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ON ÆGOPHONY.

By WILLIAM H. STONE, F.R.C.P., &c.

(*Reprinted from 'St. Thomas's Hospital Reports,' Vol. II.*)

No one auscultatory sign has been the subject of so much debate as ægophony. Every shade of opinion has been expressed concerning it, from that of Skoda, which declares it to be diagnostically worthless, up to the original view of Laennec, its discoverer, which held it to be pathognomonic of pleurisy. It has, therefore, in a sense, stood apart from the other acknowledged physical signs, and has been estimated at a variable and uncertain valuation.

No person, however, who has practised auscultation to any extent can doubt of its striking character as a physical phenomenon. Every now and then, in the examination of a case, it suddenly rings out with such force and clearness as to be absolutely startling. For this very reason, perhaps, it has been less closely studied than it would have been otherwise, the observer contenting himself with substantiating the fact and passing on to other indications.

It has long occurred to me that this, as well as many other of our auscultatory phenomena, required re-examination in the light of modern researches, specially those of Helmholtz, on acoustics. I have endeavoured, on his method, first to analyse the sonorous elements into their constituents, and then to reconstitute the whole results by a synthetical process of a mechanical nature. It was just in this fashion that the distinguished physicist in question attained to his great discovery of the formation of vowel-sounds during articulate speech; first, by applying a series of "resonators" to decompose the compound sound; and then, having isolated its harmonic elements, recompounding

these in such manner as to reproduce the original effect. This method has the greatest attainable accuracy, and all but equals mathematical demonstration.

It is now some years since I made the first step in this direction by testing the transmission of musical sounds through healthy and diseased lung. The observations were published in a medical periodical. I there showed that we were at once able to separate two very distinct phenomena, which are of necessity combined in auscultating the voice, namely, vocal fremitus and vocal resonance. The former of these is vibration of a coarse and violent kind, transmitted from the vibrating larynx through the tissues, and sensible to the hand placed over the pectoral region. The fact of its transmission through solid tissue, and not by the air-passages, is shown by its being distinctly felt all over the head of the person speaking, and by the curious observation which I have since noticed, and have now to record, that it is very distinct all over the head during the utterance of a "falsetto" note in what has always been appropriately called "the head voice," a note which entirely fails to produce any vocal fremitus over the thorax. Vocal resonance, on the other hand, is admitted to depend mainly, if not wholly, on the column of air in the trachea and bronchial tubes vibrating after the fashion of an organ-pipe. The mechanism of its transmission through healthy or solid lung has been the subject of much discussion, especially by Skoda, and will be adverted to farther on.

The method adopted for filtering off, as I may say, the coarser fremitus from the finer musical sounds consisted in the use of a pitchpipe placed between the lips, and made to utter its note by drawing a deep inspiration. The column of air was thus inspired in a vibratory state, which, by the way, is quite sensible to the delicate nervous apparatus of the tongue. However loud the note thus sounded, and however distinctly transmitted to the ear, it fails to produce any thoracic fremitus. The metal tube of the pitchpipe can be felt to vibrate, and the vibration extends to the soft tissues of the lips for a short distance, but is soon extinguished, and is only slightly felt over the head. Even this slight conveyance of fremitus can be obviated by inserting the pitchpipe into a piece of vulcanized india-rubber tubing and inspiring through the other extremity.

In the paper referred to above I pointed out that the establishment of what may be called an artificial larynx might prove of value in auscultation, where the natural organ was injured by disease; and also by enabling us to produce the same note in every case without being obliged to allow for the great discrepancies of bass and treble, male and female, infantile and adult voices.

I have since found that it leads on to an observation which is, to my mind, of considerable interest, not only in a physical point of view, but also as bringing into harmony the disagreement which has long existed respecting the diagnostic importance of ægophony. There are, indeed, many other applications of the method, which I do not propose to enter into on the present occasion; some still being under examination, others too bulky for my allotted space in this volume. The discussion of ægophony so far stands alone that it can without violence be dissociated from kindred phenomena.

'For the better investigation of musical sounds I obtained what is called a chromatic pitchpipe, on Eardley's patent, by means of which the pitch can be altered more than an octave, from F in the bass stave, a note on which many male voices speak, up to F of the treble stave, which is within the compass of most or all female voices. The experiments were made with every note of this register, so as to avoid the fallacy which might arise from the transmission of one note, and the non-transmission of another.

