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THE PHYSICAL EXPLORATION OF
THE LUNGS.

BY

GEORGE W. BALFOUR, M.D.,

PHYSICIAN TO THE ROYAL INFIRMARY.

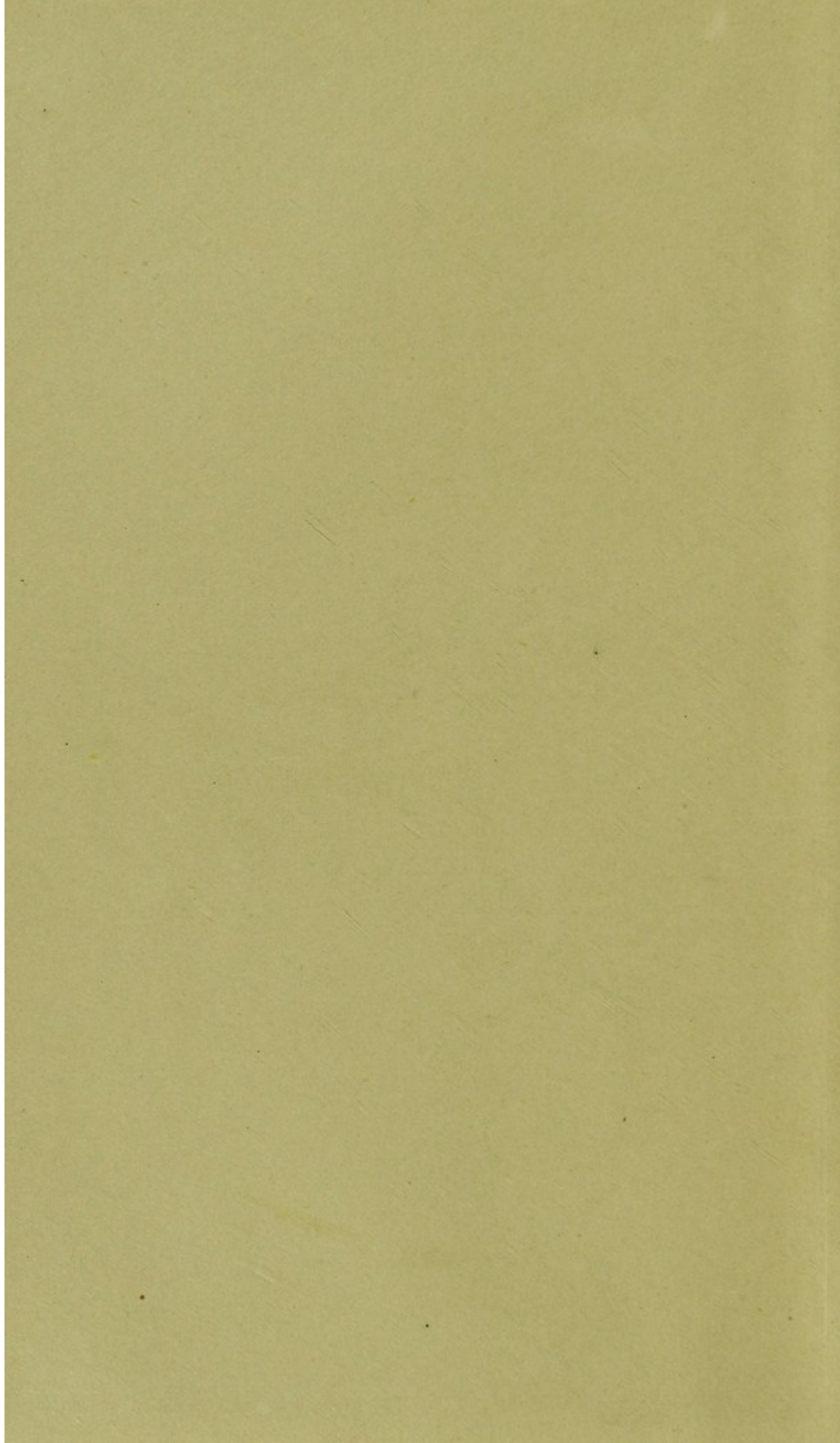
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PHYSICAL EXPLORATION OF THE LUNGS.

