ON BRONCHIAL BREATHING AND RÂLES.

A Clinical Demonstration on some of the Difficulties of Auscultation given at St. Bartholomew's Hospital.

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AUSCULTATION is not really a difficult subject. It requires some little preliminary instruction, and after that its mastery is only a question of attention and practice; yet there is no doubt that it often appears confusing to students. The difficulties, however, are chiefly of our own making, and lie not in things but in words; for the facts of auscultation, their significance, and their relation to pathological lesions, are well known and understood, while the confusion lies in the technical terms used to express the phenomena observed. Among these technical terms the chief offenders are the two with which I propose to deal to-day, namely, bronchial breathing and râles.

Technical terms are convenient, but to be really useful they must be strictly defined and accurately used; otherwise they introduce confusion instead of simplicity, and that is the case in auscultation. If we could only get rid of technical terms, and merely describe in simple language what we actually hear, there would be no confusion and little difficulty.

Students feel this confusion of terms throughout their career, but most acutely at two periods of it: early, when they are first beginning to study auscultation; and later, when they are preparing for examination. Now, why if the facts are so plain and so easy to comprehend, is so much time and energy spent in discussing the meaning of terms? It is for the simple reason that the different terms are regarded as indicating different pathological lesions. These lesions are the important conditions to recognise, and the use of a wrong term would, therefore, imply a wrong conclusion as to the pathological condition. Unfortunately, the same term has not always the same significance, that is to say, it does not always, in the mind of every teacher or examiner, correspond with the same pathological lesion, and it is because this difference of usage of terms is not recognised and taught that so much confusion is introduced into the subject of auscultation.

I propose first of all to consider what the facts of auscultation are; what their meaning is; and why it is important to give certain of them special names. I shall then be able to show where the confusion comes in, and how it will be possible to avoid it.

THE BREATHING SOUNDS.

As the air passes in and out of the larynx and air tubes it makes sounds which are carried throughout the air tubes by the column of air contained in them. These sounds are very obvious if we listen over the larynx, and they have a certain loudness and certain character. If we listen over the trachea we hear the sounds as before, but with somewhat diminished loudness and different character. Again, over the bronchi—that is, beneath the manubrium sterni in front, or behind right and left of the second or third dorsal vertebrae, the breathing sounds are still heard, but are further diminished in loudness and altered in character. Finally, if we listen in the axilla or at the base behind—that is, as far as possible away from the air tubes, the breathing sounds are entirely different from those heard in the other places specified. The breathing sounds heard in these various parts have since Laennec's time been called laryngeal, tracheal, bronchial, and vesicular respectively.

Pathologically these terms become of significance when they are heard in places in the chest where they should not normally be heard at all. If in places where vesicular breathing ought normally to be heard vesicular breathing disappears, and in its stead some other kind of breathing is heard, the conclusion may be drawn, subject to a few reservations to be dealt with later, that that portion of the lung is in a condition of disease, and the more abnormal the breathing is the greater the pathological changes which have taken place. This is the real reason why so much importance is attached to these terms, for they are regarded as the measure of the pathological change.

Over the larynx inspiration is heard as well as expiration; both are loud, noisy as it were, and both have a peculiar character, such as might be produced in a large hollow space as we know the larynx to be. On account of this hollow character this kind of breathing when heard elsewhere is often called, not laryngeal, but amphoric or cavernous. Over the trachea inspiration and expiration are both heard. The sounds are still loud and noisy; though not quite so loud as over the larynx, they are somewhat raised in tone, and have lost some of their hollow character. Over the positions described where bronchial breathing may be heard both sounds are still audible, but with a still higher pitch and a much harsher character. When in disease instead of vesicular breathing other sounds are heard they are called laryngeal, tracheal, or bronchial, according as they approach most nearly to the characters of the breath sounds heard in these respective places.

