THE CAUSATION OF ÆGOPHONY.

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THE subject of ægophony as a physical sign is one of some interest, though it has perhaps declined in importance since it has been discovered that a small needle may be inserted into the chest, and a certain diagnosis of liquid effusion can be made, with but little pain and no risk to the patient ; and there may be some who think with the late Dr. Anstie¹ that "it is, in truth, one of the *fancy* signs of pleurisy, interesting rather than useful." But it is at least a natural phenomenon, the explanation of which has been much debated ; and as a physical sign it is very desirable to know whether it has any pathognomonic significance or not.

If the morbid sound is due to the presence of liquid, and can only be explained by theories involving the presence of that medium, then the sign must be absolutely diagnostic of effusion. If, on the other hand, the sign has ever been unequivocally heard when liquid has been absent, then we must look for an explanation to

¹ Russell Reynolds' 'System of Medicine,' vol. iii, p. 929, art. "Pleurisy."

physical conditions independent of liquid. There can of course be no doubt that liquid is nearly always present in the cases in which ægophony is heard; but it must not be forgotten that liquid cannot exist in the pleural cavity without considerably modifying, by its pressure, the condition of the corresponding lung; and therefore the condition of the lung must be taken into account as well as the properties of the fluid in any inquiry into the nature of the phenomenon.

I need not go far into the history of ægophony. Laennec, who first described it, attributed it to the compression and flattening of the bronchial tubes, aided by a thin layer of fluid, which could be set in movement by the vibrations of the voice. Skoda would not allow that the flattening of the bronchial tubes could produce a tremulous sound, which, according to him, must be due to the impulses of a solid body upon another body, whether solid, liquid, or gaseous.¹ And he accordingly regards it as "probable that in most cases the wall of the bronchus, within which the air resonates, recoils in impulses upon the contained air, and so gives rise to the tremulous sound." But he also thinks it possible that sometimes a particle of mucus, which incompletely covers the opening into a bronchus, may act like the reed of a musical instrument, and cause the sound in question.² Nor does he allow that the sign is distinctively characteristic of liquid effusion in the pleura.

Since this work of Skoda's, the researches of Helmholtz have so increased our knowledge of acoustics, that we are in a better position than the older physicians for forming an opinion as to the nature of this curious sound; and the late Dr. Stone, especially, did good service in applying the principles of harmonics laid down by Helmholtz to the solution of the difficulty.

The prevailing view amongst English writers at present is that liquid in the pleura is mainly responsible for the

¹ 'Abhandlung über Perkussion und Auskultation,' 6th edit., 1864, p. 77.

² Loc. cit., p. 70.

production of ægophony ; and that it produces it either by intercepting the fundamental note and lower harmonics through its inferior conducting power (Douglas Powell), or by its multiplying the media between the lung and the surface (Stone, Bristowe, Fagge), or by its supplying additional secondary vibrations to those passing through it (Douglas Powell).

I have already been led to express an opinion on the subject in my manual of 'The Practice of Medicine,' of which the first edition, published in 1890, contains the following passage (p. 343) :

"It has been shown by Dr. W. H. Stone to be due to the suppression of the fundamental note and the lower harmonics of the vowel sounds, while the higher harmonics are transmitted in an accentuated form. The most common cause is undoubtedly the presence of liquid in the pleura ; and this suppression of the lower tones is attributed to their inability to pass through—that is, to set up vibrations in—the layer of liquid. But it appears to me it is better explained by supposing that the bronchial tubes are modified by compression, so that whereas they normally resonate the lower harmonics, now they can resonate only the higher harmonics ; thus the former are stopped, not at the fluid, but at the bronchial tubes."

In later editions the passage remains substantially the same.

The object of the present communication is to state in support of this belief such facts and reasons as I could not introduce into the work referred to, and further to supply an omission which is common to my own description with that of Dr. Stone, and that is, to adequately account for the tremulous or bleating quality of the ægophonic sound.

I shall endeavour, then, to show that—

1. Ægophony is no more than, nor different from, ordinary musical *discord* or *dissonance*.
2. This discord is the result of *beats* occurring between the higher harmonics of the note uttered by the patient.

3. The beats constituting the discord are audible because the higher harmonics are reinforced, while the fundamental tone and lower harmonics are suppressed.

4. Both the reinforcement and the suppression are due to modifications of the bronchial tubes, which cause them to resonate the higher harmonics and not the lower.

