....	33	34½	+ 1½ "
Holmes	33½	36½	+ 2½ "

On the 1st March they were again measured by the same officer, with the following results:—

	Min.	Max.	Expansions.
Cowland	32	35 $\frac{1}{4}$	+ 3 $\frac{1}{4}$ ins.
Swetland	32	35 $\frac{3}{4}$	+ 3 $\frac{3}{4}$ „
Holmes	32 $\frac{1}{2}$	36 $\frac{1}{4}$	+ 3 $\frac{1}{4}$ „

In every instance there is a gain of chest expansion, which, considering the short period these exercises have been practised, tends to show the importance of this form of training.

The reason men are rejected for the army, so far as chest measurement is concerned, is because they neither know how to fill their lungs with air on the one hand, nor empty them on the other.

Give me any recruit who is healthy, but still does not come up to the required standard of chest measurement, and I will guarantee that in a few weeks, by means of the diaphragmatic drill I have shown you, that I will expand his chest to the necessary requirements.

My experience is the younger the man the more satisfactory the results.

So far as my own experiences are concerned, I commenced practising these exercises about 10 years ago, at which time I was completing a course of singing lessons. I experienced great difficulty in controlling my breath, especially whilst executing long passages, and frequently asked my master to give me instruction in the art of breath control, but he always replied, "As long as you breathe in the right place, and phrase correctly, you may take your breath how you like."

At that time my chest expansion was 2 $\frac{1}{2}$ in., but on my subsequently employing the form of breathing I am now advocating, my chest gained corresponding strides in development, and at present, I have 6 in. expansion between my minimum and maximum. This measurement was accorded me, a short time ago, by two officers at Aldershot, on the occasion of my giving a brief demonstration on this subject at the military gymnasium.

To singers the subject of this paper is most important, but time will not permit me to dilate on my experiences, so far as this portion of the question is concerned. So I must reserve my remarks until I have an opportunity elsewhere of specially addressing musical people on the subject of breathing as applied to singing.

With reference to the recruit, I would recommend a course of these exercises at the time he undergoes his gymnastic training, and I consider it essential to his advantage that they should be exercised under the supervision of a medical officer.

General the Honourable W. H. FIELDING: Mr. Chairman, being Inspector-General of Recruiting, this is to me one of the most interesting subjects that could possibly be touched upon, one that I have long wished to see raised and properly discussed. Anything that can make the recruit a man before you begin to make him a soldier, cannot fail to facilitate the real operations of recruiting, viz., the supply of recruits who can easily and quickly be fitted for the duties of soldiers. It

