Percussion outlines / by E.G. Cutler and G.M. Garland.

PERCUSSION OUTLINES

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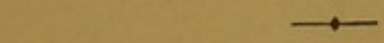
BOSTON:
HOUGHTON, MIFFLIN AND COMPANY,
11 EAST SEVENTEENTH STREET, NEW YORK.
The Riverside Press, Cambridge.
1882.

The Riverside Press, Cambridge:
reotyped and Printed by H. O. Houghton & Co

PREFACE.



THIS book is intended to teach students the anatomical position of the thoracic and abdominal viscera in the living subject, and to portray such boundaries of those organs as are accessible to percussion. The almost daily necessity in every physician's practice for determining the position and size of some concealed organ will, we trust, prepare a cordial welcome for our book from those who prefer well-defined knowledge to uncertain guess-work. We have devoted our attention mainly to the normal condition, and what we say regarding pathological phenomena is intended rather as a guide to the proper methods for detecting abnormal deviations than as a full description of the same. With regard to the preparation of the book we will add that it is essentially a condensed abstract of the German literature upon this subject, as contributed by Weil, Ferber, Luschka, and Gerhardt. We have, however, repeatedly and carefully reviewed, in our own practice and at the autopsy table, the points which we present, and have convinced ourselves that they are correct.

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PERCUSSION OUTLINES.

CHAPTER I.

METHOD IN PERCUSSION.

The first essential to intelligent percussion is a correct method. Much has been written about pleximeters of varied form and size — about hammers of different weight and material, but the secret of successful percussion lies in little details of method rather than in the fibre of any instrument. According to our own opinion the best pleximeter and hammer are the human finger. It is always available. It is never forgotten or lost. As a pleximeter it furnishes a wide scope in size, from its tip to its entire palmar surface, and it need never frighten the most timid child. It affords the best and most instantaneous information regarding the resistance of the parts percussed. The skillful use of the fingers is somewhat more difficult to acquire than that of a pleximeter and hammer, but any one who can percuss well with the fingers can also do well with instruments, although the reverse of this proposition is by no means true.

It is a matter of choice whether one or more fingers be used on each hand. We always employ the last phalanx of the middle finger of the left hand as the pleximeter, while the other fingers are raised from the chest, so as not to interfere with the sound vibrations.

The rounded end of the middle finger of the right hand forms our hammer, and we strike the pleximeter just behind the nail in such a manner that the hammer nail shall not touch the skin of the underlying finger — that is, we strike with that fleshy part of the finger where the distal surface curves into the palmar.

The pleximeter should be applied firmly with sufficient pressure to prevent the slipping about of the soft parts when the blow is given; and this pressure should be uniform for the two sides of the chest. What is of still more importance, the percussion blows should be given with uniform force, especially when comparing opposite sides of the chest. We have seen students unable to demonstrate the most striking differences of percussion tones simply because they delivered their blows with constantly varying force. The relative merits of light and heavy percussion will be discussed later, but whether light or heavy, the blows must be *uniform*.

Again, in comparing two sides of a chest, one should always percuss symmetrical spots. If the pleximeter finger be laid upon a rib on the one side, it should not be transposed to an intercostal space on the other, but should be placed on the symmetrical point of the companion rib.

Taking into careful account the correct use of the hands, attention should next be turned to the position of the patient. If the subject of percussion be a man, he should be exposed to the skin, due regard being paid to the temperature of the room. Our rule is as follows: We tell a patient to strip to the waist and then to put on his coat. This leaves the front of the body bare and easily accessible. When we reach the axillary region one arm can be slipped out of its sleeve, and while the back is examined the coat can be put on in the

reversed position. A similar amount of exposure is not usually advisable with women, but the judicious combination of a thin undershirt and a shawl, or an unstarched dressing-sack alone, will allow ample scope for a skillful percussor. The patient should be told to sit quietly and naturally, with the chest muscles relaxed. Most men, when stripped and approached for percussion, will throw back their shoulders and protrude their chest as if on dress parade. The muscular tension thus produced will always modify the sounds from the organs beneath. The two sides of the body should be held symmetrically, and the face should be directed straight forward, in order that the sounds of the apices may not be obscured by tension of the overlying muscles. It is immaterial whether the hands hang at the side or are placed on top of the head. Hanging at the side, the arms are out of the way, except during percussion of the axillary regions. A slight withdrawal of the arm backward, however, will give access to the anterior part of the axillary region, while a similar slight advance of the arm will expose the posterior part of the same space. If one hand is placed upon the head, which is on some accounts the most convenient position during percussion of the lower border of the lung, it should be remembered that such elevation of the arm carries the skin and ribs a trifle upward, and an allowance must be made for this deflection in the subsequent record of the border obtained.

Patients should not stand during percussion. They should be allowed to sit on a stool or on a chair without arms. If they are too weak to sit up and we are obliged to percuss them in bed, we should be careful to note that the body is straight, and that the shoulders are squarely placed and not twisted out of symmetry by underlying bolsters or pillows. Reference should also be made to

the fact that the position of the internal organs varies with changes in the position of the body, a point which will be treated of later under the head of the *passive mobility* of the percussion boundaries.

Examination of the abdomen is best made with the subject lying upon the back, with the head slightly raised and the knees drawn up, so as to relax the abdominal wall. To expose the spleen, the subject should lie upon the right side, or half way between the right lateral and the prone position.

Having thus discussed the preliminary stages of our task, we will now describe the manner in which an internal organ may be outlined. It will be learned later that only a small portion of all the anatomical borders are accessible to percussion. Piorry, in the enthusiasm of a new study, claimed that every organ of the body emits a sound peculiar to, and distinctive of, itself. If this were true, all the internal organs might be mapped out with anatomical nicety. Skoda was the first to vigorously attack this idea. He maintained that aerated organs are resonant by reason of the contained air. Those organs which contain no air are simply non-resonant, and the sounds which they emit when struck are indistinguishable from each other. The question of percussion outlines resolves itself into the tracing of boundaries between organs which are very resonant, and those which are less resonant or possessed of a different quality of resonance, and those which are non-resonant. Thus it is easy to trace the boundary between the lung and the liver where they lie in apposition, but impossible to distinguish the line of contact between the heart and the liver.

In order to define any border which comes within the province of our search we should percuss toward that border from either side — and alternately from both sides — in lines which are perpendicular to its known anatom-

ical course. Inasmuch as most of the percussion boundaries run transversely across the body, we have adopted the following series of perpendicular lines, which should be followed methodically and in succession: —

Sternal line	Along the border of the sternum.
Parasternal line . .	Half way between the sternal and mammillary lines.
Mammillary line . .	Through the nipple on the male. On the female this line should be drawn perpendicularly downward from about the middle of the clavicle.
Anterior axillary line	Along the anterior border of axilla.
Axillary line . . .	From the summit of the axilla downwards.
Posterior axillary line	Along posterior border of axilla.
Scapula line . . .	Through the apex of the scapula when the arms are hanging at the sides.
Vertebral line . . .	Between the scapular and vertebral column.

To illustrate the use of these lines, let us suppose that the lower border of the right lung is the object of investigation. In such case one should begin on the sternal line, and percuss downward until a point is reached where the resonance of the lung ceases, and the flatness of the liver begins. Having repeated the percussion often enough to be sure of such change, this point should be designated by a pencil mark on the skin. Then the same steps should be repeated along the parasternal, mammillary, and anterior axillary lines, and so on to the vertebral line, the point of change of sound in each case being marked. Then if these points be connected by a continuous line, one will have a sketch of the lower border of the lung. It is always serviceable to percuss toward the border sought, not only from above downward, but also from below upward, in which case one

would mark the points where flatness changes to resonance.

In outlining the heart one should percuss in the sternal, parasternal, and mammillary lines, and even in the anterior axillary and axillary lines. Under normal conditions, the left border of the heart, as shown in Plate IV., curves downward and runs parallel with the mammillary line, hence, to define this border, it will be necessary to approach it in oblique lines from the left shoulder and left axillary region.

It is difficult to find a good pencil for marking the skin. Ink spreads and dries slowly. Burnt cork is very good, but inconvenient to carry, and an ordinary lead pencil is too hard to make a mark on soft skin. Chalk and carbon work well for a time, but they rapidly absorb oil from the skin, and cease to mark unless refreshed with sand paper. We have found a very convenient marker in the pencils which actresses use for staining their eyelids. These pencils are made, like ordinary cosmetics, from grease stained with lamp-black or vermilion. They are put up in little tin cases, with slides for pushing them in and out, and can be carried about in the pocket. They can be obtained at any perfumery store.

