

the accidental admission of foreign bodies into the larynx, is furnished in diseases of the respiratory organs by the swollen condition of the bronchial mucous membrane, or the presence of fluids in the air-passages,—such as bronchial mucus, inflammatory exudations, extravasated blood, pus, or serum; occasionally, also, simple engorgement of the lungs with blood, independently of any change in the mucous membrane, appears to be sufficient to cause coughing. Inasmuch, therefore, as almost all the diseases of respiration are, at some stage or other, attended by bronchial catarrh, localized or diffuse, it is plain that in almost all these affections coughing can scarcely fail to be a more or less prominent symptom, lasting either throughout the whole of the disorder, or developed only at some particular part of its course. Coughing is thus a symptom of the greatest importance in many diseases, especially in incipient phthisical affections, as, in the absence of other indications, it is not unfrequently the first sign which directs the attention of the medical attendant to the lungs.

Complete absence of cough in pulmonary diseases, either during certain longer or shorter periods or during the whole of their course, is exceedingly rare; the most probable explanation of such an occurrence is that in these cases the sensitiveness of the nerve-terminations in the bronchial mucous membrane is blunted. This may take place even under physiological conditions: in sleep, for instance, this irritability is much less marked than during the waking hours; and in certain pathological circumstances it may be similarly affected,—as when there is disturbance or enfeeblement of the sensorial activity, in collapse, and in profound exhaustion from disease.—But in the total absence of such morbid conditions, also, diseases of the respiratory organs may run their entire course without cough,—and it is these cases only which are above referred to as “exceedingly rare.” Nevertheless even in these instances it cannot be said that cough is absolutely wanting, but only that it is so trifling, and that it appears at such long intervals, that it escapes the patient's notice.\*

The *frequency* of the cough is variable: the intervals at which it occurs are very irregular, sometimes long, at other times short; at certain periods of the day, however, coughing is more frequent and violent,—in the evening, for example, especially in simple bronchial catarrh, or in the morning, shortly after waking from sleep, as in morbid processes of phthisical character. In general the frequency of the cough is directly proportionate to the intensity and distribution of the bronchial catarrh, increasing with each exacerbation of the affection and decreasing with the remission. Thus, emphysematous patients, and some others suffering from lung complaints, cough but little in summer, as the (secondary) bronchial catarrh almost disappears at that

\* I have never yet met with a case of total absence of cough in lung disease. On careful cross-examination of the patient one rarely fails in obtaining from him an affirmative answer, even when the existence of cough is at first strenuously denied. Very many patients, also, do not regard a slight hawking from which they may suffer as a genuine cough.

season of the year, while in winter both the disease and the cough return with all their former violence. Aggravation and mitigation of the cough, therefore, are signs which enable us to form at least an approximate opinion with regard to the progress of the original morbid process going on in the lungs, though they are obviously of such value only when the patient comes frequently under observation.

The cough presents great diversity in respect to its special characters; these vary according to the *frequency* of the cough, its *intensity*, its *tone*, and whether it is *moist* or *dry*.

1. Each attack may consist of one or of only a few short, slight expiratory efforts;
2. Or of a series of several coughs, of somewhat greater intensity;
3. Or of a constant and rapid succession of violent paroxysmal seizures, broken only by a few deep, usually sonorous, inspirations.

The first variety, known in Germany by the name *hüsteln*, is met with most commonly in phthisical patients, and is regarded even among the laity as an ominous sign, though it is occasionally observed in diseases of a non-phthisical nature. This slight cough is generally not the only form which accompanies phthisis; it alternates very frequently with that described as the second variety. In particular, the cough which attacks the patient in the morning, soon after waking, is usually of a somewhat severe and persistent character, as the bronchial secretions which have accumulated in the air-passages overnight keep up a continuous irritation until expelled. Violent and prolonged coughing often excites vomiting, the sensory nerves of the stomach being irritated by the repeated and rough concussion.

The second variety of cough is the most common; it presents itself in all the diseases of the respiratory organs.