The two characteristic features of ægophony are the tremulous or quavering quality of the sound, and its high pitch. It is essential to understand that the first of these qualities is musical discord, and that it has no special relation to liquid as such, nor to the mere fact that vibrations take place in this or that medium or structure, because all sounds of whatsoever character, musical or noisy, are the result of vibrations. It would hardly be necessary to insist on this were it not that some authors have written in such a way as to make one suppose that they thought a quavering sound resulted solely from a simple vibrating motion of solid or liquid.

For instance, Guttman¹ says, "Ægophony is most probably produced by vibration of the flattened, compressed bronchi. This vibration is excited by the voice, and transmitted to the thin layer of fluid which, at the upper part of the exudation, lies between the lung and the chest wall. *This tremulous movement of the sides of the bronchi gives the voice sound a quavering interrupted character.*"

But the theory of musical discord and beats is really wanted to explain the tremulous, quavering, nasal quality of ægophony. It will not be becoming for me to do more than re-state the propositions which may be found in any text-book of acoustics as follows :

That beats are produced when two notes are sounded together which differ by a small number of vibrations from one another.

That beats are sounds resulting from the repeated coincidences of the waves of sound, which coincidences

¹ 'Handbook of Physical Diagnosis,' New Syd. Soc., 1879, p. 175.

will be repeated as many times in a second as the difference between the vibration-numbers per second of the two notes.

That when the beats reach thirty-three per second the effect upon the sound is disagreeable to the ear, and becomes more so as the number per second increases.

That the maximum of disagreeable effect is reached when the number is about 70.

That the effect is again lost when the beats number more than 133 per second.

That the number of beats required to produce this discord varies in different parts of the scale, *i. e.* according as the vibration-numbers of the notes themselves are greater or smaller.

That beats are produced not only between the vibrations of the fundamental tones, but between the fundamental tones of one note and the harmonics of the others, and between the harmonics of the two tones.

That a compound tone may be harsh or dissonant in itself, if it contains very high or loud harmonics.

Now it is the fact of the identity of the ægophonic sound with a musical discord, and the necessity of explaining the former in this way, which, with one exception, writers on the subject hitherto have entirely failed to emphasise and insist upon.

It is curious that in Dr. Stone's Croonian Lecture on this subject, as given in the 'Lancet,'¹ neither of the words discord and dissonance is ever used, and no explanation of the tremulous or quavering quality of the sound is seriously attempted. Once only does he come near it, when, referring to the voice sound transmitted through fluid contained in a bag, he says :

"The principal point to be noted was the raising of its pitch. This was usually to the extent of a minor third above the note heard by the open ear, but it seemed also to be accompanied by a squeaking or bleating sound, due

¹ Vol. ii, 1879, p. 189.

to the presence of notes some octaves higher, or too remote for the exact pitch to be ascertained."

Now *squeaking* and *bleating* are different sounds. The squeak of a mouse is a very high but pure note; the bleat of a sheep or goat is discord. The above statement that high or remote harmonics were present will account for a squeak, but does not without further details explain the bleating, which after all is the essential feature of the morbid sound known as ægophony, or goat's voice.

The exception to which I have referred is Dr. Alfred Luton of Reims, the author of the article "Auscultation" in Jaccoud's 'Nouveau Dictionnaire de Médecine et de Chirurgie.' I have quite recently found that in that article, contained in vol. iv, and published in 1866, he states (p. 128) that ægophony "presents some analogy with those phenomena of sound in which the vibrations are discordant or disagreeable to the ear, forming a succession of noises interrupted by very close intervals." In 1880, and again in 1890, he published articles in which he expanded this idea of discord, with some reference to Helmholtz's work on Harmonics and the use of resonators, but he does not seem to me to take the correct view as to the occurrence of discord in this instance. I shall refer to his view again. I may say that it was after I had convinced myself of the relation of discord to ægophony that I first met accidentally with a reference to Luton's work.

We have now to consider what changes in the physical state of the lungs or pleura will bring about the conditions which necessitate discord in the transmitted sound.

We have already seen that a compound tone, such as any word spoken by the human voice is, or may give rise to, discord if it contains very high or loud partials or harmonics,—for this reason, namely, that beats are produced between the harmonics of such frequency per second as to be disagreeable to the human ear.

It is also of course true that discord is produced when two unsuitable notes are sounded ; but it is obviously more satisfactory, in the case of a single word spoken by a single individual, if we can find an explanation that does not call for the simultaneous utterance of two sounds.

In the case, then, of the single sound, discord is favoured by—

1. The pre-existence of high harmonics in considerable force.
2. The reinforcement of those high harmonics.
3. The suppression of the lower harmonics and the fundamental tone.