Now let us turn to vesicular breathing, and analyse what it is that we hear in those parts of the chest which are far removed from the large bronchial tubes. Here there is little noise: the sounds are muffled, blowing, soft, almost sighing in character, and what is more remarkable is that they are no longer double. We hear the blowing murmur with inspiration, but with expiration we either do not hear anything at all, or we hear the blowing murmur only for a short time during the early part of expiration. Thus vesicular breathing is characterised first by the absence of noise, secondly by its blowing character, and thirdly by the absence, or diminution in length, of the expiratory sound.

All the forms of breathing may be represented diagrammatically by lines, the varying thickness of them indicating the amount of noise. Thus vesicular breathing may be indicated by a thin line for inspiration, with a very short thin.

FIG. 1. DIAGRAMMATIC REPRESENTATION OF THE BREATH-SOUNDS.

line for expiration, if it be audible at all (Fig. 1 *a*); bronchial breathing by two thick lines (Fig. 1 *e*); tracheal breathing by two thicker lines (Fig. 1 *f*). Of course, between the diagram which represents vesicular breathing and that which represents bronchial breathing various transitional forms might be drawn, and these would correspond with the transitional forms of breathing which are actually observed. Laryngeal breathing (Fig. 1 *g*) or, as it is called, "cavernous breathing," may be represented by two double lines enclosing a space, instead of two thick solid lines, thus indicating its hollow character.

Now, just as the air tubes pass without a break from one end to the other, the larynx into the trachea, the trachea into the bronchi, the larger bronchi into the small bronchi, and the small bronchi into the bronchioles and vesicles, the lines of division between them being purely arbitrary, so it is with the different kinds of breathing to which the different names are given.

The earliest pathological change from healthy vesicular breathing is that expiration becomes audible throughout its whole length (Fig. 1 *b*); the next change is that inspiration becomes louder than it should be (Fig. 1 *c* and *d*). By-and-

Diagram to show the relation assumed to exist between the altered breathing sounds and the amount of pathological lesion.

Fig. 2.

bye both inspiration and expiration are equal in loudness and intensity, and subsequently come to have the character to which the name bronchial breathing is given.

Between bronchial and vesicular breathing we have many transitional stages, and the question is how far the term "bronchial" shall extend. No one who has ever heard true or typical bronchial breathing such as is met with in acute pneumonia can fail to have been struck by it or is likely to forget it. This everyone calls bronchial breathing, and it is so characteristic and peculiar, and it means so much pathologically, that it is evident a special name is required for it.

It seems a pity to use the same name which we employ to designate this remarkable phenomenon for a variety of other forms of breathing which have not the same pathological significance. And this is the gist of the whole matter; for while some strictly limit their use of the term to that very peculiar form of breathing most frequently heard in pneumonia; others employ it as a general expression for many kinds of pathological breathing, from the slightly modified vesicular up to the typical bronchial breathing. The importance of the question is at once apparent if we look at it from a pathological point of view. In the one case we indicate a massive, considerable consolidation of the lung, and in the other a consolidation which may be comparatively trifling.

Now if, instead of using technical terms, we described in simple ordinary language the phenomena we hear, all this difficulty and confusion would at once vanish. Thus we might put into words what we really have to observe in fact. We have first to listen whether expiration can be heard. If so, whether it is as long and as loud as inspiration. Then whether inspiration or expiration has any abnormal characters in quality and tone. These changes can all be described in plain and simple language, and without the necessary introduction of technical terms. It is in this way that I

have long taught auscultation and percussion, and it is easy to make the subject intelligible and interesting, and to avoid all the confusion which technical terms introduce.

Now let us turn for a moment to the cause of the respiratory sounds, and consider where these sounds are produced; why it is they are modified in different parts of the air passages; and how it comes that vesicular breathing is so different from all the other kinds. The sounds of breathing are produced chiefly at or about the glottis, and they are diminished in intensity; that is, they become less and less loud the farther away from the glottis we pass; thus distance from the seat of production accounts for the diminished noise we hear in different parts of the chest. As we pass farther and farther away from the larynx, the sounds become not only less loud, but rise also in pitch; this is to be connected with the size of the tubes over which we are listening.