has, too long, been the notion to begin at the wrong end—to try to make a recruit, before he is fit to bear fatigue, into a soldier. This tends to wear him out prematurely. The lecturer's remarks have been extremely interesting to me, because he has explained and given theory and practice for the "rule of thumb" way by which we have been trying to inculcate the same practice ever since I have held my present appointment. At my inspections I invariably tell the officers in charge of the recruits who come from the factory districts, that before each recruit's drill begins, the squad should go through what we call "breathing drill," and the breathing drill is, practically speaking, a modified form of what our lecturer has so very lucidly put before you; but since, unfortunately, the time at our disposal for the training of the recruit is very limited, I should like very much if the lecturer could put in a short form some course not so long and which, though not so complete in its effects, would facilitate the recruit's training and after-life, through the development of his breathing power. I hope he will be able, before we separate, to give some sort of idea by which we can get at a more accurate appreciation of the measurement of chest expansion. The regulations, as far as we can make them do so, prescribe that the medical officers should judge much more of a recruit's fitness for a soldier's life by his chest expansion than by the actual minimum measurement of his chest, and I had a curious instance of that in the case of a recruit whom I authorized to be specially enlisted in 1891, although measurements on his enlistment were only $29\frac{1}{2}$ minimum and $31\frac{1}{2}$ maximum. He was the smallest chested man I ever allowed to be enlisted. That was in 1891. I went down by chance to Aldershot to the gymnasium to see a squad of the Northamptonshire Regiment go through their gymnastic course, and opposite me was one of these men, and I noticed how extraordinarily small he was at the chest, and yet how very easily he did all his gymnastic exercises, which lasted very nearly three-quarters of an hour, with only one very short stoppage for rest. At the end of the drill I asked that the men should strip to the waist, and I pointed out one or two men to be measured. The man who was actually opposite to me showed 6 in. expansion, and I found out that this was the man in question who had enlisted, and who, as a clerk, had spent all his life time in scribbling, with bent shoulders, over a desk; but the result of gymnastics at one of the depôts where breathing drill had been enjoined, was that this fellow had this marvellous expansion. It is recorded in my Annual Report for that year, and I was so struck with it, that I sent it to the Director of the Army Medical Department. I think that this shows clearly that we ought to be guided more by the chest expansion than by actual maximum or minimum chest measurements; all the more so because we really never can get a true minimum measurement from a recruit, especially so in the recruits that are enlisted in the manufacturing towns where they stand over looms and hardly ever breathe pure air, and therefore breathe as little as possible in the proper way. They are unable to do it; and therefore the first thing to do with them is undoubtedly to practise them in a form of breathing drill. If the lecturer could put forward some scheme to the Army Medical Department by which we could have a short but efficient course of breathing drill applied to every recruit when he first comes, I am sure the army would be very much indebted to him.

Surgeon-Major-General JAMESON: There was one remark of the lecturer in reference to the difference between the minimum and maximum of the chest girth of recruits. He spoke of it in one instance as being about 1 in. Under the "Regulations," no recruit would be accepted with only 1 in. of expansion. The expansion of the lungs estimated by the difference between the maximum and minimum is a great criterion of a man's condition; and to accept him with only 1 in. difference is wrong in every way. It is not in accordance with our experience that men have such small expansion. For example, at the St. George's Barracks, where most of the recruiting takes place in London, the average difference between the minimum and maximum is $2\frac{1}{2}$ in. Without any elaborate system of using your diaphragm, instances occur in which the difference of the two measurements is in some countries as much as 7 in. between the minimum and the maximum. I may mention, in taking the measurement, it is not the actual minimum that is taken; it is the minimum of actual breathing after an ordinary