1. *Existence of high harmonics in considerable force.*—On this point the ground is already clear. As Dr. Stone pointed out, the fact that ægophony is best heard in the case of words or syllables containing the vowels *e* and *i* ("three," "ninety-nine") corresponds with Helmholtz's discovery that these two vowel sounds required a considerable strength of the higher harmonics.

2. *Reinforcement of the higher harmonics ; and*

3. *Suppression of the lower harmonics and fundamental tone.*

It will be seen that these two propositions must be taken together. Let us consider some of the facts of *resonance*. If a number of different tones are sounded simultaneously in the immediate neighbourhood of a tube closed at one end, or other form of resonator, some one particular tone which corresponds in its wave length to the length of the tube will be increased in loudness, in consequence of the air in the tube being set in vibration.

If this resonator is applied to one ear, and the other ear be stopped, the observer will fail to hear, or hear but feebly, the other notes which do not correspond to the resonator.

Now the transmission of the voice to the surface of the chest has long been admitted to be a phenomenon of resonance ; it is called *vocal resonance*. The synonym of

bronchophony is *increased vocal resonance*, and yet the full significance of resonance in the production of ægophony seems not to have been recognised even by Dr. Stone in his discussion of this subject. The voice in the healthy individual is resonated in the bronchial tubes, and the loudness with which the vibrations are heard in the chest is due to their reinforcement in the bronchial tubes. The bronchial tubes, then, are resonators of certain tones: if they are completely obstructed or compressed, there is no resonance at all; the voice is practically inaudible through the chest. However superior solids may be as conductors of sound to liquids and air, the completely solid lung, with compressed bronchi, does not bring the vocal sounds to the surface of the chest. It is, indeed, practically known and admitted that the transmission of the voice sound to the surface of the chest is dependent on patent bronchial tubes, and does not take place, or in the feeblest possible way, if the bronchial tubes are, as tubes, abolished.

Vocal resonance, as is well known, varies much in individuals: it is most marked in males with low-pitched voices; it is feeble in women and children with high-pitched voices. This is not explained by conduction; it is explained by assuming that the bronchial tubes as resonators correspond more nearly to the lower pitched vocal sounds than to the higher pitched vocal sounds.

The application of this to ægophony is the following:— If we have a stopped tube which resonates to a given note, and then shorten the tube by one half, it will not now resonate to the given note, but will resonate to a note of twice the number of vibrations per second, and one octave higher.

If we can substitute for the normal condition of the bronchial tubes a condition which will make them resonate the higher tones, we shall be in the way to produce ægophony; we shall at the same time suppress the lower tones, because there is nothing to resonate them, and we shall reinforce the higher tones because the vibrations of

these higher tones meet with air-columns of lengths which correspond to the length of their undulations. If the higher harmonics of certain tones are sufficiently reinforced, discord results.

I maintain, therefore, that ægophony is produced by such modifications of the bronchial tubes as enable them to resonate the higher tones and harmonics of the vocal sounds, and render it impossible for them to resonate the lower tones.

Admitting, therefore, the justice of Dr. Stone's observation that the lower notes are suppressed, I believe that is not mainly by the resistance of the fluid or the difficulty of transmission from medium to medium, as Dr. Bristowe suggests, but by the fact that they are suppressed for want of suitable resonating spaces on the laryngeal side of the pleura.

I shall support this position by some other considerations, positive and negative.

Is the explanation that the lower tones are cut off by the fluid media consistent with our knowledge of acoustics? Under what law of acoustics does this "filtration" through media come?

Dr. Stone says that ægophony is to be explained as "vocal resonance divested of its lower fundamental tone by the deadening effect of a layer of more or less inelastic fluid."

In reference to this I may say that, on the one hand, I have hitherto failed to find in works on acoustics any statement to the effect that liquids will cut off low tones and transmit high tones; and, on the other hand, I have so far failed to get this result experimentally. I have applied bladders and india-rubber bags of water to the backs of healthy people, and have auscultated through the bag: the voice has always come through with diminished intensity, but without any ægophony or suppression of the lower tones. I fitted an india-rubber bottle containing water against the lower end of a speaking-tube in my house, and applied the ordinary binaural stethoscope; an assistant spoke

down the tube, a vertical distance of about thirty-four feet, and also sounded a pitch-pipe yielding A and C. The sounds were transmitted quite clearly without any ægophony or discord, though not as loudly as they would have been without the intervention of the water-bag.