In vesicular breathing we have another and new factor added. In the vesicles of the lungs the air column is as it were broken up by a number of partitions into compartments or spaces of different sizes. In this way the sound brought by the air tubes is so dispersed and dissipated that much of it becomes lost; the vesicular structure of the lung may be likened to a feather pillow, and the vesicles muffle the sound in a similar way. The result is that so long as the vessels are healthy but little of the breathing sounds are audible at all; we hear inspiration only, and little or nothing of expiration. As soon as the vesicular structure of the lung becomes more homogeneous—that is to say, the irregular air spaces become solid—the muffling of the sounds is less, the breathing sounds in the smaller tubes is heard, and consequently expiration becomes audible. As the consolidation extends, inspiration and expiration become more distinct, and, finally, when the consolidation becomes massive and extends, we may suppose as far as the large bronchi, the sounds produced in them are audible, and we get typical bronchial breathing. Thus it comes about that the degree of alteration in the respiratory sounds is an index of the amount of consolidation, as is represented in Fig. 2.

If, on ordinary quiet breathing, the sounds produced by the passage of air through the larynx are transmitted to the vesicles of the lung, it follows that they will be transmitted with greater distinctness when the breathing at the larynx is loud, and when it is very noisy the sounds heard over the vesicles of the lung may resemble in character those audible over some of the air tubes. It might be then difficult to say whether the cause of this exaggeration of the breath sounds lay in the larynx or in the vesicles of the lung.

Even simple increase in the rapidity of breathing produces more noise, and then both inspiration and expiration may become audible over the vesicles of the lung. This very frequently happens in children, and was named by Laennec "puerile," a term which is still retained, but which is often applied not to the breathing of children only, but to similar kinds of exaggerated or loud breathing in adults.

In children and in adults puerile breathing may very closely resemble some of the pathological kinds of breathing previously described, but in most cases it retains something of that muffled character which has been described as peculiar to vesicular breathing.

If patients are told to take a deep breath they frequently begin to make noises with the mouth, pharynx, or larynx. This must be prevented, for the noises thus produced may mask the other changes in the character of the breathing, for which we are looking.

The most serious difficulties are introduced when disease of the larynx or trachea has led to stenosis or narrowing of the tube, so that the air has to pass through a constricted aperture. It must, therefore, pass at a greater rate, and in doing so will produce a greater noise. This noisy laryngeal and tracheal breathing has received the name of "stridor." Stridor complicates diagnosis very considerably, for the sounds are loud and transmitted far and wide, and are audible over the vesicles of the lung. Under these circumstances the diagnosis of the condition of the vesicles of the lung by auscultation becomes extremely difficult, if not impossible, and mistakes may be made in either direction: either disease of the vesicles may be diagnosed when none exists, or the absence of disease inferred when considerable disease is present.

The last difficulty that needs to be mentioned is in connection with rhonchus. This sound is often of considerable intensity, so that it is frequently heard even far away from the chest. It is also often double, that is to say, both inspiration and expiration are audible. As a rule, however, rhonchus is easily distinguished from other forms of pathological breathing by its sonorous or musical character; but if these are absent, and there is nothing but the increased loudness and harshness of respiration, rhonchus may come to resemble bronchial breathing very closely, and I have seen instances in which it would be very difficult by the ear alone to say which was present. However, this difficulty is not likely often to arise.