expiration, not after a forced expiration. I have made experiments to show the difference between the two. By using a forced expiration you can get a difference of about $\frac{1}{2}$ to $\frac{3}{4}$ of an in. less than after an ordinary expiration; and in reference to the ordinary development that takes place in the chest of the recruit, we all know that in a regiment the ordinary condition of development within six months after a man joins is somewhere about 2 or 3 in. of chest measurement, and that occurs through ordinary training. I belonged to a regiment in which we took very great pains over a series of years to measure the men after an ordinary three months' course of drill in the gymnasium, and I found the average increase was about 3 in. In some cases we got $4\frac{1}{2}$ in. with men whose appearance did not denote great capacity for improvement. All these experiments that I have seen here to-day have been conducted on men in a state of rest. I should like to see them conducted on a man after hard exercise, and see where the diaphragmatic breathing comes in then. If a man is in great need of air, as after very hard exercise, he uses every muscle he has; he expands his lungs in all directions. You see the upper part work, the lower part work, every part work. He is struggling for air. That is what one sees after very hard exercise, such as a sprinter who runs 250 yds. as hard as he can go. What is the result? That man has, in the course of his exercise, manufactured within himself a large amount of carbonic acid gas, and he is trying with all his power to get rid of it. How does he get rid of it? The difficulty is in expiration, not in inspiration. The difference in length between the expiration and inspiration is as 1 to 3. He has no difficulty in inspiring; the whole difficulty is in getting rid of the carbonic acid, which has produced auto-intoxication of the blood. This carbonic acid is produced only by the violent use of a large group of muscles in a limited time, such as the muscles of the leg. If you use the muscles of the arm, you produce weakness of the muscles of the arm, but you produce no breathlessness. To produce breathlessness you must use a large number of muscles violently and in a short time. The result involved is a large development of carbonic acid, which poisons the blood, and to get rid of it the man makes every effort in his power by expanding his lungs in all directions. It struck me in seeing that man breathe he was breathing by the lower part of his lungs; the upper part of his lungs were hardly breathing. What is the result of that? The apex of the lungs is not being used. The apex of the lung is the part of the lung most liable to disease. I rather think by that kind of breathing a considerable danger is produced, namely, the danger of consumption. The upper part, the weakest part, of the lung is not properly filled, for the lower parts are being filled at the expense of the rest of the lung. In regard to the cure for stammering, that was probably cured by the ordinary reading exercise. That is the exercise used at all times for curing stammering. Holding the breath for a minute and a quarter is by no means extraordinary. The pearl divers have the power of staying in the water for two minutes. The way they do it is by preparing the lungs before descending. A pearl diver on going into the water takes three forcible inspirations and three forcible expirations, and at the end of the expirations he goes down. What he has done in the meantime is to aerate the blood sufficiently to last him a considerable time and to get rid of the buoyancy that accrues from inflation of the lungs.

