when the fluid is so abundant as to occupy the front of the cavity, the pressure from above pushing the diaphragm, and with it the stomach, downwards; the semilunar shape is then completely lost, and the area formerly resonant is now dull to percussion. The beginning of the process of absorption of the fluid is often announced by the return of an obscurely tympanitic percussion-sound in the region described.

On the *posterior* surface of the chest the pulmonary percussion-sound is heard on both sides as far down as the tenth or eleventh rib; it is less clear than in front, owing to the ample development of the dorsal muscles and the greater resistance offered by the ribs. The sound is least clear in the supra- and infra-spinous regions and at the lower part of the thorax. Bending of the body to one or other side, asymmetry of the shoulders, and frequently the fuller development of the muscles on the right side of the back, give rise to physiological differences in the percussion-note; these, however, may usually be eliminated by directing the patient to assume such a position that the parts on each side are brought into the same condition during examination, particularly by making him cross the arms in front and stoop a little forward; in this position the posterior surface of the chest is alike on both sides and the muscles in an equal state of tension.

On the *right lateral* surface the sound is loud and clear down to the eighth rib, at which point the liver-dulness begins.—On the *left lateral* surface the pulmonary sound may be elicited as far downwards as the ninth rib; between the ninth and eleventh ribs the percussion-note is rendered dull by the spleen, while at the eleventh rib the tympanitic sound of the colon is first detected.

The Sense of Resistance Accompanying Percussion.

The more solid the consistence of any body the greater is the sense of resistance experienced by the fingers in pressing or percussing upon it; it is from this cause that in ascending a stone stair the resistance perceived by the soles of the feet is greater than in ascending one constructed of wood. Hard bodies, such as wood or stone, offer very considerable resistance to percussion, soft bodies, such as cotton-wool, feathers, &c., almost none. Similar differences are observable, in percussing the organs

removed from the thorax and abdomen, between the resistance of a compressible, permeable lung and that of a firm, hepatized lung or any other solid body (liver, heart, spleen, &c.). But this sensation depends not only on the consistence but also on the thickness of the solid body; thus, the thin spleen, removed from the abdominal cavity, is considerably less resistant than the thick liver, while the relatively thin left lobe of the liver gives this feeling to a much less intense degree than the right.—The existence of these varied degrees of resistance may also be demonstrated on the body by simply percussing the lungs, liver, spleen, breast, &c., though the differences will be found to be hardly so well marked as when examining the organs outside the body, as the resistance of the thoracic walls has to be taken into account.

The resistance of the lungs may be *increased* or *diminished*; the former is an exceedingly common condition, the latter somewhat rare.

Increase of the sense of resistance at various points occurs, even though the lungs be normal, from the presence of certain obstacles which the structure of the thorax and the soft parts offer to the proper performance of percussion. Amongst those unfavourable conditions are excessive development of the bones forming the framework of the chest, narrowness of the intercostal spaces, unusual convexity of the ribs, and the presence of a large deposit of fat (especially in and around the female mamma).

The principal pathological change which gives rise to increased resistance in the lung is impermeability of its tissue to air, whether produced by infiltration, atrophy, or compression (by fluid or tumours in the pleural sac); it is thus usually traceable to the same causes which are known to render the percussion-sound dull. Hence increased resistance and a dull percussion-sound are always found associated, and point to the same conclusion—*that the subjacent media are partially or wholly deprived of their capability of entering into vibration.*

Other things being equal the feeling of resistance increases progressively with, though not proportionately to, the diminution in the air-contents of the lung; the completely air-less hepatized lung is thus much more resistant than that which is solidified (but less completely) from other causes; large pleuritic effusion

offers still greater resistance than even a consolidated lung, while in cases of tumour in the pleura this symptom is usually present in its most intense form.