THE great difficulty experienced by students in obtaining correct ideas of the condition of the lungs from physical exploration, depends mainly upon defective tuition. And tuition in this respect is faulty in two directions,—first, in that it makes use of expressions which have no meaning in physics, but are based on anatomy, conventionalism, or both; and, second, because too great a refinement in diagnosis is aimed at, and this leads to the adoption of terms which have no definite signification, and to which every teacher attaches his own. In the following pages, an attempt is made to simplify this tuition, and render it more exact, by employing only strictly physical terms as indicative of strictly physical conditions—terms which will be found as applicable to the investigation of all other bodies as to that of the human body, if their physical condition be similar—terms, therefore, which can never be mistaken or misunderstood. It is obvious that, to complete what we call the diagnosis of any case, it must be investigated from various points of view, and that, finally, all these different aspects must be duly considered from the standpoint of pathology, before we can arrive at any definite conclusion as to the actual nature of the disease, its present condition, or probable termination. In this completion of the diagnosis, however, physical exploration bears only a very subordinate part, and very much of the confusion and difficulty which prevails in regard to physical diagnosis has arisen from the attempts which have been made by successive teachers to employ its revelations as in themselves pathognomonic of certain diseases, instead of as only indicating certain physical conditions. Attempts which date from the time when every disease was thought to have

its own special acoustic sign—a time when the jubilant eureka of Laennec was considered to be in itself a triumphant answer to the mournful wail of Baglivi, “Oh, quantum difficile est curare morbos pulmonum,—Oh, quanto difficilior eosdem cognoscere.”

The methods usually employed in the physical exploration of the chest are four¹ in number, viz., Inspection, Palpation, Percussion, and Auscultation. It is with the two latter only that I propose to deal at present.

PERCUSSION is the art of ascertaining the condition of any organ of the body, as to resonance, by tapping on the surface just exterior to the part whose state we wish to examine.

What we tap with is called a *plessor*, and may be either one or two fingers of the right hand, a Winterich hammer, or the end of a stethoscope. If we tap directly on the walls of the chest, the percussion is said to be *immediate*. But percussion is less irksome for the patient, and the sounds produced are more distinct and more easily investigated if we apply some dense firm substance close to the walls of the chest and tap upon it; the percussion is then said to be *mediate*, and what we tap upon is called a *pleximeter*; this may either be a finger of the left hand, or a disk of ivory or caoutchouc. If we employ the fingers alone as plessor, we have, besides the information to be gained by the sound elicited, the advantage of perceiving the resistance of the part percussed, increase of resistance being equivalent to increase of density; but this is a matter of but small importance. In selecting a plessor and pleximeter, it is of the utmost consequence to choose those which on forcible contact give forth of themselves the least possible sound, as thus only we can avoid, as far as possible, confusing the sounds produced by the instruments employed with those resulting from the resonance of the part percussed. To an adept, this is a matter of trifling importance; to a neophyte, however, it often involves the whole question of error or accuracy in the appreciation of the sounds produced. In this respect no instruments are superior to the fingers, or to a finger of the left hand as pleximeter, and a Winterich hammer as plessor. The object of percussing is to throw the part percussed into sonorous vibrations; we must therefore tap smartly, not too forcibly, for fear of hurting the patient, but lifting the plessor quickly, lest we check the vibrations it is our object to excite.

In the estimation of the sounds produced by percussion, the only points we have to attend to are PITCH and CLANG.

¹ A fifth method, Succussion, can only be occasionally employed, and is also excluded from present consideration.