The third variety appears in its most typical form in *tussis convulsiva*, a disease of childhood which obtains its name from the nature of the cough. It occurs in distinct paroxysms of even several minutes' duration, separated only by a few deep, crowing inspirations; it is laborious and spasmodic, the countenance becomes darkly cyanotic, and the seizure not unfrequently ends in vomiting. In the intervals the fits of coughing are shorter and milder. In other diseases of the respiratory organs also the cough sometimes takes on this spasmodic character, but the attacks are then of shorter duration and not so typical.—The classification of the cough with regard to its *intensity* is embraced in the three foregoing categories; it is least marked in the first form (*hüsteln*), most marked in the spasmodic cough, and also, as in dry bronchial catarrh, when the secretions are very tenacious and therefore expectorated with some difficulty.

The cough is designated as *moist* or *dry* according as it is accompanied or not by expectoration. At the outset of any disease of the organs of respiration, especially bronchial catarrh, when the mucous membrane is still merely congested or swollen, but not yet covered by secretion, the cough is invariably dry; at a later stage it becomes moist. The expulsion of an offending portion of mucus is not generally effected by a single effort of coughing, and the process is the

more difficult and troublesome the more deeply situated the part of the air-passages from which the secretion has to be brought.

The *tone* of the cough is exceedingly variable, and depends chiefly on the character of the cough in other respects,—whether it is forcible or feeble, moist or dry. The more violent the cough the clearer its tone, the feebler it is the duller its tone. It is also clearer when dry, and scantier when moist. The cough of laryngeal and tracheal catarrh, when very dry, is not unfrequently of a peculiar loud, clear character, (the “barking cough” of the laity). If the cough be dry and extremely laborious it is generally accompanied by a hissing sound, audible at some little distance from the patient, due to the forcible rush of air through the glottis; this same sound, moreover, is heard in every variety of cough, when auscultated by means of a stethoscope. It is a matter of daily experience also that the tone of a moist cough is subject to great modification by being mixed with the sounds caused by the agitation of the expectorated fluids.

From these considerations it will be seen that, apart from the very characteristic phenomena of whooping-cough, there is in general nothing in the nature of the cough that throws much light on the actual morbid changes going on in the lungs; at best it is only when taken in conjunction with the previous history of the case, especially as regards duration, that it assumes any diagnostic value. This diagnosis is most easily made in cases of chronic character, in which the principal question to be settled is simply whether phthisis exists or not; but even here the nature of the cough is not the sole, or even the chief, guide,—it should be supported by a minute physical examination of the chest, and an inquiry as to the presence or absence of the other phthisical signs, emaciation, &c.

It is not merely in diseases of the lungs themselves that cough is observed; it occurs also in affections of the pleura (pleurisy, for instance), but always in its less marked forms. In such cases it probably arises from irritation of the sensory nerves of the pleura, partly also from the slight bronchial catarrh which often attends inflammation of the pleura.—Cardiac diseases excite cough only when they set up secondary congestive catarrh of the lungs.

#### AUSCULTATION OF THE VOICE.

The vibration of the thoracic parietes, caused by the voice, and felt distinctly on the surface as pectoral fremitus, has already been discussed in the section on Palpation (see p. 63).

*Auscultation* of the voice is also frequently employed as a diagnostic aid in diseases of the organs of respiration, to supplement or confirm the results obtained by auscultation of the respiratory murmur.

When the respiratory apparatus is in its normal condition the words spoken by the person under examination are absolutely

indistinguishable from each other, either through the ear applied directly to the chest-wall or through the stethoscope; the voice is heard merely as an undefined buzzing. The intensity of this sound at any part corresponds exactly to that of the vocal thrill; the conditions, therefore, on which depends the greater or less audibleness of the voice at any point on the surface of the thorax, are precisely those formerly enumerated as similarly affecting the intensity of the pectoral fremitus.

Pathological alteration of the voice, with respect to the distinctness with which it is conducted through the tissues to the surface, takes place in one of two directions: the voice may be rendered so feeble as to be totally inaudible; or it may be intensified to such a degree that a large number of the words become clearly articulate, and the auscultator has the impression as if the patient were speaking directly into his ear. Increase of the intensity of the voice is termed *bronchophony*; amphorophony (a metallic ring or echo produced by the voice), and ægophony (the bleating voice), are modifications of bronchophony.

