head, the chin being thrown quickly upward during inspiration, and falling slowly during expiration. I have known but one patient to recover after this type of breathing had set in.

After severe hemorrhage the breathing may be of a *sighing type* as well as very shallow.

(*e*) *Stridulous Breathing.*

A high-pitched, crowing or barking sound is heard during inspiration when there is obstruction of the entrance of air at or near the glottis. This type of breathing occurs in spasm or œdema of the glottis, "croup," laryngismus stridulus, and forms the "whoop" in the paroxysms of whooping-cough. Laryngeal or tracheal obstructions due to foreign bodies, or tumors within or pressure from without the air-tubes, may cause a similar type of respiration. It is in these cases especially that we see the sucking-in of the interspaces mentioned above (see p. 73).

VI. Diaphragmatic Movements.

Litten's Phenomenon.

The normal movements of the diaphragm may be rendered visible by the following procedure, suggested by Litten in 1892: The patient lies upon his back with the chest bared and the feet pointed directly toward a window. Cross lights must be altogether excluded by darkening any other windows which the room may contain[1] (see Fig. 55). The observer stands at the patient's side and asks him to take a full breath. As the ribs rise with the movement of inspiration, a short, narrow shadow moves down along the axilla from about the seventh to about the ninth or tenth rib. During the expiration the shadow rises again to the point from which it started, but is less easily seen. This phenomenon is to be seen on both sides of the chest and sometimes in the epigastrium.

[1] If it is inconvenient to move the patient's bed into the proper position with relation to the window, or if the foot-board interferes, or if the observation has to be made after dark, a dark lantern or other strong light held at the foot of the bed answers very well. All other light must, of course, be excluded.

It is best seen in spare, muscular young persons of either sex, and is never absent in health except in those who are very fat, or who cannot or will not breathe deeply. The latter condition occurs in

FIG. 55.—Litten's Diaphragm Shadow. Proper position of patient and of observer. The shadow is best seen near L.

hysteria and in some very stupid persons who cannot be made to understand what is meant by a full breath. In the observation of several thousand cases, I have never known it absent in health except under these conditions.

In normal chests, the excursion of the shadow is about two and a half inches; with very forced breathing three and a half inches. The mechanism of this phenomenon is best understood by imagining a coronal section of the thorax as seen from the front or back (see Fig. 56). At the end of expiration, the diaphragm lies flat against the thorax from its attachment up to about the sixth rib. During inspiration it "*peels off*" as it descends and allows the edge of the lung to come down into the chink between the diaphragm and thorax. This "peeling off" of the diaphragm and the descent of the lung during inspiration give rise to the moving shadow above described.

By thus observing the excursion of the diaphragm we can obtain a good deal of information of clinical value.

In pneumonia of the lower lobe, pleuritic effusion, extensive pleuritic adhesions, or in advanced cases of emphysema, the shadow is absent. This is explained by the fact that in pneumonia, pleuritic effusion, and emphysema the diaphragm is held off from the chest wall so that its movements communicate no shadow. In pleuritic adhesions the movements of the diaphragm are prevented. In early phthisis I have generally found the excursion of the diaphragm diminished upon the affected side, owing to a loss of elasticity in the affected lung and in part probably to pleuritic adhesions. On the other hand, fluid or solid tumors below the diaphragm, unless very large, do not prevent the descent of that muscle, and so do not abolish the diaphragm shadow. In cases in which the diagnosis is in doubt between fluid in the right pleural cavity and an enlargement of the liver upward or a subdiaphragmatic abscess, the preservation of the Litten's phenomenon in the latter two affections may be of great value in diagnosis. Very large accumulations of ascitic fluid may so far restrain the diaphragmatic movements that no shadow can be seen. Great muscular weakness or debility may greatly diminish, but rarely if ever prevent, the excursion of the shadow. In persons who cannot be made to breathe deeply enough to bring it out, a hard cough will frequently render it visible.