The *pitch* of a sound depends upon the length of the sound-wave. For an explanation of this I must refer to Tyndall on Sound, or to any of the many manuals on natural philosophy which treat of sound. According to these works, the depth of a column of air which resounds most perfectly to the note of any tuning-fork—which, therefore, most perfectly reproduces it—is exactly equal to one-fourth of the length of the sound-wave produced by the fork. And we know from experiment that this sound-wave diminishes in length as it increases in rapidity, increase in rapidity being equivalent to heightening of the pitch, as we learn from experiments on the syren. Hence the shallower any air-space the higher the pitch of the note with which it most perfectly resonates. Heightening of the pitch of the note produced by percussion is therefore significant of a diminution of the air-space beneath the part percussed. Not that there is ever any alteration in the general rapidity of the vibrations of the part percussed, because the resonance-box over which it is stretched is shallow, but simply because the air-space beneath the part percussed selects solely those vibrations with which it resonates, and makes them alone audible; precisely, as experiment shows us is the case with an air-jar, which only makes audible the vibrations of those tuning-forks the length of whose sound-wave coincides in the ratio described with the depth of the jar. And we learn from this the first important lesson in percussion, that a rise in the pitch of the percussion note indicates a diminution in the air-space beneath the part percussed. In the normal chest the second interspace in front subtends the largest air-space, which is nearly equal on both sides, and here we have produced on percussion a note of lower pitch and greater duration than on any other part of the chest, and this is the key-note to the percussion of the lungs. Whenever we have, on percussing any part of the chest, a note produced of higher pitch or shorter duration than this, or whenever the percussion note of one of these interspaces is higher or shorter in duration than that of the other, it indicates either a diminution of the air-space subtended by the part percussed, or a predominance of the clang of the part percussed over the resonance of the air-space beneath. And this leads us to the second important lesson in percussion, viz., the importance of CLANG in modifying the sounds produced.

What we call *clang* or *timbre* is that peculiar quality of sound by which we recognise the instrument producing it, so that we never mistake the noise of a drum for that of a fife, or a violin for a piano, even although the same tunes are played on them. It is acoustically referred to a mingling of the overtones or harmonics of

the body giving forth the sonorous vibrations with its own fundamental note, and in percussion it therefore varies infinitely with the nature of the body thrown into sonorous vibrations. It is therefore of importance in percussing the chest to avoid, as far as possible, all sources of confusion which may be traced to clang. For this reason I have already mentioned the care which ought to be exercised in selecting a suitable plessor and pleximeter; for this reason also we must carefully avoid indiscriminately comparing the percussion note of a rib with that of an interspace; but must always compare rib with rib, and interspace with interspace. Over the sternum, clang often simulates increased resonance by a lowering of the pitch; over the shoulder-blades, clang simulates diminished resonance by a heightening of the pitch. We must therefore percuss the sternum by itself, and avoid comparing its percussion note with that of either the ribs or interspaces on either side; and for a similar reason we must, in percussing the scapular regions, compare the right scapular region with the left one, and not with any part of the chest above or below it.

A mass of fluid or of perfectly airless flesh, when percussed under conditions which are such as completely to obviate any communication of the percussional vibrations to sonorous bodies lying above or beneath them, is incapable of being thrown into sonorous vibrations, is therefore perfectly free from clang, and gives forth on percussion absolutely no sound at all. Out of the body, the nearest approach to this absolute freedom from all sound is obtained when we percuss a mass of solid flesh, six inches at least in thickness, or a perfectly full jar of any fluid, over one inch in diameter, and at least six inches in height, both placed upon a solid stone table of some inches in thickness. Upon these masses the pleximeter must be closely applied, and the only sound then produced by percussion is simply the unavoidable clang of the pleximeter when struck by the plessor. Within the body, it is obvious that similar conditions are unattainable. The percussional vibrations are always more or less communicated to the ribs or air-containing organs—the lungs, stomach, or intestines—in the neighbourhood of the part percussed; and we have their clang always mingling with that of the pleximeter, so that the absence of sound in percussing organs within the body is never so complete as in the conditions described. In the healthy body, the nearest approach to this entire absence of sound on percussion is obtained on the left side in the fourth interspace, about an inch and a half from the left edge of the sternum; and on the right side, in the fifth interspace, anywhere to the right of the