We must again emphasize the necessity of percussing in straight lines, and of carefully completing one line before beginning another. Students are very apt to percuss across the chest in a zigzag direction or wander about in circles. Such percussion teaches nothing, and only serves to confuse the examiner.

A word in regard to the relative merits of light and heavy percussion. Undoubtedly heavy percussion has its place and serves a good purpose, especially over thick muscles on the back, and in bringing out the dullness of deep-seated consolidation. In outline percussion, however, on the lateral and anterior aspects of the body,

light percussion alone should be employed. In crossing the boundary between a resonant and a non-resonant organ, if our blows are heavy, the resonance of the former organ will be so transmitted over the latter that the line of demarkation will apparently lie several centimeters away from its actual position. We have found that the best results are obtained with extremely light percussion. The blow should never be given from the elbow, but from the wrist or from the metacarpal joint of the hammer finger. Where the chest is at all tender, and especially in percussing children, we always keep the hand quiet, and deliver our blows with the finger alone.

The burden of this book is the normal percussion outlines of the body, and we devote but relatively small space to pathological deviations. In presenting the subject thus, we have been actuated by the conviction that perfect familiarity with the normal is the only true guide to the abnormal. One who has a systematic method of searching for the normal, and pursues that method rigorously in every case, will never fail to detect abnormal deviations.

CHAPTER II.

STERNUM.

THE sternum consists of the manubrium, corpus sterni, and the ensiform cartilage. It ordinarily lies in the median line, opposite the vertebral column. Congenital and acquired deformities of either side of the chest will of course alter its position. With pleuritic effusions the sternum swings toward the affected side like a pendulum, the lower end traveling four to five centimeters, while the upper end moves only two centimeters.

The manubrium is normally quite resonant — the sound is neither tympanitic nor vesicular, but has a quality of its own. It may be rendered dull by an overfilling of the veins from valvular disease of the heart; by aneurism of the arch of the aorta; by pericardial effusion, and by pus gravitating from abscesses in the neck. In the last-named case it is important to notice that the dullness does not extend below the manubrium, because the firm adhesion of the membranes of the anterior mediastinum deflect the gravitating pus into the posterior mediastinal space.

The resonance of the sternum is clearest and loudest between the second and fourth ribs. It is also clear between the fourth and sixth ribs, although it here crosses the heart, and is to a great extent in direct contact with that organ. It would seem that the sternum is an excellent conductor of sound from the neighboring lungs, and thus conceals the flatness of the underlying heart.

DIAPHRAGM.

Anatomy.

Viewed from above, the diaphragm presents a dome-like projection into each side of the thorax, with a nearly horizontal plane connecting the summits of the domes. The upper surface is somewhat elliptical in shape, the transverse diameter being the longest. The diaphragm consists of two parts, a tendinous portion — *pars phrenica* — which forms the plane above, and a muscular portion — *pars costalis* — which constitutes the sides of the domes. The muscular portion has a long line of attachment extending from the sternum along the border of the ribs to the vertebral column. The sternal segment rises chiefly from the apex of the ensiform cartilage, and is immediately lost in the tendinous layer. The costal segment begins with one serration from the seventh costal cartilage, and another from the outer portion of the eighth cartilage. On the ninth rib the serrations extend about a finger-breadth beyond the cartilage, on to the costal bone. From here to the twelfth rib, the muscle is attached to the osseous parts and the intercostal spaces. Its serrations also interdigitate with the corresponding projections of the transverse abdominal muscle. The vertebral segment takes its origin from the first four lumbar vertebræ.

Starting from this long line of attachment, the pars costalis rises directly upward, and lies in contact with the chest wall for a distance which varies on different sides of the chest and with different phases of respiration. On reaching the lower border of the lung and the heart, it is reflected beneath those organs and becomes the pars phrenica.

The summit of the diaphragm changes with every

stage of respiration, but at the end of ordinary expiration it coincides on the right side with a horizontal line drawn through the sternal ends of the fifth pair of ribs, and it is a costal space lower on the left side. On the back it corresponds to the ninth dorsal vertebra.

Percussion of the Diaphragm.

The position of the diaphragm cannot be defined by means of any sound or modification of resonance peculiar to itself. It is only by comparing its anatomical relations to other organs with the percussion boundaries of those organs that we are able to form any opinion concerning it.

The most important points to determine, are: —

1. The line of transition from the pars costalis to the pars phrenica. This corresponds to the lower border of the lung, and may therefore be deferred to the discussion of that border.

2. The position of the dome. Gerhardt says it is idle to try to define the arch of the dome, owing to its distance from the chest wall. Weil and Ferber think it can be defined by strong percussion, but this is a difficult task, and usually we can determine the probable height of the diaphragm only by inference from the position of other organs. When the dome of the diaphragm is de pressed into the abdomen by a large pleuritic effusion, it becomes readily accessible to percussion, and may often be felt.

PLEURA.

Anatomy.

The pleural membranes are divided into four parts, according to the organs with which they are associated. These parts are: —

Pars pulmonis, which directly envelops the lung and cannot be detached from the same.

Pars phrenica, which covers the diaphragm.

Pars mediastinalis, which helps form the partition between the two halves of the chest.

Pars costalis, which lines the inner surface of the ribs, intercostal spaces, and a portion of the sternum.

At the apex of the chest, behind the sternum and along the vertebral column, the pars costalis is reflected inward, to form the pars mediastinalis, and these lines of reflection constitute respectively the superior, anterior, and posterior borders of the pleural cavity. The inferior border of that cavity is formed by the reflection of the costal into the diaphragmatic layer, or pars phrenica. The most important of these borders, for percussion, are the superior, anterior, and inferior.

The *superior borders* coincide accurately with the superior borders of the lungs, and therefore require no separate notice at this point. See description of lungs, page 14.

The *anterior borders* start on either side at the articulation of the clavicles with the sternum, Plate I., A B, C D. They advance obliquely downward and inward, behind the manubrium, until they reach the level of the inner extremities of the second ribs, where they come into contact with each other. Thence they proceed together downward a little to the left of the median line, as far as the fourth pair of ribs, when they separate. The right border continues still downward, with a slight inclination to the right, until it meets the inferior border of the right pleura, in the median line of the sternum, at the level of the sixth intercostal space.

The left anterior border bends somewhat sharply to the left at the fourth rib, and crosses the cardiac area in an irregularly diagonal direction until it reaches the

parasternal line in the sixth intercostal space. Here it sweeps in an easy curve across the seventh costal cartilage, and is lost in the inferior border of the left pleura.

The *inferior borders* of the pleuræ convex downward on either side. The left one runs obliquely downward and outward from the outer third of the sixth or seventh costal cartilage to the bony portion of the twelfth rib behind. Its termination is about on a level with a horizontal line which halves the twelfth pair of ribs. In its course it crosses the bony end of the eighth rib in the mammillary line, and from there on it comes in contact only with the bony portion of the ribs. It reaches the tenth rib in the axillary line. The lowest point of the pleural cavity is sometimes close to the vertebral column and sometimes a little out from the same. It may be as far out as the scapular line in some cases.

The right inferior border runs from the median line of the sternum outward and downward along the sixth costal cartilage or the sixth intercostal space to the outer third of the seventh costal cartilage, whence it proceeds in nearly the same manner as on the left side. It is noticeable, however, that the pleural border on the left side is a trifle lower than that on the right side, which harmonizes with the fact that the left lung is longer though smaller than the right one.

The *posterior borders* of the pleuræ form perpendicular lines on either side of the vertebral column.

NOTICE: 1. The inferior border of the pleura does not reach so low as the line of attachment of the diaphragm, which runs along the costal arch from the ensiform cartilage to the outer extremity of the twelfth rib. The diaphragm in this region is intimately attached to the ribs and intercostal spaces.

2. A portion of the pericardium has no pleural cover-

ing, owing to the oblique course of the anterior border of the left pleura. This exposed region has a triangular shape with its apex upward, and within this triangle the pericardium lies in direct contact with the chest wall. The portion of the pleura (*pleura pericardiaca*) which does overlie the pericardium is intimately attached to the latter.

3. The anterior borders of the pleuræ touch each other only between the second and fourth pair of ribs, and it is here only that the posterior surface of the sternum is wholly covered by pleura.

4. A triangular space behind the upper part of the manubrium is free from pleural covering. Certain important organs lie behind this space. A needle thrust through the manubrium at the angle formed by the pleural layers would pierce the upper part of the pericardium, which rises as high as the first pair of ribs. Above the pericardium one would wound first the vena innominata, and, back of that, the aorta. In childhood this space also contains the large thymus gland.