#### ENFEEBLEMENT OF THE VOICE.

The sound of the voice, at the surface of the chest, is weakened or suppressed by the same conditions which lessen or abolish its perceptibility to the hand, that is, by copious pleuritic exudation, pneumothorax, and to a moderate degree also by the presence of a large quantity of fluid in the air-passages (see p. 64 *et seq.*)

#### INCREASE IN THE INTENSITY OF THE VOICE. BRONCHOPHONY.

Bronchophony, like bronchial respiration, occurs as a *physiological* phenomenon; in the larynx and opposite the bifurcation of the trachea; but at the latter level it has already lost much of its force, and is heard only to the right of the vertebral column.

*Pathologically*, bronchophony may occur at any part of the thorax; but other conditions being equal, it is louder superiorly, both in front and behind (in the interscapular space), than it is inferiorly. In its more exaggerated forms its recognition is easy without the institution of any comparison with the healthy sounds; when its special characters, however, are less markedly developed, such a comparison is necessary, with the vocal resonance at the

corresponding points on the sound side of the chest, or indeed with that at any part of the lung which may have preserved its normal texture.

Bronchophony is invariably an indication that in the region auscultated the lung is somewhat extensively *consolidated* or *contains a large cavity enclosed by solid walls*.

The expression "consolidation of the lungs" embraces a well-known class of pathological processes, amongst which the hepatization of pneumonia and caseous condensation (phthisical) are found to be the commonest causes of bronchophony.—This intensification of the voice-sounds is observed more often in phthisical than in bronchiectatic vomicae, the former being more favourably situated for its development; it is but seldom, also, that gangrenous cavities attain sufficient size to give rise to bronchophony.—In very large phthisical excavations *bronchophony* has a *metallic*, ringing character, exactly as in the case of the respiratory murmur and the cough (see p. 164). This ringing sound, however, is not so loud as that which accompanies the cough, as the latter throws the air within the cavity into more powerful vibration; phthisical patients presenting caverns in the lungs, also, are usually greatly reduced in physical strength, the voice, therefore, is weak, and is further frequently rendered husky from concurrent laryngeal affection.

Bronchophony has, with regard to the determination of the physical condition of the lung, exactly the same diagnostic significance as the bronchial respiratory murmur, and in all instances its occurrence, its distinctness, its temporary disappearance and its reappearance, are dependent on precisely the same circumstances as in the case of bronchial respiration; this is true more particularly with reference to the size of the condensed part or of the cavern, which must be at least so large as to include one of the more important bronchi, and to the free communication which must subsist between this bronchus and the trachea (see p. 66).

Since bronchial respiration and bronchophony arise from the same causes they are always found associated, though not invariably of equal intensity. The presence of large accumulations of fluid in the condensed portions of the lung or in cavities, irregular infiltration of the alveoli, or the existence of spongy lung-substance between patches of consolidation, diminish the clearness of bronchophony, or prevent its development altogether.—Like bronchial respiration, it is always combined with increased pectoral fremitus,—a fact the reasons for which are self-evident; but much finer shades of difference may be detected by auscultation than by palpation, and when, moreover, bronchophony

is confined to a very circumscribed area, examination by the latter method gives very unreliable results. It is customary, therefore, except in cases of copious pleuritic effusion and other affections which render large parts of the lung void of air, to investigate the anomalies of the voice by auscultation rather than by palpation.

Lænnec drew a sharp line of demarcation between two forms of increase in the intensity of the voice,—pectoriloquy and bronchophony. By the first term he designated the loud and exaggerated quality of voice heard in very large and superficial pulmonary caverns. But pectoriloquy is in no essential respect different from bronchophony; it is simply the same character of voice in its highest degree of intensity. If so disposed, therefore, one may, with Skoda, distinguish between a faint and a loud bronchophony, the latter being merely Lænnec's pectoriloquy, though these slight differences have no particular diagnostic meaning, just as there is no special physical condition corresponding to loud and feeble bronchial respiration.—Bronchophony is generally loudest in cavities; but this is not the invariable rule, as it is occasionally observed to be weaker in such circumstances than in tissue which is simply infiltrated, but free from excavation.