Mr. A. BARNARD: Of course it would be an impertinence on my part to in any way attack this question from any other than a layman's point of view: that is to say, from the practical point of view. I have been connected with gymnastics for 20 years. I am at present captain of the Orion Gymnastic Club, and it has been in connection with that post that I have gained the experience of which I will give you one or two examples. I must, to begin with, join issue with the lecturer on one point, although, perhaps, not altogether. He says in part of his lecture that "no trainer in athletics appears to devote any thought to the subject." I may be permitted to remark that at the Orion for 12 years we have given distinct and specific attention to that one question of deep breathing. I am not prepared to say we have taught it with exactness and correctness shown here this afternoon, though I hope now to be able to do it; but, at the same time, we have done our level best to teach people that the great thing has been to fill the lungs, and not simply pant, like nine people out of ten do. Our attention was first drawn to this

by a book which I think might be read by every one with advantage; it is called "How to keep Strong," written by an American gentleman named Blakie. The Americans are considerably ahead of us in their literature on matters connected with physical development. I do not like to say that, as an Englishman, but I content myself with the statement of fact. In that book, Mr. Blakie insists upon the necessity of deep breathing. He puts it forth as an axiom that the development of a man must start from the inside, not from the outside. I know I am speaking in the presence of many medical men, and I will explain perhaps more clearly what I mean. You frequently notice with a man who, when stripped to the waist, has an enormous chest development of muscle, that if you took that muscle off you would find a very small breathing capacity underneath. Now that has been brought before my notice very often. I have more than one prominent case before me in which a man with that development has suddenly collapsed, for no apparent reason; but by the light of what I have read since, and of what the lecturer has now told me, I have not the least doubt it was simply through the improper aeration of the man's blood. Another example arising from the same cause is well known to you all. I have often had men under me, in various forms of competitive athletics, who have not lacked pluck, but they have always lacked stamina, and I believe that has been through the improper use of their lungs. What we have to start with is the axiom that Mr. Blakie lays down, namely, that the development of a man must start from his inside; that is to say, he must first be taught how to use his lungs, and after that attend to muscular development. The course I adopt is this: when a man joins he is tested as to physical capacity, put in a squad, graded according to his capacity. When we examine these men on joining we invariably draw attention to the French method of breathing, and in many instances men have come to me months or years afterwards and said what great benefit they have derived from it. They have not understood the physiology of the question; they have done it for mere mechanical practice, and they have had not only additional skill as athletes, but they have found it materially assist in their general health. I may draw attention to what I consider the very dangerous habit of wearing a webbing belt. We see the custom adopted at military gymnasia and in many amateur gymnasia. I believe it to be most dangerous, and certainly one that prevents the direct use of the lungs. That is one thing I should hope later on to see abolished. The last speaker referred to one point: he said the breathing is not hurried through hard work by the arms and legs. If I heard him correctly, I must very strongly differ from him. Putting a man to climb a rope by the use of his legs and arms, if that man is not very soon winded he is an unusually strong man. I make that remark with all deference, because I, who am only a layman, may have misunderstood the point which the gentleman has brought forward. He asked us also to notice how the man breathes after hard work. Unquestionably most men simply pant after hard work; they do not breathe. We try to get men, when they have done hard work, to steady themselves down from the nervous point of view, and then take one or two careful deep inspirations. The result is simply marvellous: the man recovers breath immediately; he quiets down, his nerves get right, and the man is all right. We cannot get all men to do that, but, where he can, that man has a distinct pull over the man that cannot. In conclusion, I would give my own personal experience on the question of deep breathing. My attention was first drawn to it 12 or 15 years ago through reading Blakie's book. I was at that time in about the best muscular condition I am in at any time during the year. My net weight was about 8 st. 5½ lbs. At that time I could breathe, when I first tested my maximum breath, up to 35 in. I could not get any more air into my lungs. That was the extreme favourable I could come to. I practised deep breathing for five minutes at a time, and, as a result, gained an expansive power of an additional 3 in., and was able to breathe up to 38. I think that fact alone is one that puts all objections to the necessity of practising deep breathing utterly out of court.