This augmentation of the sense of resistance is a very valuable sign. When, as is frequently the case, the ear fails to distinguish between the finer shades of difference in sound which mark the transition from air-containing to solid media the sense of touch fully compensates for this deficiency. For obvious reasons, (though exactly the contrary has been maintained by many authors), percussion with the unaided fingers, or with the finger and pleximeter, is much better adapted to secure the correct appreciation of this sensation than the ordinary system of percussion with the hammer. Even in the healthy subject one may convince himself of this by comparing the impression communicated to the finger on striking over the lung and over the liver; it is found that the less palpable degrees of difference entirely escape notice in examining with the hammer.

Diminution of resistance is rare, though it is sometimes observed in very aggravated cases of pulmonary emphysema and pneumothorax. In emphysema it is probably due to widening of the intercostal spaces; in such a case, however, this sign, apart from its insignificance from a diagnostic point of view, is of little specific value, as the affection, being usually bilateral, affords no opportunity for comparative examination.—In pneumothorax it arises from the facts that only the air within the pleura is thrown into vibration, and that air is a much more yielding medium than the substance of the lung.—In percussing the chest in pneumothorax a peculiar sensation, very difficult to define, but giving the idea of *undulation*, is frequently perceived by the finger. This is noticed only in the upper part of the affected side of the chest, the part filled with air, not towards the bases of the lungs, where the fluid accumulates when the case, in running its usual course, assumes the form of pyo-pneumothorax. At the latter part, at the base of the chest, the feeling of resistance is augmented.

Piorry was the first to draw attention to the increased sense of resistance which invariably accompanies the dull percussion-sound. As the various organs of the body (liver, spleen, heart, for instance) differ considerably in consistence and size, and so offer very different degrees of resistance to percussion, these tactile phenomena were at one time regarded as strictly analogous to the acoustic properties of the percussion-sound; in this way a nomenclature sprung up, in which sounds peculiar to the heart, liver, spleen, &c., were spoken of,—terms which have long been abandoned, as they are quite unsupported by physical science.

Phonometry.

Under this name Baas has described a new method of investigating the condition of the thoracic and abdominal organs. It consists in placing a vibrating *tuning-fork* on the surface of the chest or abdomen and determining, by the *intensity or the feebleness of the tone* it gives, whether the subjacent organs *do or do not vibrate simultaneously*, that is, whether they are *permeable* or *impermeable to air*. The problem proposed to be solved by phonometry is thus the same as that to which percussion is directed.—As regards the manner of conducting this method of examination, the fork (sounding A or a somewhat deeper note) is struck with a moderate amount of force and, while still vibrating, is set perpendicularly, handle downwards, on the thorax, and allowed to remain there a few seconds; it may be applied directly to the skin, or through the medium of the pleximeter. In going over the chest in this way each time the tuning-fork is placed on the surface it must be again made to vibrate by striking it anew, and in order that the results so gained may be of any value this must always be done with as nearly as possible the same amount of force. As in percussion, so in phonometry, it is obvious that much practice is necessary to enable the examiner to strike in exactly the same way many times successively and to appreciate clearly the differences in the intensity of the sounds obtained. On applying this mode of exploration to the normal chest *the sound of the tuning-fork is found to be loud and strong at all points within the pulmonary boundaries*, but *weak over organs of dense consistence*, especially the liver; the ear also appreciates these variations in intensity almost as readily as those of the percussion-sound. A thorough investigation of this subject has satisfied me that it is impossible to place phonometry on the same level with percussion as regards delicacy and certainty in the delimitation of air-containing and dense organs, either in health or disease; I invariably found the figure obtained by phonometry, representing the dimensions of the liver, heart, or spleen, considerably smaller than that furnished by percussion of these organs, and the comparative examination, by both methods, of cases of condensation of the lungs (from phthisis) of all degrees of intensity, pulmonary cavern, pneumonia, pleuritic exudation, emphysema of the lungs, dilatation of the right heart, tumours of the liver, ascites, &c., gave the same general result.—It is, further, of the nature of phonometry that it indicates only the condition of the organs with respect to absence or presence of air, or diminution in the quantity of air they should normally contain,—exactly the purpose which is served by the clear, dull, or muffled sound of percussion; but it gives no information regarding those physical changes