CHAPTER III.

LUNGS.

Anatomy.— The lungs present three surfaces and five borders for consideration. The external or costal surface is convex outward, corresponding to the concavity of the chest wall, and it is a sort of spherical triangle with its apex above, and the lower pulmonary border for the base. The inferior surface is also a spherical triangle with its concavity looking down upon the diaphragm. The median or mediastinal surface looks toward the centre of the body, and is pierced by the trachea and blood-vessels which administer to the functions of the lungs.

Pulmonary Borders.—The superior border passes yoke-like over the shoulder at three to five centimeters (two to three finger-breadths) above the clavicle. Plate IV., G, H. Anteriorly, it runs close to, and parallel with, the posterior border of the sterno-cleido-mastoid muscle, until it reaches the sterno-clavicular articulation, when it becomes the anterior border. On the back it is slightly concave upward, and terminates at the level of the spinous process of the seventh cervical vertebra. Plate VII., A B.

The anterior border of the right lung corresponds accurately to the anterior border of the right pleura, as given on page 11, Plate I.

The anterior border of the left lung runs also parallel with its pleura, as far as the inner extremity of the fourth rib. Here it bends sharply to the left, and lies along the

fourth costal cartilage as far as the parasternal line. Then descending slightly across the fourth intercostal space, it turns again toward the median line in a half-moon curve— *Incisura cardiaca* — and approaches the sternum until it reaches the sixth costal cartilage, when it again bends to the left and is lost in the inferior border. This peculiar deflection of the border produces a tongue-like projection — *lingula pulmonis* — which overlies the apex of the heart.

The inferior border of the left lung is, in front, a little lower than that of the right lung. This difference amounts to one and a half centimeters between the mammillary and parasternal lines, but no perceptible difference exists on the back. The following table shows the relative positions of the inferior border on the two sides.

	RIGHT.	LEFT.
Parasternal and mammillary lines	Upper border of 6th rib.	Lower border of 6th rib.
Axillary line	Crosses 7th rib.	Crosses 7th rib.
Scapular line	Crosses 10th rib.	Crosses 10th rib.
Vertebral line	Crosses 11th rib.	Crosses 11th rib.

This table represents the position of the borders at the end of normal expiration. The respiratory modifications of the same will be noted later.

The posterior borders run parallel with the vertebral column. Little or no information can be obtained regarding them by percussion, except in cases of pleurisy, when we find them shortened by the general contraction of the lungs.

The antero-posterior borders, which bound the lower part of the mediastinal surfaces, are inaccessible to percussion.

Incisuræ Interlobulares. — Each lung is divided into lobes by incisuræ, which extend from the surface to the root of the lung, and are lined by reflections of the

visceral pleura. The right lung has three lobes, the left lung two.

The main incisura begins on either side, behind, at the level of the spinous process of the third dorsal vertebra. This also coincides with the spines of the scapulæ, when the arms hang at the sides.

On the left side, the incisura runs obliquely downward and forward, so as to cross the fourth rib in the axillary line, and ends in the lower border of the lung on the sixth rib in the mammillary line. Plate II., E D.

On the right side the incisura divides into two branches, about five to six centimeters above the apex of the scapula. The upper branch runs forward, with very slight descent, and ends in the anterior border of the right lung at the fourth or fifth costal cartilage. In the mammillary line it stands at the level of the third rib.

The lower branch runs obliquely downward and forward until it reaches the inferior border of the lung at the sixth costal cartilage near the mammillary line. These incisuræ cannot be defined by percussion, except in cases of lobar infiltration of pneumonia.

NOTICE: 1. In the position of ordinary expiration, the lower border of the lung on either side does not reach to the bottom of the pleural cavity, but is elevated above the same by a distance varying on different sides of the chest. Plate II. During inspiration the lung descends until, with the fullest breath, it occupies the entire cavity. With the following expiration, the lower border glides upward to resume its former position. The space which is thus alternately occupied and abandoned by the lung is called the *complemental space* (GERHARDT), or the *sinus phrenico-costalis* (WEIL). As the lung deserts this space, the diaphragmatic and costal layers of the pleura are brought into contact, and thus the space becomes temporarily obliterated.

The variations in the depth of this space on different sides of the chest are shown in the following table (WEIL):—

	RIGHT SIDE.	LEFT SIDE.
Parasternal line	2½ ctm.	3 ctm.
Mammillary line	6 "	6 "
Axillary line	10 "	10 "
Scapular line	4 to 5 "	4 to 5 "
Vertebral line	4 to 5 "	4 to 5 "

These figures represent the condition of ordinary expiration. With forced expiration they may be much increased.

2. The anterior border of the left lung, in the cardiac region, does not occupy the whole of the space allotted to it. Plate I., Q. This excess of room, reserved for the play of the pulmonary border, is called the *sinus mediastino-costalis*, and it will be seen later that the recognition of its condition is very important, especially for the diagnosis of emphysema. The widest portion of this sinus is in the fourth intercostal space, where it is over three centimeters.

3. The apex of the heart does not touch the chest wall, but is separated from the same by the lingula pulmonis.

4. The lowest point of the lung is in the scapular line.

PERCUSSION OF THE LUNGS.

The only boundaries of the lungs which can be defined by percussion are the superior and inferior borders, and so much of the left anterior border as lies across the cardiac area.

Superior Borders. — The apex of the lung rises above the clavicle from three to five centimeters. The superior border extends from the inner end of the clavicle, at first upward along the posterior edge of the sterno-cleido-mastoid muscle, and then over the shoulder

in a gentle sweep, to the spinous process of the seventh cervical vertebra. Plate VII., A B. On the back, these borders concave upward.

The distinction between the pulmonic resonance of the apex and the tympanitic resonance of the trachea in front can best be made out by light percussion, and with the patient's mouth open. The importance of determining these boundaries may be noticed in phthisis, when one apex is often found considerably retracted. Plate VII., O P.

Anterior Borders. — Owing to the peculiar resonance of the sternum and to the fact that we cannot distinguish the sound of the right from that of the left lung, it is impossible to outline those portions of the anterior borders which underlie the sternum. Plate IV.

In percussing down the left sternal line, we notice a dulling of the resonance at the third rib. This dullness is due to the underlying heart, and will be further mentioned in connection with that organ. On reaching the fourth rib there is a sudden change from pulmonary resonance to flatness, which indicates the transition from lung to heart. The line of this transition extends a short distance outward along the fourth rib, and then turns perpendicularly downward across the fifth rib. At the sixth rib it turns again to the left, and is lost in the lower border. The line *a* to *c*, along the left edge of the sternum, indicates the change from cardiac flatness to sternal resonance.

Inferior Borders. — On the left side the inferior percussion border lies as follows: —

Axillary line	At the eighth rib.
Scapular line	At the tenth rib.
Vertebral line	At the eleventh rib.

The position of this border in the mammillary line is

often difficult to establish, owing to the great resonance of the stomach beneath. Ordinarily, however, it is placed at the sixth rib.

The inferior percussion border of the right lung stands as follows: —

Median line	At base of xiphoid cartilage.
Parasternal and mammillary lines	On sixth rib. Sometimes nearer the upper edge; sometimes nearer the lower edge of the rib.
Axillary line	At the eighth rib. It may be found as high as the seventh intercostal space, or as low as the eighth intercostal space.
Scapular line	At tenth rib.
Vertebral line	At eleventh rib.

The line, P Q, in Plate IV., represents the superior border of the hepatic dullness, which will be described elsewhere.

It will be remembered that these percussion boundaries represent the normal expiratory position of the lung in an adult. In extreme youth and in old age these boundaries are differently situated. Plate IX. represents the senile type, and Plate VIII. the infantile type. Thus we see in children the pulmonary boundaries may be found from one half to a whole interspace higher than in an adult, while in old age they are the same distance lower.

Moreover, during life the borders of the lungs are continually changing position with each act of respiration, and with every change of the body.

Active mobility of the lungs. — Concurrent with the acts of breathing, the inferior borders of the lungs are alternately descending and ascending, so that their percussion

limits include a considerable space. The inspiratory descent of the lower border is ordinarily:—

In the right parasternal line . . .	1½ to 2 centimeters.
In the right mammillary line . . .	2 to 3 centimeters.
In both axillary lines	3 to 4 centimeters.
In both scapular lines	2 centimeters.

(Weil.)