Captain O'CALLAGHAN: I would ask you, sir, and the other members of the medical profession who are present, to receive with every allowance any remarks that I, as a complete outsider, may have to offer. I would simply say that whenever I take a very deep inspiration, which I am in the constant habit of doing, I feel the whole three systems of breathing—the whole three classes of breathing—

to which the lecturer has referred : not only the abdominal but the costal breathing and the breathing of the upper part of the lung ; and I cannot help thinking that it is an advantage to fill all the lung as far as possible, and to get rid as much as you can of the residual air by a complete expiration. I regret the absence of one who has given a good deal of time to this question, whom I met accidentally—a Dr. Hambleton, who has written a good deal on this subject, and whose experience appears to me to be very valuable. He told me that if his system of exercises, which he has practised, I believe, with some success, were to be introduced generally, 36 in. might be fixed as the minimum chest measurement of the smallest recruit. I am sure the mere mention of his name, and what he has done and said, may evoke some remarks from those who are more conversant with the subject than I am.

Surgeon-Captain DEANE (Medical Staff): I think there is one application of Surgeon-Captain Dixon's paper which is worthy of attention, and that is with reference to the first position of the soldier—the position of attention ; and I hope, and my hopes are greater now than they were when I came in, owing to the remarks of the Inspector-General of Recruiting, that Surgeon-Captain Dixon's paper will be the real starting point of a new era in the physical development of the army. My hopes are greater, and I will tell you why. Some years ago a very experienced soldier and officer in the Indian Army told me that he had had the curiosity at one time to look up the history of reforms in the Service, and he found that they occupied 70 years from the time they began to be talked about until the final accomplishment. But I think with Surgeon-Captain Dixon's paper published in the press, and with the support of the Inspector-General of Recruiting, we may divide that 70 by 12, perhaps. The position of "Attention" of course refers to the complete position of the soldier, which I do not want to go into except as to his breathing. The position of "Attention" as regards the feet, and so on, is mechanically and physiologically wrong, but that I do not concern myself with now ; it is simply the breathing. The man is told to stand up, to draw his shoulders back, to force the chest out, and to draw the belly in. I may mention (I cannot explain it deeply, but my professional brethren will understand what I mean) what is the cause of respiration—the *sucking* action of the chest—*aspiration*. Aspiration has an effect not only on air but on fluids. If you get an air-exhausted ball and put it into water it will suck in water, or in air it will draw in air. That suction action of the chest is acting not only on the air in our lungs but on the heart and on the enormous blood-vessels filled with blood which Surgeon-Captain Dixon has told you pass from the head and neck into the chest through the narrow fixed upper opening. What does that mean? The man draws in his belly ; he stops all respiration ; he forces out his chest. I have seen it over and over again. The respiration is practically stopped. He keeps the chest at a medium state of inflation. The suction action is going on drawing the blood from the head and neck and the large blood-vessels into the heart, with the result that the recruit with three months' service so often presents himself at our station hospitals for palpitation and what we call "irritability" of the heart. I think Surgeon-Captain Dixon will earn the thanks of the whole medical service of the British Army if his paper will do anything to modify that position of the chest in the position of "Attention." And I recognise that there is a great deal of obstacle in the way ; for this reason : the military mind is thoroughly imbued—and I am speaking from personal practical experience—with the idea that a man's chest is here (pointing), and drill instructors, sergeant-majors, and gymnastic instructors are always telling their men, "Force your chest out." It is like putting a poker down a man's mouth to prize the breast-bone out. He cannot force the chest out, he cannot afford to do it, he is restraining his respiratory power. There is one point pregnant with wisdom in Surgeon-Captain Dixon's paper, and that is where he says the diaphragm is neglected because it is out of sight. The soldier, they say, must have an imposing appearance, and he gets that imposing appearance by forcing out the upper part of the chest where Nature never intended the most important part of the chest to be. With reference to Surgeon-Major-General Jamieson's remarks about diaphragmatic breathing being carried on during exercise, I may speak on that from a little practical experience. I have always recognised the importance of

beginning to draw a deep breath from the diaphragm. The military way of drawing a deep breath is from above downwards, with the result that it is done imperfectly. The physiological way, as Surgeon-Captain Dixon has so well told us, is to begin and follow the indication that Nature gives us, that is, to begin with the diaphragm and spread upwards. Then you get not only the bases of the lung inflated, but also those much-abused apices which you do not expand properly by breathing into the upper part only and leaving the bases alone. I have gone in a great deal for what, perhaps, you may call weight lifting—the use of heavy dumb-bells, and I can assure you you can get pumped by using an 80 lb. or 90 lb. dumb-bell five or six times quite as much as by using a lighter one. Lately I have noticed, since I have practised this form of breathing more, that, after my working, if I have got a little distressed from the exertion, I have recovered my breath sooner and been able to continue the exercise sooner by fixing my attention on my diaphragm. I lie down either on the floor or on the sofa, and breathe diaphragmatically, and what before took me two dozen breaths to accomplish in the way of recovery I can now do in six. With reference to the remark about holding the breath, I think perhaps Surgeon-Captain Dixon's experiment may not have been understood by everybody. He was not holding his breath; he was doing what is the most difficult of all respiratory acts—controlling his expiration. He was expiring a continuous stream of smoke from his mouth, which I know he can do for a minute and a quarter. There is one remark I should like to refer to, made by the Superintendent of the Orion Gymnasium, that is, with reference to belts. No doubt in some parts of the army they wear belts where, as he says, they should not be worn, constricting the abdominal muscles, and so preventing breathing. But where the belt should be worn, and where it is worn now, at all events at Aldershot, is so that it grips the hip bone. That was made a great point of by the late Dr. Roth, who perhaps knew as much of the subject as most people. He was great on chest expansion and respiration, and he went so far as to abolish braces among his patients, which are a source of great deformity by the way. He abolished braces, and put a band in the trousers of his patients which gripped the hip bone without constricting the abdominal muscles in any way and served the natural purposes for which braces were intended. I can certify to Surgeon-Captain Dixon's chest expansion, and I must say the members present have lost a great deal by not seeing him perform experimentally more in person. He has got the most wonderful control over his ribs and diaphragm of any man I have ever seen. He can breathe with one side of the chest and keep the other fixed, and I can certify that he has a chest expansion of a little over 6 in., for I was one of the officers who measured him.