Dr. Bristowe elaborates this part of the theory somewhat, and rightly excluding all questions of the relative conducting powers of gases, liquids, and solids, from consideration, he points to the difficulty of transmission between different media; and then, as an explanation of the filtration or differential transmission of the tones, he states that "high notes are more penetrating than those of graver tone, and hence would be less likely to suffer in their passage."

But there are difficulties in the way of our accepting this statement. Everyday experience is in direct opposition to it. It is the bass notes of the organ which at the end of the Voluntary vibrate through the seats of the church, and send a thrill up the backs of the congregation; it is the bass notes of the big drum which can be heard at a distance of half a mile, when the fifes and piccolos are inaudible; it is the bass notes of the piano which in their wearisome tum-tum are alone heard through the walls of our next-door neighbours or the next-floor lodgers; and it is the accompaniment only of the street organ, heard through closed windows, which prevents us from settling down to an original article when the said instrument is played in the adjacent street or the mews behind.

In all these instances the bass notes carry further, and have more penetrating power so far as air space, brick walls, doors, and windows are concerned. I cannot recall an everyday experience involving transmission through liquid.

That some high notes should be "penetrating," and that we should talk of "piercing shrieks," referring generally to the higher notes of the female register, is, I think, to be explained by the same laws that I am appeal-

ing to, for an explanation of ægophony, namely, those of resonance. The sounds which are penetrating to our ears are those which resonate in our external meatus,—that is, those whose lengths in air correspond to the length of the human external meatus. If anyone sing up the gamut, he will find two or three consecutive notes which sound much fuller than either those above or those below ; they seem to “ring in the ear,”—and, indeed, in more technical terms, they do resonate in the external meatus. But the sounds above them do not resonate in a cavity for which their wave lengths are too small, and those higher notes are not more penetrating than those which are lower, and certainly they are not more penetrating in proportion to the rapidity of their vibration.

The resonating properties of the external meatus are, of course, recognised in works on acoustics, and the cavity is stated to correspond to the wave lengths of tones between $E^3 = 2560$ vibrations, and $G^3 = 3072$ vibrations.

In no other sense, I believe, can high notes be shown to be more penetrating than low ones.

In support of the statement of his belief that coarse vibrations are stopped by inelastic fluid, Dr. Stone has drawn a comparison between the properties of light and sound, implying that the greater penetrating powers of the notes of more rapid vibrations of sound is an illustration, on a small scale, of the much greater penetrating powers of the waves of light.

The comparison is unsuitable, as the vibrations take place in different though co-existing media ; and it suggests that sound-waves can never penetrate where light is absolutely cut off—a proposition difficult to maintain.

But I shall bring forward in support of the opposite view an illustration from that very subject of light to which reference has been made. The colour of the sky was thus explained by Professor Tyndall. The vibrations of greater rapidity, which cause blue light, are reflected from particles in the atmosphere ; while the red rays, which are due to vibrations of less rapidity and large intervals,

are enabled to pass by and overleap, so to say, these obstructions in their way. We see the reflected blue rays ; we lose the transmitted red rays. Here is the recognition that, in the case of vibrations in the same medium, those of which the vibrations are slower and of greater wave length, have greater carrying or penetrating power than those which have greater rapidity and less wave lengths.

Here the analogy is complete, and we see that in each case the slower vibrations carry farther.

Dr. Luton,¹ to whom I have referred above, supposes that the discord is produced between two sounds which take different routes, one through the liquid and the other outside it; and that the former is delayed in its transmission. His most recent statement is as follows :

“ Now we have already said that ægophony results very probably from the superposition of two sounds at least in musical discordance. Of these two components, one is the vocal sound transmitted entirely by the solid parts of the neck, chest, and sometimes even by the indurated lung. The other, more feeble and more distant, has to pass through the liquid pleural effusion, and undergoes refraction thereby. These two sounds, although emanating at the same moment from the same point, are dissociated in consequence of the slight delay which the effused serum imposes on the vibrations which pass through it ; and both arrive simultaneously at the ear, but with a delay sufficient to give rise, by their mingling conflict, to that discordance which is called ægophony.”