With forced expiration, these borders will be retracted as far above their usual position, and even further than they are lowered by the fullest inspiration. The amount of excursion, therefore, between the position of fullest expiration and that of fullest inspiration is:—

In the mammillary line	8⅙ centimeters.
In the axillary line	9⅓ centimeters.
In the scapular line	7⅓ centimeters.

That portion of the left anterior border which overlies the heart also undergoes active movements during respiration. With inspiration this border is carried forward into the sinus mediastino-costalis, so as to greatly diminish the area of cardiac flatness. In some persons the advance may be so great as to almost obliterate the cardiac flatness. In a similar way, the area of flatness is noticeably increased during full expiration.

Passive mobility of the lungs. — Gerhardt found that the pneumono-hepatic border, when a man lies on his back, is one to two centimeters lower than in the erect posture. When one turns on to the right side, the inferior border of the left lung descends by a distance equal to a full inspiration. The same is true of the lower right border, when one lies on the left side. These changes of position are called the passive mobility of the lungs, and it is important to bear them in mind when percussing an invalid in bed.

The active and passive mobility of the lungs are usually

diminished or entirely absent in cases of emphysema and pleurisy. In the former disease the lungs are permanently enlarged and incapable of retraction, while in pleurisy the lungs may be either permanently retracted, or so tied up by adhesions as to be held stationary.

NOTICE: The diagram of percussion boundaries, Plate IV., does not portray any divisions between the lobes. This is because the resonance of contiguous lobes cannot be distinguished from each other under ordinary conditions. In cases of pneumonia, where one lobe is solidified and its neighbor is not, the line of transition from the dullness of the former to the resonance of the latter will coincide with the anatomical sulcus. The careful delineation of these lines will often assist in removing doubts between pneumonia and pleurisy.

PATHOLOGY.

PNEUMONIA. — Pneumonia does not produce any marked change in the gross outlines of the lungs. It causes a diminution of the pulmonary resonance, however, which varies in intensity and extent according to the amount and degree of infiltration. In catarrhal pneumonia, the dull area may be limited to a few lobules only, but it is usually impossible to accurately define the outline of such an area, because the transition from dullness to the resonance of neighboring lobules is very gradual.

When an entire lobe is hepatized, as in croupous pneumonia, the percussion line of demarkation between the dull and the companion resonant lobe corresponds to the anatomical sulcus which separates them. It is important to remember that in some stages of pneumonia — in the beginning of lobular pneumonia, and during the resolving stage of croupous pneumonia — we may obtain a tympanitic resonance over the parts which are relaxed by disease.

CAVITIES. — Taken by themselves alone, and judged by any or all of the signs which are peculiar to themselves, pulmonic cavities are very difficult of diagnosis. It may be laid down as a safe rule, to start with, that such cavities possess no pathognomonic percussion signs.

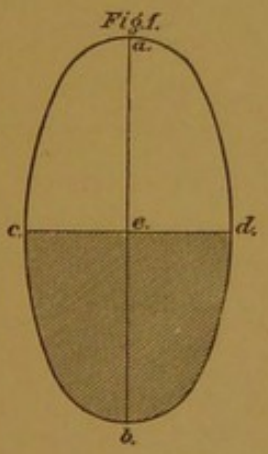
Several signs have been described, however, and more or less importance has been attributed to them by different writers; and yet a careful analysis of the conditions under which they may occur will reveal their fallibility as indicators of cavities. These signs are: the cracked-pot sound, tympanitic resonance, Wintrich's *variable-pitch*, Gerhardt's *variable-pitch*, amphoric resonance.

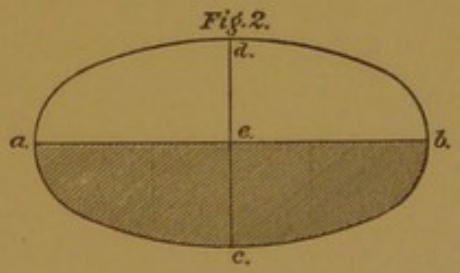
The *cracked-pot sound* is obtained by listening at the open mouth of the patient, while strong percussion is made upon the chest. It resembles the chinking of money, and may be imitated by clasping the hands loosely together and striking the back of one of them upon the knee. This sound may be obtained from the chest, however, without the presence of a cavity, as with pleural effusion, pneumonia, pneumo-pericardium, and even upon healthy persons. Thus, if we percuss the back of a screaming infant, or of a thin woman, we may produce the cracked-pot sound.

Tympanitic Resonance. — The best observers unite in declaring that a cavity must be as large as a man's fist, superficially situated, and surrounded by a certain amount of indurated tissue, in order to give forth a tympanitic note. But tympanitic resonance occurs more often without cavities than with them, as with pleurisy and pneumonia. Weil thinks that not more than ten per cent. of the cases of tympanitic resonance over the lungs are attributable to pulmonic cavities. This sign, therefore, has but little value in itself. It has gained a new importance, however, by certain investigations made regarding its pitch under various conditions.

Wintrich's Variable-pitch. — Wintrich observed that when a cavity gave forth tympanitic resonance, the pitch of this resonance could be raised by opening the mouth of the patient. In order to obtain this sign the cavity must connect with a free bronchus. Sometimes the sign will appear and then disappear, by reason of the plugging of the bronchus with secretion. In such cases an effort at coughing will clear the tube and restore the sign. A similar change of pitch on opening and closing the mouth may be noticed when percussing over relaxed pulmonary tissue, and also with the so-called Williams' *tracheal tone.* It follows, therefore, that other possibilities must be eliminated before this sign can decisively indicate a cavity.

Gerhardt's Variable-pitch. — Gerhardt noticed that a cavity which is oval in shape and contains both fluid





and air, as in Fig. 1, will give forth a tympanitic resonance which will vary in pitch with changes in the position of the patient. Suppose the long diameter of the cavity (*a b*) to be in the longitudinal axis of the body, then the percussion note will have a higher pitch when the patient stands, and a lower pitch when he lies on his back, because the column of air (*a e*), above the

fluid, is shorter in the former case (Fig. 1) than the column (*a b*) is in the latter (Fig. 2).

Amphoric Resonance.—This is a rare phenomenon with cavities. In order for its production the cavity must have a certain size; its inner surface must be smooth, and its walls must be of uniform consistency. Leichtenstein says that this phenomenon can often be detected by listening to the chest, while a second person percusses over the suspected cavity with a lead pencil upon an ivory pleximeter. This method, he says, will often reveal a cavity when all other tests have failed.

To sum up regarding the above signs, it may be said that the cracked-pot sound and tympanitic resonance have nothing characteristic of a cavity. The amphoric resonance is more conclusive, and yet this sound may be obtained over bronchi and trachea.

Wintrich's variable-pitch is very dubious. Gerhardt's variable-pitch, when well marked, is perhaps the most reliable of all. Weil says that in all cases where the pitch was lower in the upright position, and higher on lying down, he found a cavity present. In cases where the pitch became higher on sitting up, he found a cavity present in all but one instance.

Valuable evidence regarding the formation of a cavity may be obtained under the following circumstances. During a prolonged observation of a dull region on the chest, if the resonance suddenly becomes clearer, or less dull, with a tympanitic tinge, then we may suspect a cavity, especially if the change in resonance is accompanied by a sudden and profuse expectoration.

As to the size and exact form of a cavity, almost no information can be obtained under any circumstances. Thus, amphoric resonance, when present, is usually associated with large cavities, but cases have occurred where it appeared with a small cavity which connected freely with a bronchus.

EMPHYSEMA. — In emphysema the entire chest assumes permanently the position of inspiratory expansion, which varies in degree according to the duration and amount of the disease.

Pulmonary Borders. — The inferior borders are the ones chiefly affected. They may descend as low as the seventh intercostal space, or the eighth rib in the mammillary line; the tenth rib in the axillary line; the twelfth rib in the vertebral line. With moderate emphysema the sinkage of the border will of course be proportionally less.

The cardiac border is advanced so as to occupy the cardio-mediastinal sinus. By this means the area of cardiac flatness becomes diminished to a narrow zone at the level of the sixth rib, or it may be entirely obliterated in excessive cases.

It will be remembered that, in old age, the diaphragm, heart, and inferior borders of the lungs always stand at a lower level than in adult life. Hence, in diagnosing emphysema, one should always compare the amount of pulmonary expansion with the age of the patient. If the lower border in a person over sixty-five years of age reach no further than the seventh rib in the mammillary line, the condition is normal.

Another sign of emphysema is the diminution or absence of both the active and passive mobility of the inferior borders of the lungs. We have seen cases where the most energetic efforts at respiration, in various positions of the body, failed to change the percussion borders.