Bronchophony is also heard when the lung is compressed by pleuritic exudation, *but only at those parts of the chest at which the dense lung is in immediate contact with the chest-wall*, that is, *posteriorly*, between the vertebral column and the scapula, when the effusion is non-encysted.—One condition which seems to be essential to the development of bronchophony is that the larger bronchi must still be patent, to permit the entrance of the waves of sound; should these too be closed by reason of the greatness of the pressure bronchophony is wanting. At those parts, on the other hand, at which the lung is separated from the chest-wall by the effusion, the vocal resonance, like the pectoral fremitus, is feebler than on the sound side. Nevertheless, all exudations do not offer the same opposition to the transmission of the voice-sounds; Baccelli has shown that the more fluid and homogeneous the effusion the more easily and completely is it penetrated by the vocal vibrations, and that in favourable circumstances even a whisper may be audible through effusion; but through fibrinous, and particularly through purulent exudations the waves of sound pass with difficulty or not at all. There is thus a possibility of ascertaining, by auscultation of the voice, especially of the whispered voice, whether the exudation is serous, fibrinous, or purulent. To facilitate the appreciation of these differences in the intensity with which the voice is conducted Baccelli recommends that the auscultating ear should be

pressed firmly against the spot under examination, that the other ear should be closed with the point of the finger, and that when the patient speaks, either aloud or in a whisper, he should turn his face away from the head of the examiner.

Compression of the lung from other causes than the presence of fluid is seldom so extensive or so complete as to offer conditions favourable to the production of bronchophony; for the same reasons, also, pneumothorax is not characterised in every case by bronchophony, and in those instances in which it does occur it is heard only posteriorly, where the collapsed lung lies close to the spinal column, whilst anteriorly and laterally the voice is weakened or suppressed.

#### PHYSICAL CAUSE OF BRONCHOPHONY.

The cause of Bronchophony is to be found in the superior sound-conducting power of *impermeable* lung-tissue. This increased vocal resonance is never observed in the thorax in health, as spongy expansible lung is composed of non-homogeneous (dense and rare) media, namely, air and pulmonary substance, or the tissues forming the walls of the bronchi; the vocal sounds are thus constantly refracted, and therefore weakened. But should these unfavourable conditions be removed by pathological processes which render a large part of the lung more or less solid, and so change it into a body of uniform consistence, the development of bronchophony is certain.—This theory, which was first started by Lænnec, and which has already been described in detail when treating of the causes of bronchial respiration, explains in a perfectly satisfactory manner all the phenomena of bronchophony.

In accounting for both bronchial respiration (see p. 136) and bronchophony Skoda combats the idea that either of the phenomena arises from the better conduction of the voice-sounds through the dense pulmonary parenchyma; the incorrectness of his views on this subject, however, has been shown on the above-mentioned page. This, nevertheless, seems to be the most fitting place in which to discuss fully the theory of *consonance*, which Skoda brings forward as the cause of bronchophony in all cases in which it occurs. He develops his theory in the following way:—

When the voice as heard in the thorax has the same intensity as at the point at which it is formed (the larynx), we have to do with a condition which must obviously have its origin in one of two ways: either the voice is concentrated whilst being propagated from the larynx to the ear of the observer,—the principle on which the speaking-trumpet is constructed, or it is reproduced and intensified by consonance.