Now, I think we are in a position to see the whole matter. Bronchial breathing introduces confusion in our ideas, because it is used in different senses by different persons. Although all agree in calling the extreme form "bronchial breathing," there is great difference of opinion as to the term to be applied to the intermediate forms, and some attempt to solve the difficulty by calling them all bronchial. It would be well if we had names for those intermediate forms which lie between bronchial breathing and vesicular, but none have been accepted. They have been called "intermediate," "undefined," (*unbestimmtes*), but these terms are unsatisfactory, indefinite, and not in general use. As our terminology is in the main anatomical, we might carry it a little further, and while speaking of laryngeal, tracheal, and bronchial breathing, add to the list "bronchiolar" breathing. There is an objection to the introduction of a new term into auscultation, and I am not inclined to advocate it. Still if we could agree upon some such intermediate term, we should do away with much of the confusion which now exists.

RALES.

I now turn to the second term which is a source of confusion—namely, "*rales*." The sounds heard on auscultation fall into two groups: first, modifications of sounds heard in the healthy chest; and, secondly, new, added, or adventitious sounds never heard in health at all. The latter group consist of rattling, bubbling, crackling, rubbing sounds. The last is called "friction," and the rest have been named "*rales*." Thus, *rales* is a general term, with several varieties. Of these Laennec made five, namely: 1, crepitant; 2, mucous; 3, sonorous; 4, sibilant; 5, dry crackling. This is really a good classification, and if it had been adopted in its entirety, as Laennec intended, there would be little confusion. Unfortunately, this is not done.

1. *The Crepitant Rale*. This is fine crackling sound, such as is heard when the hair is rubbed between the fingers over the ear, and is now more commonly known by the name of "fine hair crepitation." It is heard most frequently in the early stages of pneumonia, but it is also met with in some other conditions of lung disease.

It is usually explained as being due to the opening out by the entrance of air of collapsed air vesicles which have stuck together, the crackling sound being produced on the separation of the two surfaces.

It would be well to place the fifth variety of *rale*, the dry crackling *rale*, also under this heading—a noise which Laennec compared to the crackling of a dry bladder, and described as met with occasionally in emphysema. It is not a *rale*, but a large, coarse crackling (*rale crépitant sec à grosses bulles ou craquement*).

Between these two forms of crepitation Laennec placed another variety which he called "subcrepitant," not quite so fine as the fine-hair crepitation, nor yet so coarse as the other form. This was observed frequently in cases of early phthisis. Laennec, however, did not say, as subsequent writers have done, that this subcrepitant *rale* was pathognomonic of phthisis. Nor is the statement true, for this *rale* may be heard in many conditions of the lung which are not of tuberculous nature, and notably in bronchopneumonia.

This term "subcrepitant *rale*" is one which is not required; it is very indefinite, difficult to comprehend and to explain, and therefore would be better formally banished from our nomenclature, as indeed it now almost is in practice.

All these forms of *rale* Laennec thought not to be due to fluid, and he therefore called them "dry *rales*."

2. *The Mucous Rale*.—Mucous *rales* are crepitant, crackling

sounds also, but regarded as due to the bursting of air bubbles in fluid. They have therefore been called "moist *rales*." These *rales* vary in character according as they make more or less noise, or are produced in larger or smaller tubes, and so they give the impression of being caused by large, medium-sized, or small bubbles bursting. They are therefore described as small, medium, and large-sized crepitation. The largest of all is often called "bubbling," and in its coarsest form is known as "the death rattle," from which the name "*rale*" was originally taken. All these mucous *rales* alike are now termed "crepitation."

The larger forms of crepitation are easy to recognise by the ear, and are obviously due to the bursting of bubbles in fluid. The small crepitation has been likened to the crackling of salt when thrown on the fire, or the bursting of very fine soap bubbles in lather. This small-sized crepitation is by no means easy to distinguish from the crepitant *rales* just described, and which are now called "fine-hair crepitation." Nor are they easy sometimes to distinguish from a form of friction in which the sound, instead of being rubbing, has this crackling character.