right edge of the sternum. If we percuss the whole chest after the manner prescribed, carefully comparing interspace with interspace, and rib with rib, we shall find that the peculiarities of the note elicited on percussion over the parts just described, are that it is higher in pitch and shorter in duration over these parts than over any other part of the chest; and as a rule, that these conditions are usually more marked on the left side than on the right, because on the former the lung is less apt to intrude than on the latter.

In estimating the physical condition of the chest, therefore, from a consideration of the sounds obtained on percussion, we must remember that a rise in the pitch of the percussion note, with a shortening of its duration, over those parts where normally air-containing tissue alone is present, is always due to a diminution of the air-space beneath the part percussed. But we must also remember that in the normal chest the pitch varies, its rise in certain positions being solely due to the clang of the superficial parts, as over the scapulæ posteriorly; and in others, to the clang of certain airless organs, as the heart and liver, which normally encroach on the pulmonary air-space, organs which are mobile to a limited extent, and which carry their high-pitched percussion note with them, while they themselves are in their turn liable to be encroached upon by an abnormal extension of the air-containing lungs, and in this way may have the normal pitch of their percussion note lowered in varying degrees and over a varying extent. In these positions where the alteration in the pitch of the percussion note is due to the clang of superficial parts, a still further rise in its pitch and shortening of its duration may be brought about by a diminution of the air-space beneath, precisely as occurs in those parts of the chest where this form of clang is not observed; while in those parts where it is due to the clang of dense organs which are normally present there, the only possible alterations are a lowering of the pitch over the whole, or a greater or less part of the space usually occupied by the high-pitched percussion note, due to encroachment by the air-containing lung tissue; an increase of the area of the high-pitched note depending on various causes; and occasionally an alteration in its position, its area remaining nearly the same. While, therefore, we can accurately map out the surface of the chest, indicating in each part the low and prolonged or high and abbreviated character of the notes produced on percussion, it is only by having a perfect knowledge of the normal percussion sounds over every part, and of the modes in which these may be modified by the mobility of the organs, that we are enabled to determine, by an

estimate of probabilities, whether a rise in pitch is due to the diminution in size of an air-space, to the clang of an airless body in a normal or abnormal situation, or to infer the cause of the lowering of the normal pitch, which may also occur in certain parts. We may remember that a normally high pitch is always symmetrical posteriorly, and anteriorly follows a certain pattern with which we ought to make ourselves familiar, while an abnormally high-pitched percussion note is only exceptionally symmetrical either in front or behind. Further, a great deal of information as to the nature of the clang in the various organs composing the thorax, and of the mode in which this modifies the percussion note in certain conditions, is yet to be obtained by careful experiment in the percussion of those organs, both in their natural position and also when removed from the body; and this has special reference to the percussing of the lungs in various conditions of inflation.

What is termed the METALLIC RINGING PERCUSSION SOUND is simply an amphoric clang, produced by the resonance of the percussion note within a cavity surrounded by dense walls. The CRACKED-POT SOUND is produced by a whiffing of air accompanying the percussion sound; it is supposed to indicate a cavity communicating with the bronchial tubes. In the flexible chest-walls of children or young people it is often produced without any cavity. It is doubtful if as yet we know all the conditions under which it may be produced; certainly I have occasionally heard it in old dense-walled chests, without any other sign of cavity being present, and in them it has occasionally disappeared without any ascertainable reason.

By AUSCULTATION we endeavour to obtain information as to the physical condition of the chest by listening to the sounds produced by the movement of the air within that cavity, or by the voice, or by the friction of the parietal and visceral pleuræ against one another.