The apices of the lungs are often raised to a higher elevation — five to six centimeters — above the clavicles, in which case the superior borders are correspondingly higher.

Hepatic Boundaries. — The outlines of the liver are considerably changed in emphysema. The pneumono-

hepatic border is always lower, and the apparent size of the liver will then depend upon its relation to the expanded lung. If the liver remains in its normal position, or nearly so, then the area of hepatic flatness will be necessarily diminished. On the other hand, if the liver be simultaneously depressed by a descent of the diaphragm, then the area of flatness may remain normal in size or even appear increased.

Pleurisy. — The changes produced by pleurisy in the percussion boundaries of the lungs will vary according to the character, seat, and extent of the affection. A simple dry pleurisy with adhesions may leave the pulmonary boundaries little affected, except as regards their mobility. Thus firm adhesions may interfere with the respiratory expansion, and also with the passive movements which normally accompany changes of the position of the body. Again, thick deposits of pleuritic membranes will produce a general diminution of vesicular resonance.

Pleurisy with Effusion. — With an encysted pleuritic effusion, an area of dullness (or flatness, with a large amount of fluid) will be found, which varies in shape and position according to the size and situation of the exudation. No general law can be laid down for such cases, and the dullness thus observed must be distinguished from that which accompanies consolidation of the lung, by such other evidence as can be obtained through auscultation and palpation.

An accumulation of free fluid in the pleural cavity (pleuritic effusion, empyema, hydrothorax, hæmatothorax,) causes marked changes in the percussion outlines of the pulmonary borders. As the fluid gradually forms, it gathers at the bottom of the chest, and the lung begins to contract in volume. Let it be said here, that a lung which retains its integrity and elasticity cannot be pressed

upon, or compressed by, an encroaching effusion, until it is completely collapsed, and the amount of fluid present is excessive. The lung simply contracts in volume, but it still sustains the weight of the diaphragm plus that of the fluid in the same manner that it previously sustained the diaphragm alone.

As soon as sufficient effusion has collected for detection by percussion — 200 cc. according to Seitz — we obtain over the fluid a flat sound, and varying degrees of dullness over the collapsing lung above. The line of demarkation between the flatness of the fluid and the dull resonance of the lung is usually well marked. The shape and position of this line, however, have been the subject of much controversy. Most German writers follow Wintrich in declaring that this line stands generally highest behind in the neighborhood of the spinal column, and thence descends obliquely to the sternum. Some allow that the line may sometimes be horizontal, but they think that this shape is exceptional, and due to the position maintained by the patient during the early stage of the effusion. Thus, if the patient lie quietly in bed during that stage, the fluid will assume a level corresponding to that position. Subsequently, as the patient arises and walks about, the fluid is prevented from reaccommodation by adhesions, and hence the obliquity of its surface. Among the French, Piorry and his followers teach that an effusion ordinarily adjusts itself to a horizontal level for all positions of the body. On the other hand, Damoiseau declared that the line in question is never horizontal, but is more or less parabolic with its summit in the axillary line, and its branches extending down on either side to the sternum and vertebral column.

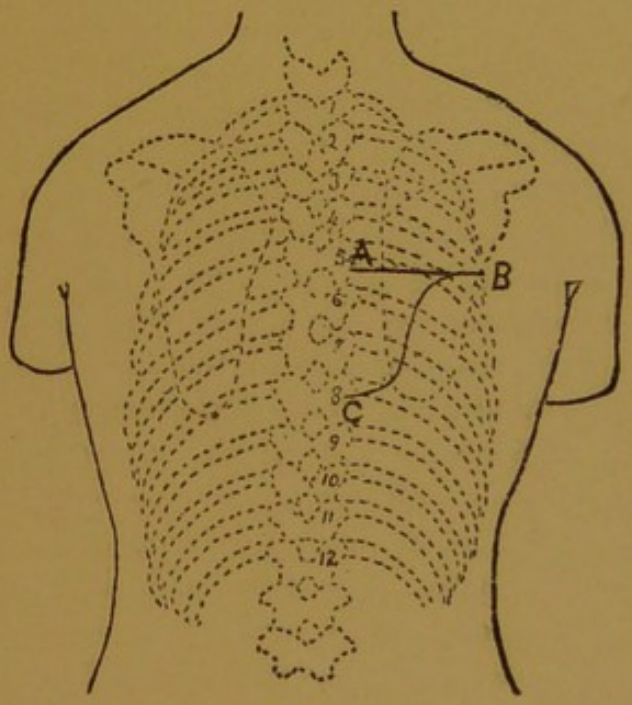
In our own experience, we have never seen a pleural effusion (pneumo-hydrothorax excepted) which presented a horizontal line of demarcation, nor do we obtain a line

like that described by the Germans. On the contrary, we find that the position assumed by an effusion is that which was first described by Prof. Calvin Ellis, of Boston. This observer discovered that with small and medium effusions the line of flatness begins lowest behind at the vertebral column. Thence it ascends obliquely across the back, in a letter S curve, to the axillary region, where it reaches its highest point. Then it advances to the sternum with a slight inclination downward. With large effusions, which fill the chest to the second rib or higher, this curve disappears, and the line becomes more nearly horizontal, and more difficult to trace. As absorption takes place, however, or the fluid is removed by aspiration, the curve reappears and passes through retrograde phases corresponding in shape to those of the earlier stages.

It is sometimes difficult to trace the curve on the back, owing to the great dullness of the lung immediately above the effusion. This dullness is often due to a lack of proper ventilation of the lower lobe, especially when the patient is lying down, and therefore one should not attempt to trace the line until the patient has taken several deep breaths and thus thoroughly filled the lung. In Fig. III. it will be seen that we have drawn a horizontal line, A B, from the summit of the curve to the vertebral column, and have thereby inclosed a rough, triangular space, A B C. This space corresponds to the lowest portion of the lung, and is especially liable to be obscured by dullness. The lung lies here in contact with the chest wall, but its resonance may be so dull as to escape detection unless careful percussion is made and the patient breathes deeply. We have termed this space the *dull triangle*, and its recognition is of vital importance. Heitler, in Vienna, has observed this same triangular space of resonance, and has likened it to a

monk's hood cut longitudinally through the centre and hanging apex down. Rosenbach, of Breslau, has also noticed that the resonance of this portion of the back in pleurisy will often clear up on exercise or by breathing, and such clearing up of the resonance of a dull back he

Fig 3.



has made distinctive between pleurisy and pneumonia. The same condition of things obtains in hydrothorax, but in some cases the triangle may be still more dull, and require careful auscultation and percussion, owing to the œdema of the lung itself.

CHAPTER IV.

HEART.

Anatomy.—The heart, inclosed in the pericardial sac, lies in an oblique plane extending from the right side above downward and forward toward the left side. It is situated partly behind the sternum and partly behind the right and left costal cartilages. Its highest point, the upper border of the left auricle, corresponds to a line connecting the lower borders of the sternal insertion of the second pair of ribs. Its lowest point is at the middle of the upper border of the sixth left costal cartilage. The heart extends eight or nine centimeters to the left, and four or five centimeters to the right, of the middle line of the sternum. We distinguish in the heart in relation to the chest wall, a right, a lower, and a left border. The right border (Plate I., M N) is formed by the right auricle, and runs in a line curving outward two to three centimeters beyond the right edge of the sternum, from the middle of the second right intercostal space to behind the sternal end of the fifth right costal cartilage.

The lower border N O, is formed by the right ventricle, and extends from the sternal end of the fifth right costal cartilage in a slightly descending line to the fifth left intercostal space, where it meets with the left border in the mammillary line, or a trifle inside it.

The left border P O, runs in a convex curve from the second left intercostal space downward and outward to

unite with the left end of the lower border at the apex of the heart.

By far the greater portion of the heart is covered by lung; only a segment of the organ belonging exclusively to the right ventricle lies directly against the chest wall; this segment is bounded below by the lower edge of the heart, and on the right and left by the diverging anterior borders of the right and left lung. The size and shape of this parietal portion of the heart depends wholly on the course of the anterior edges of the lungs, which have been fully described elsewhere. During quiet respiration it has a four-sided shape (Plate I.). The right border is bounded by the front edge of the right lung running near the left border of the sternum from the level of the fourth to the sixth (or seventh) costal cartilage; the upper border is bounded by that part of the incisura cardiaca behind the fourth left costal cartilage running outward to the fourth intercostal space; the outer side is bounded by the more vertical portion of the anterior border of the left lung, running in a convex curve outward from the fourth intercostal space to the sixth rib. The upper and outer borders unite with no sharp line of division between them, and even in quiet respiration exhibit manifold differences in their course. This uncovered space is crossed diagonally by the left pleura, in such a way that only in the lower portion does the pericardium come in actual contact with the sternum.