There is a want of clearness about this explanation, which imagines tones arriving simultaneously, but one behind the other ; but the main objection is that the hindrance which a layer of liquid opposes to the sound-waves does not result in loss of their frequency per second as waves, but in diminution of their amplitude ; it

¹ Loc. cit., tome iv, p. 128 ; ‘ Union Médicale et Scientifique du Nord-Est,’ Reims, March, 1880, p. 65 ; ‘ Union Médicale du Nord-Est,’ Reims, May, 1890, p. 168.

is not pitch that is affected, but loudness. His subsequent record of success in separating one of the tones or harmonics by means of a resonator, only proves that there is discord from the co-existence of two tones of a certain relation to one another; it does nothing to confirm his view of the manner in which the dissociation arises.

The theory requires also that ægophony should be always heard at the edge of the liquid, which is not necessarily the case, as I hope to show later. We see, then, that transmission through a liquid medium is not sufficient to account either for the suppression of the lower tones, or for the discord of the higher.

I will now call attention to the different familiar noises with which ægophony is compared, and I shall attempt to show that their occurrence has nothing whatever to do with transmission through liquid media, but solely with conditions of resonance. Indeed, it was this comparison which first convinced me that an explanation must be found outside the relation of liquid to the transmission of sound-waves, and also led me to recognise that in the phenomena of beats or discord we must find the cause of the tremulous quality of the sound.

These noises are the bleating of a goat, the human nasal voice, the noise of the Punch-and-Judy show, and the doubtful sort of music made by wrapping some tissue-paper round a comb and then blowing on it. In each case there are notes of high pitch, and tremulous, twanging, discordant quality. The human nasal voice is produced by the resonance of the laryngeal vibrations in the meatuses of the nose, instead of, or in addition to, their being resonated in the cavity of the mouth. The meatuses are shorter and narrower passages than the buccal cavity, and they will resonate high notes, which the mouth cannot; while the mouth will resonate low notes, which the meatuses cannot. If there is little resonance in the mouth, the lower tones will be suppressed; if there is resonance in the nose as well as in the mouth, the higher tones will be at least reinforced to a greater extent than

occurs in the ordinary speaking voice. The instrument which is employed for producing the well-known Punch-and-Judy voice consists of two small strips of tin bent into a gentle curve, and bound to each other with their concave faces opposite, so that they enclose a fusiform space ; across this and parallel to the strips runs a piece of tape, dividing the fusiform space longitudinally and equally. The tape can be made to vibrate by blowing between the strips, and produces a discordant sound ; the construction of the instrument, which is about an inch and a quarter long and a quarter of an inch wide, obviously provides for the formation and resonance of higher tones. In the comb organ it is obvious that the sound is due to resonance in the spaces between the teeth of the comb. We may probably with safety assume that the bleating of the goat is due to resonance of the laryngeal vibrations in some cavities, whether nasal or buccal, which only correspond to the higher tones ; and it is not very likely that it depends upon the presence of a layer of fluid placed anywhere to intercept the lower tones.

I may here, perhaps, deal with the position in which the morbid sound is usually best heard, as this is sometimes thought to have lent some support to the prevailing theory of its production. It is commonly stated that ægophony is best heard in the neighbourhood of the angle of the scapula, or at the upper level of the liquid. Now of these two statements I think the former is the more accurate, but then it is very incomplete ; while the latter is quite often contradicted by the facts. It is this latter statement, however, which seems in accordance with the current explanation of ægophony, because a thin layer is thought to be sufficient to modify the voice, while a thicker layer will entirely suppress it.

As a matter of fact, the area over which ægophony is heard may be entirely within the area of dulness, so that the upper margin of the former does not approach the upper margin of the latter ; the area of ægophony may reach down to the tenth or eleventh rib, when the dulness

reaches above the angle or even above the spine of the scapula: the area of ægophony may occupy a vertical extent of five or six inches. Analysing twenty-one cases in which I carefully ascertained the limits of ægophony, I find nine in which it occupied a small area of one to five square inches below the lower angle of the scapula, either close to it, and then generally on the outer side; or at some distance below it, and then generally near the spine. In all cases but one ægophony was below, and mostly several inches below, the upper margin of the dulness (Figs. 1—9).

In four cases ægophony occupied a band of about six inches long and two or three broad, running outwards transversely or somewhat obliquely from near the spine to the posterior border of the axilla; twice across the angle of the scapula, and twice entirely below it, but always far below the upper margin of the dulness (Figs. 10—13).