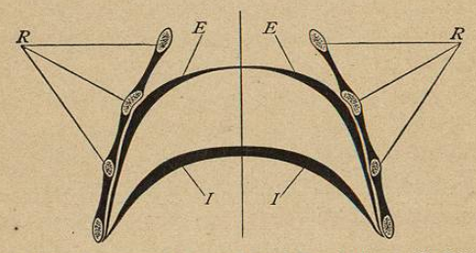

FIG. 56.—Excursion of the Diaphragm during Forced Respiration. *R*, Ribs; *E*, position of the diaphragm at end of expiration; *I*, position of diaphragm at end of inspiration.

The use of this method of examination tends, to a certain extent, to free us from the necessity of using the *x*-rays, inasmuch as it furnishes us with the means of observing the diaphragmatic movements, on the importance of which so much stress has been laid by F. H. Williams and others, much more easily and cheaply than with the *x*-rays, and upon the left side, more plainly as well.

It also frees us to a considerable extent from the need of using the spirometer to determine the capacity of the lungs.

By measuring the excursion of the phrenic shadow and taking account of the thoracic movement, we obtain a very fair idea of the respiratory capacity of the individual.

VII. Observation of the Cardiac Movements.

(1) *The Normal Cardiac Impulse.*

With each systole of the heart there may be seen in the great majority of normal chests an outward movement of a small portion of the chest wall just inside and below the left nipple. This phenomenon is known as the cardiac impulse.[1] It is now generally admitted that the "apex impulse" is caused by the impact of a portion of the right ventricle against the chest wall and not by the apex of the heart itself. [The bearings of this fact, which have not, I think, been generally appreciated, will be discussed presently.] The position of the *maximum* impulse in adults is usually in the fifth intercostal space just inside the nipple line. In children under the age of six it is often in the fourth interspace or behind the fifth rib; while in persons of advanced age it often descends as low as the sixth interspace. In adults it is occasionally absent even in perfect health and under certain pathological conditions to be later mentioned.

(*a*) The position of the impulse varies to a certain extent according to the position of the body. If the patient lies upon the left side, the heart's apex swings out toward the axilla, so that the visible impulse shifts from one to two and one-half inches to the left (see Fig. 57). A slight shift to the right can also be brought about by lying upon the right side, and, as a rule, the impulse is less visible in the recumbent than in the upright position.

[1] For a more detailed description of the normal position of the cardiac impulse, see next page.

Since the heart is lifted with each expiration by the rise of the diaphragm and falls during inspiration, a corresponding change can be observed in the apex beat, which, in forced breathing, may shift as much as one interspace. Of the changes in the position of the impulse brought about by disease, I shall speak in a later paragraph.

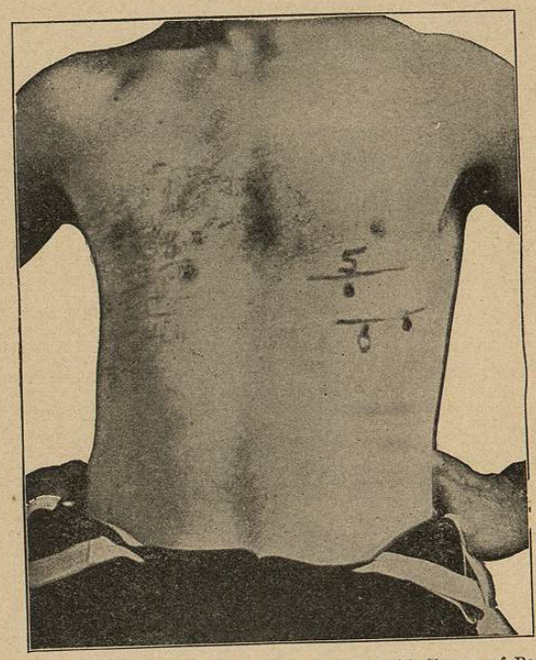

FIG. 57.—Showing Amount of Shifting of the Apex Impulse with Change of Position. The inner dot represents the position of the impulse when the patient lies on his back; the outer dot corresponds to the position of the apex with patient on left side.