If we listen to the breathing over a healthy chest, a soft sighing murmur alone is audible, which is louder and harsher in children than in adults. This vesicular murmur, as it is termed, with which we should make ourselves intimately acquainted, varies somewhat in every different individual—all we have to do with it is to note whether it is of an ordinary character, faint, or rough and puerile—as in children, and whether these characters are uniform over all the chest or confined to certain localities, whether its rhythm is regular or jerking, and whether the normal relation of inspiration to expiration 3 : 1 is preserved, or whether one or other is prolonged. A faint vesicular murmur indicates imperfect air movement from some cause, the nature of which we must take other means to discover.

A puerile vesicular murmur heard in the adult indicates that the part of the lung over which it is heard is doing extra duty to make up for some defect elsewhere. Alterations in the rhythm and in the ratio between inspirations and expirations depend on various causes, and have merely to be noted for further inquiry.

In abnormal conditions of the lung this vesicular murmur may be replaced by one or other of two sounds. The one of most importance is what is termed *Pure Bronchial breathing*: this has the sound of the guttural *ch*, pronounced with the mouth wide open during both inspiration and expiration. This is only heard when the lung tissue is condensed round a bronchial tube of at least moderate size. Through this of course no air passes, the lung tissue beyond it being consolidated, and the peculiar sound is due to the resonance of the air within it with the blowing sound produced by the passage of the air through the trachea or the larger bronchial tubes above it. This theory is agreeable to what we know of the phenomena of resonance. It is also proved by the fact that obstruction of the affected tubes with mucus, or any interruption of their communication with those parts of the lung in which the air is in motion, is followed by total cessation of the phenomenon of bronchial breathing, which is at once restored when the obstruction is removed by coughing. If the ordinary explanation of this phenomenon by the better conduction of sound by the solidified lung were true, any mucous obstruction would tend rather to enhance the phenomenon than to annihilate it. Besides, we know from experiment, that sound is reflected and refracted like light, and passes only with difficulty and with loss instead of gain from one medium to another. The known phenomena of resonance also sufficiently explain why bronchial breathing is occasionally absent when all the conditions necessary for its production appear to be present.

Besides the vesicular, which is the normal respiratory murmur, and the bronchial breathing due to consolidation alone, we have another form of breath sound termed *indeterminate*, which is neither bronchial nor vesicular, but which may be either obscured by rattles; which it is, must be determined by a consideration of probabilities, in the estimate of which the character of the expiration, which may be vesicular or bronchial or otherwise altered in character or in its normal relation to the inspiration, and the percussion sound, are important elements.

RATTLES are sounds produced within the chest by the passage of air through fluids contained in the air-passages. They may be divided into *crepitant*, *subcrepitant*, and *consonating*. The crepitant

rattle resembles the rubbing of the hair by the fingers close to the ear, or occasionally the crackling of salt when thrown in the fire ; it originates in the air vesicles alone, and might be termed the vesicular rattle ; it is only heard in pneumonia and in œdema of the lungs. The subcrepitant or mucous rattle may also be termed the *indeterminate* rattle ; it is the bubbling sound of air passing through fluid, is free from resonance, and occurs in the bronchial tubes or in pulmonary cavities ; it may be heard as a fine bubbling rattle in tubes or cavities of all sizes, but large gurgling rattles only occur in large tubes or large cavities. Such rattles are termed moist when the bubbling sound is distinct ; and dry, when they resemble more the creaking of leather or snow, but no inference can be drawn from these characters, though of course from the uniform scantiness or abundance of these rattles we are permitted to conclude that their fluid cause is present in a greater or less quantity. When these indeterminate rattles occur in bronchi or cavities surrounded by dense walls, the sound produced by them is reinforced by resonance, they become *consonating* rattles, are louder, more distinct, and appear drier in character, and have the same signification as bronchial breathing. RHONCHI are dry sounds produced by the passage of air through tubes whose calibre is narrowed in any way. They are divided into *sonorous*, *sibilant*, *whistling*, and *chirping*. Sonorous rhonchi are believed to be produced by moderate narrowing of the calibre of the larger tubes ; sibilant rhonchi, by a greater narrowing of the larger tubes, or a moderate narrowing of the medium-sized tubes ; while whistling and chirping rhonchi depend upon narrowing of the smaller tubes. Rhonchi may be indeterminate—that is, they may arise in narrowed bronchial tubes with a normal or an abnormal condition of the lung tissue, without consonance ; or they may be enhanced by resonance, and then their signification is the same as that of bronchial breathing or consonating rattles.