I was early surprised to find how little the musical sound was conveyed. Even over a lung solid from pneumonia there was hardly any transmission, usually none whatever. This fact at once disposed of the old and before refuted fallacy that consolidated pulmonary tissue conveys sound better than the same tissue in a healthy state. I have long satisfied myself that Skodas' absolute negative to this effect is perfectly true, and can only feel astonishment at the vitality of the error. No doubt bronchophony as a crude fact exists, but the very simplest experiments will prove to any one who thinks it worth while to try them, that either Skodas' doctrine of consonance or some other must be found, competent to its explanation. With a pure musical note, such as that of a pitchpipe, from which vocal fremitus has been cut off, bronchophony only exists in the

neighbourhood of the large bronchi, even where the lung is extensively pneumonic. In phthisical cases there is more transmission, though the complications with cavernous and cavernulous sounds render the subject too long for the present moment, and, indeed, require further investigation. I may, however, state provisionally that every now and then a cavity, if empty, and communicating freely with the bronchi, seems to possess the same key-note as that sounded, and reinforces it powerfully, while it is quite silent to other notes. This reinforcement can often be brought about by varying the note, and in some degree affords a measure of the size and condition of the vomica.

At first I felt somewhat disappointed at these negative results, and more so at finding that the pitchpipe produced no evidence of ægophony, even where it was marked with the speaking voice, and the other signs of pleurisy were distinct. But it occurred to me to reduce the voice to the same conditions as the pitchpipe, by making the patient sing or intone a note. Here there were great difficulties in my way; most of the lower classes from whom hospital patients are recruited being uneducated, and profoundly unmusical. Many of them, therefore, resented what seemed an ill-timed jocularity on my part; some were shy, and others, with the best will in the world, produced a groan or screech which lacked every possible musical character, and was open to all the inflections and complications of the speaking voice. With patience I succeeded in obtaining from a patient with chronic pleurisy a good intoned bass note, about A or G. Then I found that this, like the pitchpipe, produced no œgophony, although the phenomenon was perfectly distinct whenever he spoke in his ordinary conversational tone. I was thus led to notice that the ægophony did not occur with every sound, even of the speaking voice, but came and went, and again returned, according to the syllable pronounced. I then tried the converse experiment; having made him sound a note without vocalising, I asked him to whisper loudly. The ægophony was immediately distinct, and almost painful in its clearness. Now, whispering is vocalisation pure and simple; it is articulate speech made entirely in the mouth and fauces without any laryngeal ground-note; to this, ægophony, absent from the musical sound, seems to belong.

Whatever may be the correctness of my coming explanation, I can honestly affirm the above facts to be mere matter of observation. In this case, that of Joseph Hardwick, of which I propose to give my notes farther on, and in another, that of George French, now under my care, I have demonstrated the condition described several times to a large class of students, and Joseph Hardwick went with me by appointment to the house of my colleague, Dr. Bristowe, for examination. Dr. Bristowe was able to confirm, in every respect, the presence of the sounds as given above, and of some which shall be presently mentioned.

Having obtained this clue to the mechanism of ægophony, the next step was to test the explanation by reproducing the sound artificially. A piece of india-rubber tubing was obtained, somewhat over a yard in length, and nearly an inch in bore. Over this was placed a bladder or a small india-rubber bag containing water. A mouth-piece like that of an ordinary speaking-pipe was adapted to the end of the tube, and by its instrumentality notes of various kinds were transmitted into it. The ear, or, still better, the stethoscope, was steadily applied to the upper surface of the water-bag, and the effects noted. As in the lung, a pure musical note, whether of the voice or of a pitchpipe, was hardly at all transmitted; I say hardly, because from the elasticity of the india-rubber it was impossible to prevent some transmission of vibration through the solid containing wall. This was easily distinguished from that passing through the water, after a little practice. When, however, spoken words containing vocalised vowel sounds were used, the ægophonic twang reappeared in startling force and distinctness; indeed, combinations of words could be formed expressly calculated to develop the phenomenon.

If the india-rubber tube was flattened by pressure, or naturally took an oblate form, the ægophony became more distinct, the flat side of the tube apparently acting as a vibrating membrane.

On analyzing the sound transmitted, 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 to the presence of notes some octaves higher, and too remote for their exact pitch to be ascertained. The same

observation was very clearly made in some of the pleuritic cases examined, of which I proceed to give a few notes.

Case 1.—Joseph Hardwick, æt. 26, engineer. Had been under my care in February, 1871, for chronic pleurisy, for which I had ordered his admission into the hospital. He remained some months under the care of Dr. Clapton, and left on May 10th not materially relieved. The general symptoms were not very urgent, and he was a ruddy, healthy-looking young man.

The left side of the chest was evidently distended and fuller than the right. It was universally dull on percussion. Breath sounds of a feeble though fairly healthy character were audible down to the base, apparently the lung being tied down by old adhesions, and, therefore, not forced upwards by the fluid.