All the sounds alike may be modified by the condition of the lung which surrounds their place of production. Thus, if the lung be solid they may acquire a sharp, clear character, and appear as if produced immediately beneath the ear. In this respect they may be compared with the clear transmission of the voice sounds which is called "pectoriloquy." Again, if the crepitations are produced in a cavity, they may not only be large and bubbling, but in addition have a ringing, hollow character, strictly comparable with amphoric breathing or amphoric resonance.

3 and 4. *Sonoro-sibilant Raies*.—The third and fourth variety of *rales*, namely, the sonoro-sibilant *rales*, are now universally called "rhonchus" and "sibilus" respectively, the former being a snoring or sonorous, the latter a hissing, piping, or whistling sound; and they both, as the epithets applied to them imply, frequently have a musical character.

It is now evident that Laennec's classification may be arranged somewhat differently. The sonoro-sibilant *rales* (the third and fourth varieties) are now called "rhonchus" and "sibilus." All the other kinds of *rales* are comprehended in the general term "crepitation," other descriptive terms being added to it to indicate what kind of crepitation it is.

Now, I think it becomes clear where the confusion is introduced in respect of the term "*rale*." The term is sometimes used strictly as a general expression, as Laennec used it with all the varieties which he described. Others, finding that "rhonchus" and "sibilus" are in such common use, and forgetting that they form but the "sonorous" and "sibilant" groups of Laennec's *rales*, use it as simply representing the remainder of Laennec's varieties of *rales*—namely, those which we describe for the most part as "crepitation."

"*Rale*," therefore, like "bronchial breathing," nowadays has two meanings, and it is impossible to say beforehand which meaning it is intended to have. It may be used as a general expression, in the same way that Laennec employed it, or it may be used as meaning nothing else than crepitation. It is evident, therefore, that we do not want the term "*rale*," and I think it would be well if we could get rid of it.

To the other terms, "mucous *rales*," "moist *rales*," and "dry *rales*," there are other objections. Terms in auscultation should be descriptive only; they should state facts and facts only, and not mix up facts with theories or inferences drawn from them. Now, this is what these terms do. The mucous *rale* is a *rale* of a crackling character; this is a fact. It is due, it is supposed, to the bursting of bubbles in fluid, the fluid being mucus; these two implications are opinions only. It is evident that the fact may be correct and the theories or inferences wrong.

Again, with the dry *rales* the sounds are crepitant, not bubbling. This is descriptive of their character. It is assumed that they are not due to the passage of bubbles of air, which is an opinion. The dry *rales* fall into two kinds, the "crepitant" and the "sonoro-sibilant." These are easily distinguished by the ear. Rhonchus and sibilus are called "dry" sounds, and are supposed to be due to secretion which lines the tube, and thus narrows its lumen; yet if the secretion be a little more in amount and lie not upon the walls of the tube, but get into the cavity of the tube, bubbles

may be produced and thus crepitation arise, so that actually the same secretion may produce a moist or a dry *râle* somewhat at random.

Again, in respect of some of the forms of fine crepitation the ear recognises the sounds readily, and they are described correctly as small crepitation, but the ear alone is quite unable to decide in many cases what the cause or mode of production of these sounds is. The same fine crepitant sound may have four modes of origin. It may be due (1) to the opening out of collapsed air vesicles, the crepitant *râle* of Laennec; (2) to the crepitation of emphysematous lungs, the "dry crackling crepitation" of Laennec; (3) to the bursting of minute air bubbles, the small mucous crepitation of Laennec; or (4) to pleuritic friction. According to the method of production we might call three of these "dry" *râles*, and the other "moist"; but it might be quite impossible by the ear alone to decide to which cause the particular crepitation were due.