PERCUSSION.

The heart gives forth a flat sound where it lies directly against the chest wall. The boundaries of this region of flatness above, to the right and left follow in general the course of the anterior edges of the lungs, and correspond to those lines in which the transition from the clear vesicular sound to the flat sound occurs. The lower border

of the heart cannot be defined by percussion, because the flat sound of the heart is indistinguishable from that of the left lobe of the liver. The lower border, therefore, from the point where the liver meets it to the apex of the heart, must be drawn arbitrarily, as described later.

We recognize an area of absolute flatness and one of relative dullness in the percussion of the heart. It is perhaps unnecessary to add that there are great diversities of opinion in regard to the size and shape of this absolute flatness, but we have generally found the following dimensions to be most nearly correct.

In adults, the absolute cardiac flatness is an irregular quadrangle (Plate IV., A B C D). The right border A C is formed by the left edge of the sternum from the level of the fourth to the sixth or seventh rib ; the upper border A B runs behind the fourth costal cartilage outward and downward, and meets with the left side of the quadrangle at an obtuse angle ; the latter, B D, runs more vertically downward to the sixth rib, where it meets with the lower side of the quadrangle, C D, at an acute angle. While the inner and lower sides have a tolerably constant length, and, as a rule, measure five to six centimeters, the upper and outer sides show manifold differences in their course which it appears superfluous to mention in detail. We need only say, that when the upper side deviates more from a horizontal course, or the outer side becomes less vertical in its direction, the region of absolute flatness becomes smaller, and its form more triangular. The right, the upper, and the left borders of this space are readily obtained by gentle percussion. As the lower border, in the greater part of its course, overlies the left lobe of the liver, we can only obtain it by determining the point on the right, where the cardiac and hepatic flatness meet, and the position of the apex, and then join these two by a straight line. It is only in rare instances

that the heart extends beyond the left lobe of the liver, and in such cases the cardiac flatness is bounded by the tympanitic sound of the stomach.

NOTICE: Comparison of the absolute cardiac flatness and the portion of heart uncovered by lung shows a difference only in two places. (1.) The right border of the cardiac flatness lies at the left edge of the sternum, the front edge of the right lung on the other hand is half way to the right of this line; the cause of this difference is the oft mentioned vibration of the sternum. (2.) The thin lingula pulmonis overlying the cardiac apex cannot be mapped out.

The shape of the heart's flatness, described and figured in Plate IV., A B C D, is normal for healthy people from the middle of the second to the end of the sixth decade. In childhood, and also in old age, the shape and size of this area is somewhat different. In children, the absolute flatness of the heart begins at the third rib, and extends to the mammillary line (Plate VIII.), the apex impulse being frequently met with in the fourth intercostal space. The absolute cardiac flatness in children, therefore, is found to be relatively greater and situated higher up than in middle age. In old age, on the other hand, the opposite condition is observed (Plate IX.). Here the area of cardiac flatness is smaller, it does not begin till we get to the fifth rib, and it reaches outward to a less extent; its height and breadth amount to about four or five centimeters. The cause of this diminution in the size of the absolute flatness is the entrance of the border of the left lung into the sinus-mediastino-costalis dependent on senile emphysema, which may be regarded as a normal senile condition. We need hardly call special attention to the fact that these three types of cardiac flatness given for childhood, adult life, and old age, are not sharply defined, but rather gradually run into each other.

Active Mobility of the Absolute Cardiac Flatness.

The boundaries of absolute flatness are found in the shape and extent described above, when the person examined maintains the dorsal decubitus and breathes naturally. These boundaries, however, suffer certain respiratory displacements, and also certain displacements in changes of the position of the body; in other words, they have a considerable active and passive mobility.

The upper border descends two to three centimeters, the left border moves about as much to the right, and the right border remains unchanged; so that the absolute cardiac flatness is diminished perhaps one third. With the deepest possible inspiration, only a strip of flatness the breadth of the finger can be discovered close to the sternum, or it may be replaced by a clear pulmonary resonance at the left edge of the sternum.

The expiratory displacement of the borders averages two centimeters outward and as much upward.

Passive Mobility.

When the individual examined changes from the dorsal decubitus to the upright position, no displacement of the cardiac boundaries follows. On the other hand, when one is in the right lateral decubitus the same effect is observed on the left and upper boundaries as in the deepest possible inspiration; and very frequently a region of flatness is found on the right of the sternum, between it and the parasternal line, at the level of the fifth or sixth rib, and even as high as the fourth intercostal space. This right-sided absolute cardiac flatness is separated from that on the left side by the clear sound of the sternum; and it may be enlarged by forced expiration. The change from the *dorsal* to the *left lateral decubitus* involves an excursion of the upper and left

borders in the same way: the left border, however, moves somewhat further toward the left than in forced expiration.

Relative Cardiac Dullness.

The size and shape of the relative dullness of the heart, that is, where it is overlaid by lung, in most healthy individuals between the middle of the second and the end of the sixth decade is represented by the line A I K, Plate IV.

The right border of the figure is formed by the left edge of the sternum from the level of the third to the sixth intercostal space.

Above and toward the left the dullness is shut in by a curved line, with its convexity directed outward, I K. The upper more horizontal portion of this curve runs through the third intercostal space, and over the fourth rib obliquely outward and downward. The lower outer portion of the curve runs in a nearly vertical line from the fourth intercostal space to the sixth rib, just inside the mammillary line.

NOTICE: 1. The percussion boundary corresponds to the anatomical on the left only. All that portion of the heart lying beneath the sternum and behind the left third rib and second intercostal space cannot be brought out.

2. The boundary of the cardiac dullness above and to the left is parallel to that of the cardiac flatness, and is removed two to three centimeters from the same.

Mobility of the Relative Heart's Dullness.

The above boundaries suffer displacement just as do those of the absolute flatness on deep inspiration and changes of position; and this is about the same in kind and extent as in the absolute flatness. They maintain the same relation to each other, therefore, as in quiet respiration or the dorsal decubitus. Two points deserve to be mentioned, however.

First, In those cases where the absolute flatness quite disappears on deep inspiration, there still remains on the left edge of the sternum, from the level of the fourth to the sixth rib, a region of relatively dull sound several centimeters broad.

Second, When absolute flatness appears on the right of the sternum in the right lateral decubitus, a zone of dull resonance one or two centimeters in width may also be found surrounding this flatness. (WEIL.)

PATHOLOGY.

Diminution or disappearance of flatness in the cardiac area is observed: 1. In congenital dexiocardia; 2. In left-sided pneumothorax with great expansion of the chest and displacement of the neighboring organs; 3. In extensive emphysema; 4. In pneumo-pericardium.

In congenital dexiocardia, usually also in pneumothorax of the left side, a cardiac flatness may be demonstrated on the right side between the right edge of the sternum and the right parasternal or mammillary line between the third or fourth and the sixth rib; while in great emphysema and pneumo-pericardium there is entire absence of all cardiac flatness. In the extremest degrees of emphysema there is everywhere above the lower border of the lungs, even on the left side, a loud, clear pulmonic sound. In less pronounced cases absolute flatness may be absent, but a narrow zone of relative dullness may be demonstrated along the left edge of the sternum in the fifth and sixth intercostal space. In the slightest degrees of emphysema, both relative and absolute cardiac flatness can still be outlined, though they are smaller and are situated lower down than in normal conditions.

The diminution of the cardiac area of flatness in emphysema is explained by the expansion of the lung into

the sinus mediastino-costalis. A disappearance of the absolute cardiac flatness may occasionally be caused by the transmission of resonance from the neighboring lung, when the intercostal spaces are very narrow, and the costal cartilages are very elastic.

In the rare cases where free gas is present in the pericardial sac, a clear tympanitic, almost metallic, sound is obtained over the heart when the patient is lying on the back. When the patient sits up or bends forward the sound over the lower portion of the above tympanitic region is dulled because the heart and any fluid present in the pericardium sinks forward and downward.

Increase of the Cardiac Flatness.

In by far the greater number of cases, this is due to hypertrophy and dilatation of the whole heart, or portions of the same, or to the presence of fluid in the pericardium. Again, when the heart is of normal size, and the pericardium does not contain fluid, the cardiac dullness may appear to be enlarged upward to the left, or toward the right, or in fact in all directions, by reason of solidification or retraction of the pulmonary borders. It is not possible to distinguish by means of percussion alone which part of the dullness belongs to the heart, and which to the unaerated lung (or fluid collected in the sinus mediastino-costalis).