With his ordinary speaking voice there was distinct ægophony. On making him sound a pitchpipe by inspiration no sound whatever was transmitted. After some little trouble I taught him to sing a note in unison with me. Directly the tone became musically pure, and what a singer would call a good note, the ægophony disappeared, returning more or less when his voice failed and the tone became uncertain.

On June 7th, I took this patient to the house of my colleague Dr. Bristowe with a view to more careful observation. Dr. Bristowe confirmed the physical condition, which was, moreover, testified to by Dr. Clapton's notes during his stay in hospital.

Besides the facts above stated we elicited the following facts: With the broad â or rather *ah* used by singers, there was hardly any ægophony. With the sharp à (as in the word "April" or "Apron") it immediately became distinct. With the sharp è also (as in "easy") it was more marked. With the u, or oo, as in "use" or "ooze," it was the most remarkable of any; because apparently the notes on which these closed vowels are spoken lie much lower than those of à or è. When at Dr. Bristowe's suggestion I made him whisper, the conveyance of a high pitched sound was singularly clear and striking.

This patient continued for a month or two more under my care. Vocal fremitus, at first absent on the affected side, became slightly perceptible, but otherwise he altered little.

Case 2.—James Levens, æt. 25, horsekeeper, came to the hospital on October 10th, 1871, with symptoms of albuminuria. The face, legs, and scrotum, were very œdematous; the breath was short, the urine abundant, containing much albumen.

On his first visit there was dulness and pneumonic crepitus at the base of both lungs, most marked on the left side.

On the 26th the dulness was marked over the lower third of the left lung; there was no crepitus beyond slight creaking at the end of a deep inspiration. Vocal fremitus was abolished in the same space. With the speaking voice there was a combination of bronchophony and ægophonic twang, the result being that the note heard through the stethoscope was of a distinctly higher pitch than the ordinary

voice, and of a different character. On making him sound a pitchpipe no sound whatever was transmitted.

Case 3.—George French, æt. 28, brewer's servant, made out-patient on October 26th, 1871, with signs of pleurisy.

He suffered from cough, pain on the right side, short breath, with rapid emaciation and profuse night sweats. No hæmoptysis. The apices of both lungs were normal. On the right side there was complete dulness over the lower two thirds, no vocal fremitus, and high shrill ægophony. On measuring the musical interval between the transmitted and the natural note, it was found to be a minor third higher.

There was no transference whatever of the vibrations from the pitchpipe, though vigorous and continued inspiratory efforts were made.

This patient only attended twice, with some improvement. The sounds were easily demonstrated to a large class of students, and it is probable that he objected to the examination.

I am anxious as much as possible to separate this first part of my paper from any explanation which I now proceed to offer. The facts as hitherto stated are simple and easily demonstrated; utterly independent of views or theories, and perhaps susceptible of other solutions than mine. But on considering the curious, and, I believe, new observation, that a pure musical vibration within the limits of the ordinary speaking voice is not transmitted at all, either through consolidated lung or through a layer of pleuritic fluid; but that the same note, when vocalised and modified by the addition of vowel sounds, immediately passes through the obstructing media at a changed pitch, I cannot avoid connecting the phenomena with Helmholtz's discoveries as to the mechanism of vocalisation. I need not recapitulate his views more than to remind my readers that he finds all vowel-sounds surrounded with numerous remote harmonics. Many of these vowels he has succeeded in reproducing from a series of tuning-forks kept in steady vibration by electrical agency. He specially states that he experienced a difficulty in obtaining the E and I sounds, until he reinforced the extreme high harmonics at the expense of the fundamental notes. Now, these are exactly the sounds on which ægophony is most distinct, whether in a living lung or in an artificial india-rubber substitute. I am, therefore, led to the impression that ægophony has the same, or rather the converse, modus operandi; that the layer of fluid, while it stops the larger and coarser vibrations of the ground-tone, lets pass the finer and closer undulations of the high harmonics. We thus

have phenomena in what we may call an ascending scale; beginning with the rough vibration of vocal fremitus, which, like some forms of loud cardiac murmur, is actually sensible to the tactile papillæ of the finger, but which is easily intercepted, through the phenomena of vocal resonance which are more penetrating, up to ægophony; which is thus explained to be vocal resonance divested of its lower fundamental tones by the deadening effect of a layer of more or less inelastic fluid. Therefore, I was led early in the paper to name it a filtration. It is thus not dissimilar in kind from that which in a transparent medium, like glass, obstructs the undulations of sound and heat, but gives free passage to the finer and more subtle pulsations of light.