Should the voice be *louder* in the thorax than over the larynx the conclusion that this change is the result of consonance is *unavoidable*.—The voice as it issues from the mouth is augmented in volume and force by consonance, the shock of the original sound generated in the larynx throwing the air in the buccal and nasal cavities into simultaneous vibration; closure of the mouth and nose, also, produces an immediate alteration in the timbre of the voice. The vocal sounds must further consonate in the air of the trachea and bronchi in the same way as in the air-spaces just mentioned (the pharynx, mouth, and nose); this is clearly indicated by the pulsation of the trachea in speaking. But this vibration is not transmitted directly through the walls of the larynx and trachea to the bronchi, this being prevented by the dissimilar structure of these parts, otherwise bronchophony should be heard over the whole of the thorax; the voice can therefore consonate only in the *air* of the bronchi, and that only when this air is pent up in an enclosed space, as in the sounding-board of a stringed instrument. In *normal* circumstances, however, the bronchi constitute but very imperfectly enclosed spaces, their parietes being composed of non-homogeneous tissues; thus, whilst the trachea and its two primary divisions are tubes of a perfectly uniform cartilaginous structure, forming chambers well adapted for the manifestation of consonance, the bronchi immediately beyond are not surrounded on all sides by complete rings, their walls being strengthened only by small cartilaginous plates, which become fewer and thinner the further the ramifications of the bronchi are followed out, and finally disappear entirely in the bronchioles. The voice in these bronchi, therefore, becomes progressively weaker and is ultimately almost lost to the ear, its sonorous waves being broken up and dispersed through the substance of the lung and the thoracic parietes. But if the walls of the bronchi become more solid, and so acquire a uniform structure, by morbid processes which condense the pulmonary parenchyma and render it void of air, the air-passages are transformed into closed spaces, surrounded by dense rigid parietes, and present then the most favourable conditions for the development of consonance of the voice; that is, the air within them is caused to vibrate by the voice, and the vibrations so aroused are reflected by the firm walls and go to add to the force of the originally feeble waves of sound proceeding from the larynx. Intensification of the voice in this manner furnishes at least *one* explanation of the fact that it is occasionally audible over the thorax even in the presence of conditions which hinder its free transmission to the surface; but it seems probable also that these reinforced voice-waves excite the surrounding airless dense tissue to simultaneous vibration, exactly as in the case of the walls of the larynx, so that the voice reaches the ear of the auscultator *unimpaired in intensity*.

In the first place it must be stated that the circumstance on which this theory is chiefly founded,—that the voice in the *thorax* is, under certain pathological conditions, louder than over the *larynx*,—is one of exceeding rarity, and one the existence of which seems to me, in common with many other observers, to be open to doubt; but even if such

cases do occur they offer no conclusive proof that the voice as generated in the larynx is *weaker* than that heard over a pulmonary cavern or consolidated lung-tissue, as in auscultating over the larynx only a portion of the laryngeal voice-waves which pass in a downward direction in the air-passages is collected in the tube of the stethoscope, the latter being placed perpendicularly on the surface,—an unfavourable position for receiving the whole of the sound. To ascertain the real strength of the laryngeal voice it is necessary to auscultate in the mouth, and here the voice is found to have such a degree of intensity as it never has over the thorax. And Skoda's argument that the same obstacles are encountered in the propagation of the voice through the thoracic parietes as through the wall of the larynx, is inapplicable to very large and superficial caverns,—and it is only in such cavities that very loud bronchophony is heard,—as in these the waves of sound reach the ear undiminished in intensity, being transmitted in the direction of the periphery of the lung, that is, exactly in the direction of the stethoscope (Wintrich).—Further, the assertion that the vibration of the larynx in speaking is communicated only to the column of air enclosed by the bronchi, is incorrect; the walls of the bronchi also are caused to vibrate.—Apart from these considerations, on purely physical grounds, the theory of consonance is rejected by many authorities (Wintrich, Schweigger, &c.) as untenable as an explanation of the causation of bronchophony in most of the cases in which it is observed. Thus, in enclosed spaces the air can consonate only with tones whose sound-waves are of equal length, and therefore of equal height, that is, usually with only *one* tone, the fundamental tone; and further when this fundamental tone is characterised by a certain degree of intensity consonance may take place with those sounds to which it bears a harmonic relation (1 : 2 : 3 : 4, &c., that is, its octave, its twelfth, its double octave, &c.)—in other words, with its *higher harmonic sounds*.

Skoda is also of opinion that the air-containing spaces in the lungs cannot be properly compared with those formed by closed tubes, which are capable of entering into consonance only with certain sounds; he holds that the bronchi, or pulmonary excavations, are rather "air-spaces of very varied form and structure, differing widely as regards their mode of communication with the larynx, so that the number of their consonating notes must of necessity be large, and that the compass of the voice in speaking is not so great that enclosed spaces of so exceedingly diverse conformation are unable to supply the appropriate harmonic sounds."—This, however, is a somewhat forced argument; if such spaces, adapted to the production of consonance with any tone whatever, really existed in the lungs, the thoracic voice at parts corresponding to the situation of pulmonary cavities should, even in speaking, and still more when tones of different pitch are sounded, show great differences in intensity according as the original tone is or is not in unison with the proper tone of the cavity. But this is not usually the case; it is only in very large excavations, (but never in simple consolidation of the lung), that signs are observed