In eight cases ægophony spread over a large area. In seven of these it occupied the base, reaching from above the angle of the scapula nearly to the bottom of the chest, with a vertical extent of four to seven inches, and laterally extending from the spine to the posterior border, or even the anterior border of the axilla (Figs. 14—24). In the eighth case there was an oval area running from the angle of the scapula upwards and forwards into the axilla (Figs. 25, 26). In six out of these eight cases the dulness reached some distance above the upper margin of the ægophony, and it would be quite correct to say of some of them that ægophony occupied the lower two thirds, and of others that it occupied the middle, of the area of dulness. In one of these cases there was for a short time ægophony over the front of the same side laterally from the sternum to the anterior axillary border, and vertically from the third to the fifth rib; it corresponded here to the upper half of the dulness (Fig. 23).

In another of these cases the right chest was dull back and front from apex to base; ægophony was well marked

from the vertebræ to the anterior axillary line, and had a vertical extent of six inches from just above the lower angle of the scapula to near the base. From this chest seven pints of serum were removed by the aspirator (Fig. 14).

From such facts it seems impossible to draw any inference as to a constant relation between the quantity of pleural serum at any one point and the production of ægophony. Probably the most correct description of its position would be this: It occurs most commonly in the lower half of the back within the limits of the area of dulness; if it occupies a small area, it is rather more frequently close to the angle of the scapula than remote from it.

It has now to be shown what is the relation between the liquid which undoubtedly exists in so many cases when ægophony is heard, and the altered conditions of resonance upon which I have attempted to show it depends.

Liquid cannot exist in the pleural cavity without modifying the condition of the lung, which must be to a certain extent compressed; and compression of the lung has been stated by many writers to be the cause of ægophony, but without sufficient explanation of the *modus operandi*. Graham Brown¹ writes, "Most observers are agreed that it depends upon compression and partial obstruction of the bronchi." Certainly, if it is to resonance that we are to look, we must consider the influence of the bronchi; and it seems to me that we can imagine that compression should so modify the size or working length of the bronchi as to alter their relations to particular notes,—to convert them, as it were, from buccal cavities into nasal meatuses, and thus at the same time to suppress the lower harmonics by declining to resonate them, and to reinforce by resonance those harmonics which are highest.

The fact that ægophony is often a transitory phenomenon, and that it is not often heard when the chest is

¹ 'Medical Diagnosis,' Edinburgh, 1882.

full, would then also be explained ; for when the fluid is abundant the bronchi are completely closed, and no resonance in them takes place at all.

According to this view ægophony ought sometimes to be heard in other conditions than pleuritic effusion,—conditions, that is, affecting the bronchi either by compression or some other kind of obstruction. And, indeed, it is believed, as I have already stated, by more than one writer, that such occasions do occur. Dr. Finlayson¹ says, “It is also found in the course of pneumonia and in inflammatory thickening of the pleura.” He adds, “Its cause is still a matter of dispute.” Guttman,² although he explains it by the presence of fluid, points out that Skoda recognised it in pneumonia, caseous pneumonic infiltration, and even between the shoulder-blades in perfect health ; and he says that no explanation of its causation under these circumstances has been offered. Fraentzel³ says, “It is an unimportant variety of bronchophony, and is not a characteristic phenomenon of pleuritic effusion.” Osler⁴ also says it may occur in pneumonia. Under the head of the physical signs of that disease he writes, “The bronchophony may have a curious nasal quality, to which the term ægophony has been given.”

But, on the assumption that a modification of the bronchi is competent to produce ægophony, it is not so difficult to imagine how in some of the above conditions the necessary requirements may be brought about. For instance, in pneumonia it is well known that tactile vibration may be entirely abolished without the presence of any fluid. I had an example of the kind a few years ago, in which tactile vibration was absent only a few hours before death over a large part of the back, and *post mortem* the affected lung was unusually distended

¹ ‘Clinical Manual for the Study of Medical Cases,’ 3rd edit., 1891, p. 600.

² Loc. cit.

³ Ziemssen’s ‘Cyclopædia of Medicine,’ English translation, vol. iv, 1876.

⁴ ‘Principles and Practice of Medicine,’ Edinburgh, 1892, p. 520.

by the enormous quantity of effused inflammatory products. It may be supposed that in such a case the bronchial tubes are actually obliterated by the pressure of the new products. Another way in which the passage of the air through the tubes may be hindered in pneumonia is by the formation of fibrinous clots in the tubes themselves. If either one of these bring about obliteration of the tubes, either of them might bring about such a modification of the tubes by narrowing or otherwise, as to alter its resonating qualities in the direction of suppression of low tones and reinforcement of high tones.

This possibility is confirmed by the following case which was under my care in 1887. C. G—, æt. 47, was taken ill in November with shivering pains in the left side and epigastrium.