(*b*) *Relation of the maximum cardiac impulse to the apex of the heart.*—I mentioned above that the maximum cardiac impulse is not due to the striking of the apex of the heart against the chest wall, but to the impact of a portion of the right ventricle. The practical importance of this fact is this: When we are trying to localize the apex of the heart in order to determine how far the organ extends to the left and downward, it will not do to be guided by the posi-

tion of the *maximum* impulse, for the apex of the heart is almost always to be found three-fourths of an inch or more farther to the left (see Fig. 58). This may be proved by percussion (*vide infra*,

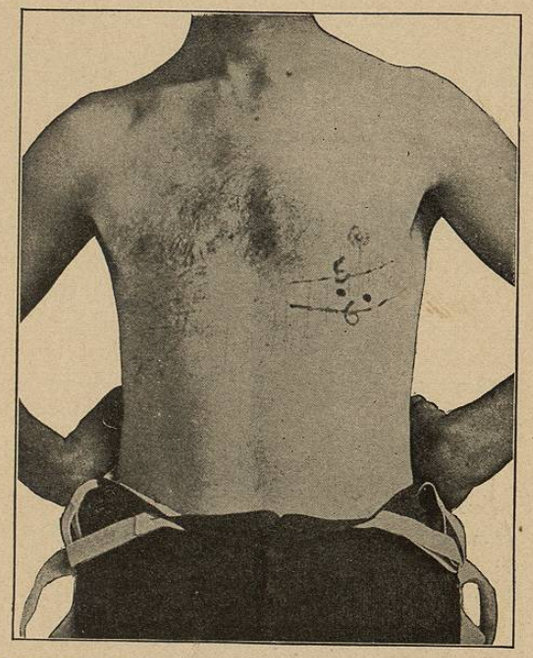

FIG. 58.—The Inner Dot is the Maximum Cardiac Impulse. That to the right is the true apex of the heart, as obtained by percussion. The ribs are numbered.

p. 58). The true position of the cardiac apex thus determined corresponds usually not with the *maximum* impulse, but with the point farthest out and farthest down at which *any rise and fall* synchronous with the heart beat *can be felt* (for further discussion of this point see below, p. 272).

(*c*) Besides the definite and localized impulse which has just been described, it is often possible to see that a considerable section of the chest wall in the precordial region is lifted "*en masse.*" The phenomenon is the "*Herzenstoss*" of the Germans, with which

the "*Spitzenstoss*" or *apex impulse* is contrasted. A variable amount of "*Herzenstoss*" can be seen and felt over any normal heart when it is acting rapidly and forcibly, and in thin, nervous subjects or in children even when the heart is beating quietly. It is more marked in cardiac neuroses or in cases in which the heart is hypertrophied and in which there is more or less stiffening of the ribs with loss of their natural elasticity. At times it may be impossible to localize any one point to which we can give the name of apex impulse, and what we see is the rhythmical rise and fall of a section of the chest as large as the palm of the hand or larger.

(*d*) *Character of the cardiac impulse.*—Palpation is considerably more effective than inspection in giving us information as to the nature of the cardiac movements which give rise to the "apex beat," but even inspection sometimes suffices to show that the impulse has a heaving character or is of the nature of a short tap, a peristaltic wave, or a diffuse slap against the chest wall. In some cases a distinct undulation can be seen passing from the apex region upward toward the base of the heart, or less often in the opposite direction.

(2.) *Displacement of the Cardiac Impulse.*

To one familiar with the position, extent, and character of the normal cardiac impulse, any displacement of this impulse from its normal site or any superadded pulsation in another part of the chest is apparent at a glance. I will consider first the commonest forms of dislocation of the apex impulse.

(*a*) *Displacement of the cardiac impulse due to hypertrophy and dilatation of the heart.*—By far the most common directions of displacement are toward the left axilla, or downward. As a rule, it is displaced in both these directions at once. I shall return to this subject more in detail under the heading Cardiac Hypertrophy, but here I may say that enlargements of the left ventricle tend especially to displace the apex impulse downward, while enlargements of the right ventricle are more commonly associated with displacement of the impulse toward the axilla.