which point unquestionably to the presence of consonance of the voice in the lungs. Such an indication is the formerly-mentioned (p. 170) ringing metallic quality acquired by the voice-sounds, amphorophony, heard when single words are spoken in a tone of a certain pitch. The applicability of Skoda's consonance-theory is therefore limited to the so-called metallic (amphoric) phenomena which may accompany the voice, the cough, the respiratory murmur, and râles (see pp. 139 and 156).

#### ÆGOPHONY.

This term is employed to designate a peculiar tremulous, interrupted quality of voice, which in timbre resembles the bleating of a goat, the nasal twang of the human voice when the nostrils are closed, or the sound produced by speaking against a comb which is covered with paper and held in front of the teeth; it very frequently creates the impression also as if it came from a great distance. It is very commonly met with in cases of moderate pleuritic exudation, (not if the effusion be exceedingly abundant or of very small amount), and usually towards the upper margin of the fluid; it is most often heard in the space included between the axillary line, the inferior angle of the scapula, and the vertebral column. All the sounds uttered by the patient do not assume the bleating character, and those which do so have not all the same timbre. When such a change, from the bleating to the non-bleating voice, takes place in pleurisy, the former is higher in pitch and seems remote from the ear, the latter deeper and closer to the ear.

Ægophony lasts, in some cases, for a considerable length of time, when the condition which gave rise to it, the presence of exactly the requisite amount of fluid in the pleura, undergoes no change; but it quickly disappears on increase of the exudation.

Ægophony is most probably produced by the vibration of the walls 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-sounds a quavering, interrupted character; and as they have to pass through a fluid medium to reach the surface they lose in clearness and precision, and acquire the nasal twang.

The diagnostic signification of ægophony, so far as it reveals

the physical condition of the pulmonary substance in pleurisy with exudation, is the same as that of bronchophony, of which, indeed, it is simply a modification. It is not unusual to find ægophony and ordinary bronchophony in the same patient, and at points not far distant from each other.

According to Skoda ægophony occurs not only in cases in which there is fluid in the pleura, but also in the absence of such fluid, in some cases of pneumonia, in caseous pneumonic infiltration of the lung substance, with or without excavation, and sometimes even between the shoulder-blades of children in perfect health; no satisfactory explanation has yet been offered of its causation in such circumstances.

## EXAMINATION OF THE SPUTA.

ALMOST all diseases of the organs of respiration are accompanied by more or less considerable catarrh of the bronchial mucous membrane, the secretions resulting from which are expelled by *coughing*. This coughing is characteristic of the expectoration of fluids secreted by the lining membrane of the respiratory apparatus proper, those from the pharynx or nares being got rid of by a quick, hawking expiration. Expectoration may also be entirely wanting at various stages, or during the whole course, of the pulmonary affection; its absence therefore does not *exclude*, nor does its presence *prove*, the existence of disease of the respiratory organs. Still another source of error has to be guarded against: the secretions may pass downwards from the fauces or nose into the larynx, and are then naturally discharged by coughing.

The sputum in the different diseases of the lungs consists of very diverse morphological and amorphous elements, by which its appearance and general characters are so modified that a rough estimate of its composition may usually be made even on examination with the naked eye, though its exact constitution can be determined only by means of the microscope.

### MORPHOLOGICAL ELEMENTS OF THE SPUTA.

1. *Epithelium*. The expectoration usually contains pavement epithelium, more seldom columnar epithelium, most rarely of all ciliated epithelium.

The *pavement epithelium* may be derived from the upper portion of the air-passages; it usually comes from the buccal mucous membrane, however, and is mechanically mixed with the sputum in the passage of the latter through the mouth.

It is easily recognised by the polygonal outline of the individual cells, by their size, and their large nucleus.

Epithelium of this kind is most abundant in the sputa of those suffering from catarrh of the pharynx and mouth. The epithelial cells of the deeper layers of the buccal mucous membrane are more