He was admitted on the 5th, when he was very ill with dyspnœa and quick pulse and respiration. When examined at 9 p.m. there was dulness over the lower two thirds of the left chest behind, but none in front. In the lower half of the chest behind was distant bronchial breathing and ægophony. The ægophony extended from the eighth rib to the twelfth, and from the spine to the posterior axillary line. Tactile vocal vibration was very deficient, if not absent. There were no râles. The sputum was viscid and green. (The chest had already been explored by the house-physician without result.)

The following day, at 11.30 a.m., the sputum was less viscid, and of greenish-yellow pink colour; it gave a faint blue reaction with the guaiacum test. The physical signs were much the same, but the whole left back was dull; bronchial breathing was more extensive, but still distant over the lower half. Ægophony was heard again, but its extent was not measured. I concluded that the severity of his symptoms was mainly due to pneumonia, and that even if fluid was present, its removal would not materially improve him. However, at 6.30 p.m., as he was becoming worse, we explored in the eighth and ninth spaces, and drew off only a thin, turbid, grey-green fluid

containing air bubbles, which filled the needle but did not rise into the syringe. He died at 8.30 p.m.

At the post-mortem examination the whole of the left lung was in a condition of grey hepatisation, except one piece the size of an orange, which was hepatised but still red. It broke down readily under the finger, and exuded pus copiously; the upper lobe was congested, and a little condensed where it was in contiguity with the lower; but it still contained air, and was slightly cedematous. It weighed 67 oz. The bronchi contained mucopus, but some of the lower bronchi traversing the consolidated lobe were filled with long plugs or casts of fibrin.

The left pleura was universally adherent by recent pleurisy over the parietal and visceral layers, and there was also interlobar pleurisy.

If ægophony is to be explained by modifications of the tubes, it is obvious that some intra-pulmonary conditions may be supposed capable of producing it, as well as such extra-pulmonary conditions as the presence of pleural liquid. As I have already stated, the evidence of several observers is to the effect that conditions do occasionally arise, independent of fluid, which may produce ægophony. What I have endeavoured to show in this paper is that the presence of pleural liquid, viewed as a medium capable of transmitting, and modifying in that transmission, the sounds of the voice, is not necessary to explain the occurrence of ægophony; and that this morbid sound is merely a discordant modification of the voice, due to altered conditions of resonance in the bronchial tubes. In regard to pleural effusion, it seems to me at present almost a hopeless task to attempt by pathological investigation to find out the exact change in respect of length which the particular tubes undergo, in which this special resonance takes place; that is, to find out the exact difference between the tubes of the small portion of lung, over which ægophony is heard, and those of the lung, under otherwise exactly the same conditions,

over which ægophony is not heard. And it is difficult to invent a satisfactory hypothesis, when we consider the different relations which occur between the amount of the effused fluid and the surface extent of the morbid sound. I shall be only glad if anyone else will devise experiments or propound hypotheses which will effect what is wished. The case of pneumonia I have recorded suggests that it may be more easy in some cases of consolidation, apart from liquid compression, to see how the resonance in the tubes is likely to be modified.

EXPLANATION OF DIAGRAMS.

FIG. 1.—Female æt. 16. Ill one week. Signs of pleuritic effusion. Heart displaced to right of sternum. *Ægophony* only faintly near the angle of the scapula. Withdrawn by aspiration the same day, 65 ounces.

FIG. 2.—Male æt. 42. Ill three weeks. Pneumonia followed by empyema. *Ægophony* near the angle of the scapula. Pus found by exploration in ninth space. Incision.

FIG. 3.—Male æt. 60, admitted after ten days' illness, with signs of fluid at right base. Exploration on several occasions negative: once fifteen minims serum withdrawn, but aspiration failed. Three weeks after admission dulness of same extent as before; *ægophony* near angle of scapula.

FIG. 4.—Male æt. 22. Empyema following influenza. *Ægophony* near angle of scapula. Sero-pus found on exploration.

FIG. 5.—Male æt. 36. Ill five days with obvious pneumonia. Rusty sputum for two days. *Ægophony* at a point on the right side near the spine and midway between the lower angle of scapula and the last rib.

FIG. 6.—Male æt. about 37. Three weeks ill with pains in joints. Very little complaint as to chest. Physical signs of fluid at right base. Faint *ægophony* below angle of scapula.

FIG. 7.—Male adult. Pneumonia on sixth day; rusty sputum. Bronchial breathing affecting the whole of the right lung, except lower part in front. Faint *ægophony* close to angle of scapula.