The CHAIRMAN (Mr. Lennox Browne): I will venture to say a very few words on points that have struck me in reading and also listening to this admirable paper. I am sure all those present who belong to the medical profession will agree that the anatomy and physiology have been very clearly and, at the same time—which is not always in combination—correctly described; and on his part Surgeon-Captain Dixon may well feel proud of the reception that has been accorded to his paper by so competent and high an authority as General Feilding. This question of commencing the respiratory act at the diaphragm is most important, and I regret that I am obliged to speak with some disagreement with the opinion of a colleague in my profession, Surgeon-Major-General Jameson. The fact is this, we divide the act of breathing into three methods, diaphragmatic, often called abdominal rib, costal or lateral, and clavicular or collar bone; but it is impossible, except to a gymnast, to do the lateral or rib breathing without commencing with the diaphragm; but if you commence with the diaphragm you must of necessity expand the ribs, the latter overlapping the former. On the other hand, it is almost certain that if you commence breathing by expansion of the ribs without using the diaphragm you will extend it to the elevation of the collar bone, that is, to clavicular breathing. Surgeon-Major-General Jameson has objected to the fact that these exercises were done in repose; but he should remember that we were not shown the action of the man in breathing by Captain Dixon's method in the position of either standing or sitting. Of course, solely to save our time, breathing in the standing posture would represent the amount of chest expansion when in motion;

and Major-General Jameson may be assured that however trying the exercise of breath taking is begun by contraction of the diaphragm, there is no occasion whatever—presupposing a state of health—to draw up the collar bone, and that act is an hindrance and in no sense an advantage. There are certain points not alluded to by Surgeon-Captain Dixon, probably from want of time, with reference to the diaphragm, one is that from its anatomical connection with the pericardium—the covering of the heart—and its continuity with the deep tendinous covering of the muscles of the neck, which we call the deep cervical fascia, the act of breathing by elevation of the collar bone draws on the heart, and leads to a serious strain on that organ and to a general congestion of all the large blood vessels. I disagree with Captain Dixon slightly in that he considers that the diaphragm is put in any degree to useful action in collar bone breathing, for in point of fact its normal action is opposed; and, as to clothing and uniform, it is not so much the tightening of the neck by the stock to which attention was drawn so long ago by Baron Larrey and, in later years, by Mr. Myers, who was surgeon in the Coldstream Guards, that leads to heart disease, for that matter has been remedied, as it is very imperfect and exaggerated respirations. The ill effects of collar bone breathing may well be responsible—without considering the question of collar—in bringing about an over-dilated heart, and a tendency to aneurism; for this actual stretching of the cervical fascia attached to the pericardium by the elevation of the collar bone is, in itself, a source of heart weakness, and of over engorgement of the large vessels, even to the extent of aneurism. Another point has to be considered with regard to this diaphragmatic breathing, that is, with every act of inspiration, the blood pressure, as proved by an instrument called the sphygmograph or pulse graphic recorder, is increased; in other words the heart has more work to do; this takes place in normal breathing. How much more likely is it to occur in an increased degree in exercise, as in running or climbing? If the diaphragm is brought into play, not only is the chest capacity for the time being increased, but the breath-holding power, such as Surgeon-Captain Dixon has shown in that misunderstood experiment of controlling the exit of the breath, is also increased, and, therefore, so far from its not being useful in exercise, it diminishes fatigue and lessens the tendency to disease. Another useful reason for performing these exercises in the recumbent position is, that in that posture, except in illness—where there is a fight for life due to some disease of the respiratory organs—movement of the collar bone is impossible. You will see at Madame Tussaud's, and at other exhibitions, a representation of a breathing figure. The manufacturers thereof have recognised the correct mechanism of breathing in sleep, and you will always see that these sleeping figures are made to breathe with the diaphragm and the lower resilient chest walls, and with a complete immobility of the collar bone and the upper or fixed ribs. Many of these exercises, as Surgeon-Captain Dixon knows, are based on what has been taught by us for the last 20 years with regard to singing; but Exercises 10 and 15 are most original and excellent. The Exercise 16 of rapid panting of the diaphragm is, I suppose, intended to give suppleness to that muscle, and so make it more capable of controlling the exit of air. One word about these weights over the lower chest when exercising in the recumbent posture. The history of them is very curious. Sir Morell Mackenzie, in an article in "The Contemporary Review," in August, 1889, pointed out that Nero, who, although a detestable man, no doubt, politically and socially, was a most enthusiastic patron of the arts, and was particularly vain of his voice, used to lie on his back with a small plate of lead on his stomach. This, Sir Morell Mackenzie argued, was used for checking the tendency to so-called abdominal breathing, but as I contended in a rejoinder in the same Review (September, 1889), the small leaden plate on the stomach was in the nature of a dumb bell, as explained to-day by the lecturer. Now, curiously enough, Surgeon-Captain Dixon did not know of these articles in the "Contemporary," nor did I know at the time that my late collaborator, Mr. Behnke, in his breathing exercises, would first teach the pupil, by placing the flat of his hand on the stomach, to feel that he was lifting the lower chest walls; and in all cases of stammering he taught them to place a weight, such as above, in the same situation, for the purpose, not of checking, but of strengthening muscular action by offering some degree of resistance. One of the handicaps of a chairman on such an occasion as