whose existence we infer from alteration in the pitch of the percussion-note, from the presence of the tympanitic sound, from variation in the pitch of the sound on opening or closing the mouth, from the bruit de pot fêlé and the amphoric resonance. The increased sense of resistance, by which dense organs may at once be detected on percussion, is perceptible to but a very slight degree in the phonometric method.—I consider phonometry badly adapted for the examination of the abdomen, except, perhaps, in the delimitation of the liver and spleen. There is almost no difference between the phonometric sound of the thorax and that of the abdomen, though the percussion-notes of these parts are so exceedingly unlike and characteristic; while even the most pronounced pathological changes in the abdomen,—very abundant ascites, for instance,—announce themselves very much less distinctly by phonometry than by percussion. Finally, a phonometric examination of the whole thorax, as may be inferred from the description of it already given, cannot be made in a shorter time than a period at least three times as long as that required for examination by percussion. For all these reasons phonometry,—however interesting it may be scientifically, and however certain it may be that in the hands of those skilled in its use it may suffice for the recognition of very fine shades of difference in resonance,—has hitherto found little favour with practical physicians as a means of physical diagnosis.

AUSCULTATION OF THE LUNGS.

Historical Note.

The knowledge of at least some of the phenomena of auscultation, more particularly of the sign known as *Hippocratic succussion*,* observed in pyo-pneumothorax, dates from the time of Hippocrates. That Hippocrates was also acquainted with the friction†-sound of pleurisy and many of the catarrhal sounds seems equally unquestionable, not merely from the description of these given in his works, but also from his account of the diseases in which they were heard.

His observations, however, seem soon to have been entirely forgotten, as there are only a few scattered and obscure references to auscultation, but no precise enumeration of signs, in the works of certain of the ancient writers who came after him.

The real discoverer of auscultation, and of almost all its phenomena in the domain of the respiratory and circulatory organs, is *Lænnec* (born 1781, died 1826). The discovery was made in the year 1816, the first stethoscope which Lænnec used, to enable him to hear better the beat of the heart in a case of cardiac disease, being a roll of paper. Three years' further study and observation in the Hôpital Necker made him acquainted with nearly all the auscultatory signs, the result of his labours being first given to the world in 1819, in a work entitled "Traité de l'Auscultation médiate et des maladies des poumons et du cœur."—*Skoda* has submitted Lænnec's teaching to a most searching criticism, and, by tracing each of the auscultatory phenomena to its physical cause, has worked as great a reformation in this department of physical diagnosis as in the science of percussion. He has not only simplified matters by setting aside many of the points which found a place in Lænnec's system, but has also established, on physical principles, a classification of the phenomena of auscultation which has found universal acceptance up to the present time.

Our knowledge of the signs revealed by auscultation has received

* . . . . . ἕτερος μὲν τὰς χεῖρας ἐχέτω. σὺ δὲ τὸν ὦμον σείων ἀκοάζεσθαι, ἕως ὁκότερον ἂν τῶν πλευρέων τὸ πάθος ψοφέῃ. (Another holds the hands of the patient, whilst thou, shaking him by the shoulders, listenest from which side the sound proceeds.)

† . . . . . τρίζει τὸ πνεῦμα οἷον μάσθλης . . . . . (the respiratory sound is attended by a creaking, as of leather.)

Another passage, relative to the presence of fluid in the chest, is to the following effect:—τούτῳ ἂν γνοίης, ὅτι οὐ πῦον, ἀλλὰ ὕδωρ ἐστὶ, καὶ ἢν πολλὸν χρόνον προσέχων τὸ οὖς ἀκουάζῃ πρὸς τὰ πλευρὰ, ἐστὶν ἔσωθεν οἷον ψόφος. (Hereby mayst thou know that the fluid is water, not pus,—by holding thine ear to the side and listening, when it is as if a sound came from within.)

Catarrhal sounds also are repeatedly mentioned by Hippocrates. A very complete collection of the passages in which he treats of the above subjects and of physical diagnosis generally, has been made and published by Küchenmeister.