FIG. 8.—Male æt. 46. Influenza a week ago; was a little better, then had pulmonary symptoms. Physical signs of pneumonia, but all sounds rather faint and might be due to fluid. Faint *ægophony* at extreme base near the spine.

FIG. 9.—Male æt. 60. J. A.—Ill seven weeks with trouble at right base. Right base now dull from tenth rib downwards; no vesicular murmur; faint tactile vibration. *Ægophony* two inches vertical extent and three inches laterally. Needle in tenth space drew clear serum.

FIG. 10.—Male æt. 28. Ill a week with obvious pneumonia. Sputum rusty at first, now muco-pus. Dulness to spine of scapula. Breathing obscurely tubular. *Ægophony* from eighth to tenth rib.

FIG. 11.—Male æt. 40. Signs of fluid over right chest, which was bulged at the lower part, the costal margin being raised. Dulness nearly up to spine of scapula. *Ægophony* in a broad band, just below and including the lower angle of the scapula. Some time later two pints of liquid were withdrawn.

FIG. 12.—Male æt. 40. Pleurisy left side. Dull all over back on that side. *Ægophony* as shown. Fifty-eight ounces clear serum withdrawn.

FIG. 13.—Male æt. 49. Right pleuritic effusion and ascites. Dulness up to midway between spine of scapula and lower angle. *Ægophony* along the ninth rib. Three days later one pint of serum withdrawn.

Dulness ||||

Bronchial breathing X X

Ægophony /////

Râles

EXPLANATION OF DIAGRAMS (*continued*).

FIG. 14.—Male æt. 34. Right chest uniformly dull. Heart's impulse two inches outside left nipple. *Ægophony* well marked over lower two thirds of back, reaching forward to anterior axillary line; vertical extent in back at least six inches. Seven pints of serum withdrawn.

FIG. 15.—Male æt. 49. Dull nearly up to spine of scapula: obscure, high-pitched, almost bronchial breathing for $1\frac{1}{2}$ inches above angle of scapula. *Ægophony* typical and well marked over right base from seventh space inside scapular angle to the eleventh rib, and extending laterally four inches from spine.

FIG. 16.—Male æt. 60. Ill fourteen days, beginning with hæmoptysis, then febrile. Impaired resonance, not absolute dullness, over left back. Tactile vocal fremitus rather faint. Bronchial breathing up to spine of scapula. Bronchophony over much of back becoming *ægophonic* in character.

FIG. 17.—Same patient five days later. Impaired resonance up to spine of scapula. The voice-sound over the whole of this area has an *ægophonic* twang quite distinctly, but most marked in the axilla at the border of the scapula. Nowhere, however, could it be called loud typical *ægophony*. Exploration yielded no result. Patient ran the course of phthisis and died two months later.

FIG. 18.—Male æt. 32. Pleuritic effusion. Ill three weeks. Dull over whole of left back. *Ægophony* from spine of scapula to tenth rib, and laterally from spine to posterior axillary line.

FIG. 19.—Male æt. 13. Empyema. Left chest dull front and back, and apex to base. Heart beating to right of sternum. *Ægophony* over large part of back as shown, extending to axillary line, not in front.

FIG. 20.—Male æt. 16. Pleural effusion left side. Ill one week. Dullness behind from apex to base and in front from second space downwards. Heart beating to right of sternum. *Ægophony* in lower half of back over an area measuring at least $6\frac{1}{2}$ inches by 4 inches. Forty ounces of serum withdrawn the following day.

FIG. 21.—Male æt. 33. Pleurisy. Ill one week. Dullness of left chest to one inch above angle of scapula. *Ægophony* half an inch above and below angle of scapula and near spine on same level.

FIG. 22.—Same patient six days later. Dullness nearly up to spine of scapula. *Ægophony* distinct at upper half of dullness as shown.

FIG. 23.—Same patient after another four days. *Ægophony* behind unaltered; in front occupies upper part of area of dullness around nipple as shown.

FIG. 24.—Same patient after another five days. Dullness as before. *Ægophony* from midway between spine and angle of scapula for four inches downwards and laterally from spine nearly to border of latissimus dorsi.

FIGS. 25, 26.—Male æt. 9. Rigors on September 12th, followed by typical pneumonia. Suspensions of fluid on September 19th and 22nd. September 27th, physical signs as shown. *Ægophony* from below and outside angle of scapula outwards, upwards and forwards to axilla and pectoral region. Pus removed by incision the same day.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. vii, p. 61.)

Dulness ||||

Bronchial breathing X X

Ægophony /////

Râles