Auscultation of the Voice.—When a patient with healthy lungs speaks when we are auscultating his chest, only an indistinct *humming* or *buzzing sound* is heard over the greater part of the thorax ; even in health, however, in certain parts, as in the interscapular region posteriorly, and over the upper part of the right lung anteriorly, particularly towards the sternal end of the clavicle, the voice sounds are louder and more distinct than elsewhere, giving rise to what is termed a *weak bronchophony*. This humming sound of the voice may be heard both in normal and in abnormal conditions of the lungs ; it may be called indeterminate bronchophony. When, however, weak bronchophony is heard over other

parts of the chest than those specified, it indicates an abnormal condition, the exact nature of which has to be determined by auscultation of the respiration and by percussion over the parts affected, as well as by an inquiry into the whole history of the case. One of the most important alterations is when the voice sounds are equal over the infra-clavicular regions on both sides. But the most important alteration of the voice sound is when it is heard distinctly and articulately through the stethoscope placed on any part of the chest. This is termed *Loud Bronchophony*, and has the same signification as pure bronchial breathing or consonating rattles; it is the product of the local resonance of the laryngeal voice in a column of air surrounded by dense walls. What is termed *ægophony* or the punchinello voice is simply a bronchophony loud or weak, to which a tremulous character is communicated; it may be produced in various ways, is occasionally heard in the normal chests of women and emaciated children, and is not pathognomonic of fluid effusions, being as often heard when fluid is absent as when it is present.

AMPHORIC RESONANCE, or METALLIC TINKLING, may accompany all or any of these auscultatory phenomena just described. They depend upon the clang which accompanies these sounds when resonating within a large cavity. The presence of fluid is not necessary for their production, nor does it prevent it. The metallic tinkling is simply a rise in pitch of the amphoric resonance.

The COUGH may resonate or be indeterminate, as well as the respiration or the voice, etc. Auscultation of the cough is chiefly useful, as by its means accumulations of fluid are removed, and the phenomena of resonance are thus clearly brought out, enhanced by the forcible inspiration which precedes the act of coughing. To obtain the full advantage of this, the cough should be repeated two or three times.

If the surfaces of the pleuræ are in any way roughened, a rubbing or FRICTION SOUND is produced, which may be heard only during inspiration, only during expiration, or during both. It is generally to be felt as well as heard, and is mainly to be distinguished from a rattle by this characteristic, as well as by its superficial character. It may possess any quality, from the most trifling jerking rub to the loudest continuous creaking.

Such, then, is a cursory outline of the physical exploration of the lungs, so far as regards percussion and auscultation, based upon a due consideration of the three important factors, pitch, clang, and resonance, which are alone able to convey to us correct impressions of the physical conditions by which the sounds produced in the normal

chest by percussion of its exterior coverings, by the movement of the air within its contained organs, or by the voice, may be so variously modified. It is obvious that these altered physical conditions refer only to changes in density of the lung tissue, to diminution of the calibre of tubes, to the presence of fluid where there ought to be none, and to the occurrence of cavities of an abnormal size in the organs explored, but that the pathological causes of all these alterations have to be ascertained by a totally different series of investigations, and that we have finally to take the results of all these separate investigations, and, by reasoning upon them, endeavour to ascertain the probabilities in favour of their dependence upon one definite pathological cause. This constitutes our diagnosis of the case, and for this diagnosis physical signs alone are wholly inadequate.