It is dangerous for anyone, whether student or teacher, thus to mix up fact and inference in a common term, and it is fatal to clear teaching. I may make my meaning clear if I take another example. Nothing is commoner in the examination of the heart than to hear a murmur described as "mitral systolic." Now, what does this expression really involve? It means that there is a murmur audible at the apex, systolic in time, transmitted in certain directions—that is, to the axilla and to the interscapular space, associated with certain changes in the heart itself and in the character of the heart sounds elsewhere, and because of these facts we infer that it is produced by regurgitation through the mitral valve. The proper place for this conclusion would be at the end of the description of the case, where the diagnosis comes, and not in the commencement of it under the physical examination, where we have only to describe the facts observed, and not the conclusions drawn. At any rate, what is a more common experience with students than to hear them say that there is a mitral systolic murmur, the simple fact being that there is a systolic apex murmur, while their opinion that it is due to mitral disease is quite as likely to be wrong as right? This tendency therefore to mix up facts and inferences in a common term should be discountenanced.

What we require in an account of the physical examination is a statement of facts observed, not of inferences drawn. As long as the terms employed are descriptive only they are useful; as soon as they involve an inference or a theory they become dangerous, for the facts may be right and the conclusion or theory wrong. With care even beginners can easily be right as to the facts of observation, but from want of knowledge and experience they are only too likely to be wrong in the conclusions they draw, and what the beginner has to learn is how to observe accurately and ascertain correctly the facts. The correct conclusions to be drawn from these facts can only be learnt by time and experience.

The term "*râle*" thus becomes a source of confusion, first because it is used in different senses either as a special term or as a general one; and, secondly, because the addition of such descriptive terms as "moist" and "dry" imply a theory about which there may be great difference of opinion. It would be well, therefore, if we could banish "*râle*" altogether from our vocabulary. We do not want it, and a term which is redundant is often the cause of confusion.

When I find a student puzzled by technical terms in listening to the chest, I often say, "Now drop all technical terms, and describe simply what you hear." I rarely find that they have any difficulty in hearing what there is to hear, and describing it in simple language. I may then supply the proper technical term and explain its meaning.

Treated in this way auscultation is easy to teach and easy to learn, for the facts are plain; it is only the terms and theories which differ.

I will end as I began by saying that auscultation is easy enough, and that words alone make it difficult. The difficulties may be to a great extent avoided by not using ambiguous terms. I wish teachers could be all agreed on terms as well as they are on facts: of this I have no hope at present, but a step in the right direction will have been made if it is generally recognised that the chief sources of difficulty in auscultation are the ambiguous terms in use.

A METHOD OF STAINING THE MALARIA FLAGELLATED ORGANISM.

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STUDENTS of the malaria parasite may like to know of a simple method of making permanent preparations of the oval, spherical, and flagellated phases of the plasmodium.

So far as I am aware Sacharoff (*Amœba Malariae (Hominis) Specierum Variarum Icones Micro-photographice*, Tiflis, 1892) is the only one who has hitherto successfully stained the flagellated organism. This he succeeded in doing by collecting a series of drops of malarial blood on cover-glasses which he immediately placed in a moist chamber. When, by observing under the microscope an ordinary slip and cover-glass preparation of blood simultaneously made from the same patient, he had ascertained that exflagellation had taken place, he removed the cover-glasses from the moist chamber, spread out the drops of blood, and fixed and stained the films—using gentian violet for the latter purpose. Gentian violet stains the plasmodium so deeply that it completely obscures the pigment and all internal structure of the parasite. By employing the method which I shall describe, and by using weak carbol-fuchsin as the stain, a large number of preparations of the flagellate body, showing the pigment and certain details of structure, can be procured with the greatest ease and certainty, and, at the same time, an elaborate moist chamber be dispensed with.

Fig. 1.

Thirty or forty strips (3 inches by $1\frac{1}{2}$ inches) of thick blotting paper, each having an oblong hole (1 inch by $\frac{3}{4}$ inch) cut lengthways in its centre, are prepared; they are then slightly but sufficiently moistened with water and laid in rows on a sheet of window glass.

Fig. 2.

A patient in whose blood the crescent form of the malaria parasite abounds is selected. His finger is pricked and a minute droplet of blood, the size of a large pin's head, is