The form of cardiac dullness varies according as the left or right ventricle is especially implicated in the dilatation and hypertrophy.

In hypertrophy of the left ventricle the boundaries of both the absolute flatness and relative dullness are moved chiefly to the left and downward, more rarely upward, while the right border remains at the left edge of the sternum or near it. With a moderate increase of volume, as from arterio-sclerosis, the absolute flatness may begin

at the third rib, and extend three or four centimeters beyond the mammillary line at the fifth rib. While, for example, in insufficience of the aortal valves and consequent high degree of hypertrophy and dilatation of the left ventricle, the upper boundary may be normal, and the left may reach into the anterior axillary line.

In dilatation and hypertrophy affecting chiefly the right side of the heart, the upper borders of both absolute flatness and relative dullness are normal, the left border extends but slightly outward, and the right border either remains at the left edge of the sternum, or, where the dilatation is excessive, a new area of dullness on the right is met with, divided from the normal area by the resonant sternum. This may begin as high as the fourth costal cartilage on the right edge of the sternum, and at the level of the fifth and sixth costal cartilages extend one and a half to two centimeters beyond it.

The displacements caused by respiratory movements and changes of position with hypertrophy are more considerable than in the normal condition. During a deep inspiration the absolute cardiac flatness suffers a considerable decrease in extent toward the left, and in decubitus on the right side, not only does the same phenomenon occur, but in addition there is found absolute flatness on the right of the sternum. Change from the prone to the upright position of the body does not alter the boundaries.

With pleuritic effusion on the left side the heart is displaced to the right, and with excessive accumulation of fluid may be carried as far as the right axillary line.

With effusion on the right side the heart is carried to the left, and may reach to the left axillary line.

With excessive distention of the abdomen, either by ascites, tumors, or tympanites, the heart is pushed upward. In a case of great ascites, confining the patient

upon the left side, we found the cardiac impulse at the third intercostal space in the left axillary line. The impulse presented a peculiar intermittency, coinciding with the respiratory movements, and was very strong during expiration, while it disappeared with full inspiration.

The mobility of the cardiac boundaries may be limited by pericardial and pleural (sinus mediastino-costalis) adhesions.

PERICARDIUM.

Anatomy. — The external or parietal layer of the pericardium is the only one presenting any interest to us. It corresponds neither in form nor volume with the inner layer covering the heart, but is so much broader than the latter, that even when the heart is moderately filled with blood, it will still hold six ounces of water without being extremely distended. (LUSCHKA.) The physiological purpose of this arrangement is evident, and in pathological conditions it affords room for the dilatation and hypertrophy of the heart which are compensatory to valvular lesions, emphysema, and so forth. The pericardium reaches beyond the base of the heart up to the middle of the first costal cartilage on the right side, and on the left to the middle of the second costal cartilage. It extends below on the right to the mammillary line in the fifth intercostal space, and on the left to the sixth rib at least in the mammillary line. It is capable of some distention beyond these points.

PATHOLOGY.

Fluid in the pericardium collects in the lowermost part first; and Rotch, basing his conclusions on a series of injections, claims that flatness in the fifth right intercostal space, three centimeters from the edge of the sternum, is diagnostic of this condition. The figure obtained by percussion is triangular, with a broad base below and a blunt apex above.

With moderate collections of fluid, the blunt apex of the triangle is found in the third or second intercostal space, near the left edge of the sternum. It runs from here obliquely downward, and to the right as far as the sixth rib in the sternal or parasternal line, and to the left beyond the mammillary line.

If the fluid is very abundant, the apex may be situated at the manubrium sterni, while the base reaches from the right mammillary line at the level of the sixth intercostal space, to the left axillary line at the height of the seventh rib or even seventh intercostal space. The area of absolute flatness is said to be greater in the erect than in the prone position, and if this be true it forms a most important point in the differentiation of pericardial effusion from enlarged heart.

CHAPTER V.

LIVER.

Anatomy.—Three quarters of the liver lie in the right half of the upper abdomen. This includes the lobus dexter, lobus Spigelii, and generally the entire lobus quadratus. The boundary between the right and left lobes lies, in many cases, in the median line, but it may be a finger-breadth to the right of the same. The left lobe pushes in between the stomach and that portion of the diaphragm upon which rests the heart. It extends five to six centimeters to the left of the median line.

The upper border of the liver is a curved line corresponding to the arch of the diaphragm. Its highest point is in the right mammillary line, where it stands on a level with the fifth pair of ribs in front, and with the ninth dorsal vertebra behind. At the end of expiration it is five centimeters higher than the pneumono-hepatic border.

The lower edge of the liver begins at the eleventh rib in the vertebral line. It runs along this rib to the scapular line, when it turns obliquely upward and forward, and emerges from beneath the costal arch in the mammillary line, at the level of the tenth costal cartilage. It then crosses the epigastrium, meeting the median line of the body between the upper and middle thirds of the distance from the umbilicus to the apex of the xiphoid cartilage. It disappears behind the left costal arch between the left mammillary and parasternal lines.

PERCUSSION.

The liver presents two percussion areas and three borders for consideration — the first area is the portion covered by lung; and it gives a dull resonance on strong percussion. The second area is the lower part of the liver, which is not covered by lung, but lies in actual contact with the chest wall. Here we obtain a flat sound on percussion.

The *superior border* corresponds to the arch of the diaphragm, as previously remarked. Near the vertebral column it is impossible to outline this border, owing to the resonance of the intervening lung. On the sides and in front it can usually be made out with sufficient accuracy for practical purposes. (Plate IV., P Q.) With a very thick lung, however, or with emphysema, it is impossible to detect it. That portion of the superior border which underlies the heart cannot be distinguished because there is no difference between hepatic and cardiac flatness.

The *inferior border* is more accessible, and can generally be made out by light percussion. It is indicated by the transition from hepatic flatness to intestinal and gastric resonance. When the intestines and stomach are very resonant the percussion must be very light.

The *pneumono-hepatic border* separates the hepatic flatness from the pulmonic resonance, and has already been described. Irrespective of the actual size of the liver, the area of hepatic flatness will depend upon the position of this border, and therefore will diminish with inspiration and emphysema, and be increased by expiration or other shrinkage of the lung.

GALL BLADDER. — The gall bladder ordinarily lies beneath the liver, and is inaccessible to palpation or percussion. Let the exit of bile be obstructed, however,

and the gall bladder becomes distended by accumulated secretion, and it will produce a well-defined tumor. In such cases the tumor appears at the angle formed by the junction between the lower border of the liver, as it emerges from the costal arch, and the outer border of the rectus abdominis muscle. The dull area is then usually pear-shaped, and may be defined by the resonant intestines about it.

PATHOLOGY.

Changes in the size of the liver are often very difficult to determine by percussion, and even when variations in the extent of hepatic flatness are detected it is still difficult to decide whether such variations are due to modifications of the liver itself or of the neighboring organs. A diminution of the area of hepatic flatness may be produced by acute or chronic atrophy of the liver. It may also be due to the intrusion of coils of intestine between the liver and abdominal wall. Tympanites, ascites, ovarian and uterine tumors will produce the same result by pushing the liver further up behind the lung. Emphysematous enlargement of the lung, by lowering the pneumono-hepatic border, will make the liver appear small. An actual diminution of the liver can be diagnosed only when, with decreased flat area, we still find the pneumono-hepatic border at normal height, and we can exclude all conditions which produce elevation or twisting of the organ. The most difficult cases to decide are those where a loop of intestine lies between the liver and the chest wall. Frerichs says that this condition may be surmised when one of the diameters of the liver is unusually small as compared with the remaining diameters.

An enlargement of the area of hepatic flatness occurs with hypertrophy of the organ itself; also with any retraction of the lung which elevates the pneumono-hepatic border. Displacements of the liver by pressure of tho-

racic tumors or pleuritic exudations cause an enlargement of the flat area. In all such cases, therefore, it is obvious that no diagnosis regarding the actual size of the liver can be made until all associated conditions have been carefully reviewed.

Weil gives the following valuable schedule of possible complications, which cannot fail to be of service in deciding many obscure cases.

1. The inferior border of the liver is in normal position: —

   (*a*) The pneumono-hepatic border is high: enlargement of liver upward; medium-sized pleuritic effusion; enlargement of liver with coincident dislocation upward, as in hyperæmia or amyloid liver with ascites.