(*b*) Next to hypertrophy and dilatation of the heart perhaps the commonest cause of dislocation of the cardiac impulse is pressure

from below the diaphragm. When the diaphragm is raised by a large accumulation of gas or fluid or by solid tumors of large size, we may see the apex beat in the fourth interspace and often an inch or more inside the nipple line.

(*c*) Of nearly equal frequency is displacement of the heart due to *pleuritic effusion* or to pneumothorax (see below, p. 336).

When a considerable amount of air or fluid accumulates in the left pleural cavity, the apex of the heart is displaced to the right so that it may be concealed behind the sternum or be visible beyond it to the right; in extreme cases it may be dislocated as far as the right nipple. Right pleuritic effusions have far less effect upon the position of the cardiac impulse, but when a very large amount of fluid accumulates we may see the impulse displaced considerably toward the left axilla

(*d*) I have mentioned causes tending to push the heart to the *right, to the left, or upward.* Occasionally the heart is pushed *downward* by an aneurismal tumor or a neoplasm of the mediastinum. In these cases there is usually more or less displacement to the left as well. As a result of arteriosclerosis or cardiac hypertrophy the aorta may sag or stretch a little, and the diaphragm stands lower, and hence the apex beat may descend to the sixth interspace, or (more often) it may be lost to sight and touch behind the bunch of convergent costal cartilages just to the left of the ensiform. Very frequently in men past forty-five the whole heart sinks considerably, so that a marked systolic retraction (less often pulsation) is seen below the ensiform in the epigastrium.

(*e*) Displacement of the cardiac impulse resulting from *adhesions* of the pericardium, or of the pleura, with subsequent contraction, occurs in *fibroid phthisis* and in some cases of long-standing disease of the pleura. Through the effect of negative pressure the heart may be sucked into the space formerly occupied by a portion of the lung, when the latter has become contracted by disease. It seems likely, however, that in the majority of cases adhesions between the pleura and pericardium play a part in such displacement. By these means the heart may be displaced to the right of the sternum, as it is by left-sided pleuritic effusion. It is often drawn upward

as well as to the right in such cases by the contraction which takes place in the upper part of the lung. More rarely we may see the heart drawn toward the left clavicle in fibroid phthisis of the left apex.

(*f*) Distortion of the thorax due to spinal curvature or other causes may bring about a considerable displacement of the heart from its normal position.

(*g*) *Dextrocardia and Situs Inversus.*—In rare cases a displacement of the apex impulse to the right of the sternum may be due either to a *transposition of all viscera* [the liver being found upon the left, the spleen upon the right, etc.], or to *dextrocardia*, in which the heart alone is transposed while the other viscera retain their normal places.

Summary.

The apex impulse is displaced by
(*a*) Hypertrophy and dilatation of the heart.
(*b*) Pressure from below the diaphragm.
(*c*) Air or fluid in one pleural cavity, especially the left.
(*d*) Aneurism, mediastinal growths, and sagging of the aorta.
(*e*) Fibroid phthisis.
(*f*) Spinal curvature.
(*g*) Transposition of the heart or of all the viscera.

(3) *Apex Retraction.*

Before leaving the subject of the cardiac impulse it seems best to speak of those cases in which during systole we see a *retraction* of one or more interspaces at or near the point where the cardiac impulse normally appears.

(*a*) In by far the greater number of instances such retraction is due to negative pressure produced within the chest by the vigorous contraction of a more or less hypertrophied and dilated heart. In these cases the retraction is usually to be seen in several interspaces. Such retraction is not at all uncommon and usually attracts no attention.

(*b*) In rarer cases several interspaces, both in the precordial region and in the left lower axilla and back, may be drawn in as a result of adhesions between the pericardium and the chest wall, such as form in cases of adherent pericardium and fibrous mediastinitis (see below, pages 276 and 303.)