the present, is that the wind is very often taken out of his sails, so that when the time arrives for him to speak, there is not much left for him to say. I allude particularly to the admirable remarks of Surgeon-Captain Deane, and I entirely agree with what he has said as to the general misconception of where the chest, so far as respiration is concerned, is situated. Our opponents say "you teach abdominal or belly breathing;" nothing of the kind, we teach deep chest breathing; and here, once more answering Surgeon-Major-General Jameson, if you practise deep breathing, the apices or tops of the lungs will be better filled than they are when the collar bones are drawn up as is commonly and erroneously contended. I venture as a civilian to say that I have never seen a regiment on parade but I have felt that the position of the soldier is most unphysiological, and I am glad to have heard Surgeon-Captain Deane's remarks on that subject. I had intended to have referred to that point, but I could not have hoped to illustrate it so forcibly as he has done. I am pleased also to say I have learned considerably from the other gentlemen who have spoken, especially from Mr. Barnard, and I feel myself all the stronger to combat the fast-dying opposition to the views advocated by our lecturer. I will now call on Surgeon-Captain Dixon to answer the remarks of any speaker who may have appeared to differ from him.

Surgeon-Captain DIXON (in reply) said: To General Feilding I would say that, so far as the chest expansion goes, it alters a good deal. You may take a man's measurement one day, and find it entirely different the next. I need hardly say, in response to your invitation, that I should be only too pleased to furnish a brief and useful sketch to the military authorities of the drill I have shown you to-day. To Surgeon-Major-General Jameson I would say that it is not impossible to recruit a man because he has only 1 in. chest expansion. If his age is reasonable, and he is desirable in other respects, he may be enlisted as a "special." Concerning a man with huge chest expansion, like Sandow for instance, it is merely a question of muscular development. He shoots his pectoral muscles out in front, and scapular muscles behind, and the result shows an extraordinarily large chest measurement. But take a knife and pare these muscles off, and then measure his chest expansion, and the result would probably show it to be very small. With reference to my exhaling a continuous volume of smoke for over a minute, it has nothing to do with the pearl diver. The diver may go under water for two minutes, I know, but put a looking-glass in his hand, and tell him to breathe on it in one continuous exhalation for two minutes, and I think you will find that after about 15 seconds he will be very glad to give it up. I congratulate Mr. Barnard on the good work he has done at the Orion Gymnastic Society, and shall always be pleased to give him any assistance I can. In conclusion, I beg to thank you all, Mr. Chairman and gentlemen, for the kind, indulgent manner in which you have received this paper.