(4) *Epigastric Pulsation.*

In a considerable portion of healthy adults a pulsation or retraction at the epigastrium synchronous with the systole of the heart is to be seen from time to time. Such pulsation has often been treated as evidence of hypertrophy of the right ventricle of the heart, but this I believe to be an error. It is not at all uncommon to find, post mortem, considerable hypertrophy of the right ventricle in cases in which during life no epigastric pulsation has been visible, while, on the other hand, the heart is frequently found normal at autopsy in cases in which during life there has been marked epigastric pulsation. In some cases such pulsation is to be explained as the transmission of the heart's impulse through the liver, or as a lifting of that organ by the movements of the abdominal aorta. In other cases it is due to bathycardia ("low heart"—a condition very common in arteriosclerosis).

(5) *Visible Pulsations due to Uncovering of Portions of the Heart Normally Covered by the Lungs.*

One of the commonest causes of visible pulsations in parts of the chest where normally none is to be seen is *retraction of the lung.*

(*a*) It is in chlorosis, perhaps, that we most frequently see such pulsations. In that disease, as in other debilitated states, the lungs are often not adequately expanded owing to the superficiality of the respiration, and accordingly their margins do not cover as much of the surface of the heart as they do in healthy adults. This results in rendering visible, in the second, third, or fourth left interspace near the sternum, pulsations transmitted from the conus arteriosus or from the right ventricle. Less commonly, similar pulsations may be seen on the right side of the sternum.

(*b*) A rarer cause of retraction of the lungs is fibroid phthisis or chronic interstitial pneumonia. In these diseases a very large

area of pulsation may be seen in the precordial region owing to the entire uncovering of the heart by the retracted lung, even when the heart is not drawn out of its normal position.

VIII. Aneurism and Other Causes of Abnormal Thoracic Pulsation.

So far I have spoken altogether of pulsations transmitted directly to the thorax by the heart itself, but we have also to bear in

Fig. 59.—Position When Looking for Slight Aneurismal Pulsation.

mind that a dilated aorta may transmit to the chest wall pulsations which it is exceedingly important for us to recognize and properly to interpret. No disease is easier to recognize than aneurism when the growth has perforated the chest wall and appears as a tumor externally, but it is much more important as well as much more difficult to recognize the disease while it is confined within the thorax. In such cases, the movements transmitted from the aorta to the chest wall may be so slight that only the keenest and most thorough inspection controlled by palpation will detect them. When slight pulsations are searched for, the patient should be put in a position

shown in Fig. 59, and the observer should place himself so that his eye is as nearly as possible on a level with the chest and looks across it so that he sees it in profile. In this position, or in a sitting position with tangential light, he can make out pulsations which are totally invisible if the patient sits facing the light.

Pulsations due to aneurism are most apt to be seen in the first or second right interspace near the sternum, and not infrequently the clavicle and the adjacent parts may be seen to rise slightly with every beat of the heart, but in any part of the chest wall pulsations due to an aneurism are occasionally to be seen, and should be looked for scrupulously whenever the symptoms of the case suggest the possibility of this disease (see below, p. 281).

Pulsating Pleurisy.

In cases of purulent pleurisy in which the pus has worked its way out betwen the ribs so that it is covered only by the skin and subcutaneous tissues, a pulsation transmitted from the heart may become visible, and the resemblance to the pulsation seen in aneurism may be confusing. Such pulsation is apt to be seen in the upper and front portions of the chest. Very rarely a pleuritic effusion which has not burrowed into the chest wall may transmit to the latter a wavy movement corresponding to the motions set up in the fluid by the cardiac contractions.

IX. Inspection of the Peripheral Vessels.

In a work dealing with diseases of the heart and lungs it is impossible to avoid reference to vascular phenomena apparent in the neck or in the extremities, since such phenomena have a very direct bearing upon the interpretation of the conditions obtaining within the chest. Inspection plays a very large part in the study of these vascular phenomena. We should look for:

(*a*) Venous phenomena.
(*b*) Arterial phenomena.
(*c*) Capillary phenomena.