   (*b*) The pneumono-hepatic border is low: emphysema of moderate degree. In such a case the height of the hepatic dull zone, above the pneumono-hepatic line, is normal or increased.

2. The inferior border of the liver is too low.

   (*a*) The pneumono-hepatic border is high: very large hypertrophy or tumor of liver: large pleuritic exudation.

   (*b*) The pneumono-hepatic border is normal: hypertrophy of liver; anomalous position of the same.

   (*c*) The pneumono-hepatic border is low: excessive emphysema; pneumothorax.

3. The inferior border of the liver is too high.

   (*a*) The pneumono-hepatic border is high: dislocation upward.

   (*b*) The pneumono-hepatic border is normal: atrophy of liver; dislocation upward.

4. The hepatic flatness is entirely absent.

Oblique position of the liver, with meteorismus and ascites; intervention of intestines; formation of free gas in the peritoneal cavity.

5. Transposition of the hepatic flatness to the opposite side of the body in cases of congenital transposition of all the internal viscera.

CHAPTER VI.

THE SPLEEN.

Anatomy. — The spleen is situated in the left hypochondrium, between the diaphragm, the left kidney, and the posterior wall of the stomach. It extends from the ninth to the eleventh rib, with its longest diameter directed obliquely forward and downward, following the course of these ribs. We distinguish an upper end (Plate II.) distant two centimeters at least from the body of the tenth dorsal vertebra, and an anterior end, corresponding to the point lying nearest the middle line of the body. When the spleen is oval in shape, besides the upper and anterior ends, we may speak of two borders, an anterior and a posterior, which unite at G and H. The anterior end is about in the axillary line, and does not extend beyond the linea costo-articularis under normal conditions. The anterior edge corresponds to the course of the ninth rib; in its upper portion it is covered by lung, and only emerges from the pulmonary edge in the posterior axillary line. In the angle made by the lower border of the lung and the spleen, the stomach and colon are located. The posterior edge follows the eleventh rib, and overlaps the left kidney a short distance in its middle third. Where the posterior edge of the spleen and the outer border of the kidney meet, the descending colon is situated. When the shape of the spleen is more rhomboidal, its front edge follows the course of the ninth rib still farther forward than in the oval form,

and the lower edge runs obliquely backward and downward.

NOTICE: 1. About a third of the spleen (the upper end, a part of the front and posterior borders) is covered by lung.

2. The posterior border of the spleen lies in apposition to the anterior border of the left kidney for about a third of its course.

PERCUSSION.

We are unable to define by percussion that portion of the spleen which is covered by lung. We can at most obtain, in some cases, by strong percussion, a relatively dull sound above the lower edge of the lung, extending from the anterior axillary line to midway between the posterior axillary and scapular lines, or to the scapular line. The upper border of this area is parallel to the pneumono-splenic border at a distance of two or three centimeters. Between the scapular line and the vertebræ relative dullness for the spleen is no more demonstrable than is the case with the liver on the other side. Between the anterior axillary line and the mammillary line, as a rule, there is also no relative dullness above the edge of the left lung. On gentle percussion the sound here is as loud as it is higher up, and on stronger percussion it usually becomes tympanitic, because the stomach, which is full of air, is set in vibration underneath the lung. The same condition frequently occurs also between the posterior axillary and scapular lines, so that here likewise there is no relative dullness above the pneumono-splenic boundary.

DETERMINATION OF THE BOUNDARIES OF THE SPLEEN.

The best position for the patient to assume is decubitus on the right side, diagonal decubitus (on the right shoulder-blade and right hip), or standing erect. The disadvantage of the first position is that the lower end of the organ is often difficult to define, from the near approach of the crest of the ileum to the lower ribs. The disadvantage of the second position is that unless the patient is near the edge of the bed, it is often impossible to define the posterior boundary. While the chief disadvantage of the last position is the impossibility at times of placing the patient erect. Where great accuracy is sought, it is well to compare the boundaries found in the recumbent position with those obtained while the patient is upright. If the spleen is percussed in the upright position, we must in the first place determine the pneumono-splenic border, by percussing vertically downward from above, in the vertebral, scapular, posterior, middle, and anterior axillary lines. We thus obtain the border B D (Plate V.), corresponding to the lower edge of the left lung. Below the edge of the lung we find, as far as the point E in the posterior (or middle) axillary line, a dull sound; further forward, a tympanitic sound. If we percuss vertically downward in the axillary region, we find, at I and K, the transition of the dull to the loud tympanitic sound, and thus obtain the oval figure of dullness E K L. Posteriorly, the splenic dullness becomes merged in that of the kidney and thick dorsal muscles, and is difficult to outline.

The size of the organ is determined by the vertical diameter of dullness in the axillary line, and by the distance of the anterior end of dullness from the costal arch. To give the normal boundaries of splenic dullness in the

upright position more exactly, the pneumono-splenic angle, as a rule, is in the posterior axillary line; or between it and the middle axillary line, at the level of the ninth rib; more rarely of the ninth or eighth intercostal space. The distance of the lower splenic border from the upper one in the vertical line is five and a half to six and a half, sometimes even seven, centimeters. The anterior end of the spleen is behind the costo-articular line, or at most, just reaches it; or in other words is four to six centimeters from the costal arch. In using the linea costo-articularis as a defining point for the position of the anterior border of the spleen, we must remember that, on account of the varying length of the eleventh rib in different people, this line may be carried more toward the front, sometimes more towards the back.

To define the splenic dullness we must employ sometimes gentle, sometimes strong percussion. Thus, while the pneumono-splenic boundary between the axillary and scapular lines, as a rule, is better obtained by medium strong percussion, the definition from the tympanitic sound of the stomach and colon, in cases where these organs contain much gas, is better made by gentle percussion, since by strong percussion the organs lying behind the spleen are set in vibration, and their tympanitic sound either causes the splenic dullness to appear too small, or to disappear altogether. On the other hand, the difference in sound is more distinct on strong percussion when the stomach and colon have fluid or solid contents. The sound is seldom perfectly flat in the region where the spleen is accessible to percussion. There is usually a tympanitic accessory sound which is especially distinct toward the edges of the organ. The boundaries of the spleen, therefore, as of the liver, are to be placed where the tympanitic sound becomes clear and loud; or better, where the loud tympanitic sound of the

stomach and colon begins to be dulled, as we approach the splenic region.

On change from the upright to the right lateral decubitus, the pneumono-splenic border sinks two to four centimeters, and the anterior extremity of the spleen advances to or beyond the linea costo-articularis. The dull area of the spleen thus assumes a narrower and more horizontal position.

Slight deviations from the conditions already given are exceedingly common; as, for instance, instead of the oval figure described above as normal, we may obtain by our percussion a figure distinctly triangular or rhomboidal; or, especially when the patient is in the upright posture, the longest diameter may run more vertically. Still these are all rather exceptions to the rule. Other variations from the conditions mentioned are caused by differences of age in the individual. Corresponding to the lower position of the pneumono-splenic border, we always find in advanced age the upper border of the splenic dullness deeper, and the splenic dullness itself smaller than in persons of middle age. It is of the greatest practical importance to know all the conditions which render determination of the splenic boundaries either difficult or impossible. Cases are by no means rare in which, while the lower border of the left lung has a normal position, yet the splenic dullness cannot be demonstrated at all, or it has a very circumscribed area. In such cases the pulmonic sound suddenly changes to a loud tympanitic one. The conditions which cause a diminution or disappearance of the splenic dullness in perfectly healthy individuals are usually merely transitory, and depend on the presence of a considerable volume of gas in the organs surrounding the anterior and posterior edges of the spleen, that is, in the stomach and colon. They are of less practical importance than a diffused dullness so frequently

seen in health, extending far beyond the normal boundaries, and they do not lead so often to a false diagnosis. This diffused dullness in the region of the spleen is readily explained. If the underlying colon and stomach do not contain gas, but are filled with solid or liquid substances, they give forth a sound which is indistinguishable from that of the spleen. The splenic dullness then runs over into that of these organs, and therefore appears enlarged. In such cases, an examination after fasting for a time, or after a brisk cathartic, will show that the splenic dullness may be normal after all. Again, a very fat omentum may stretch to the left end of the transverse colon, and displace it from the thoracic wall. The shape of the dullness will often rouse suspicion that we have something else before us; as, for example, when the dullness is only five or six centimeters broad and reaches to the costal arch, or when it has a breadth of eleven centimeters and does not extend beyond the linea costo-articularis. In cases where the shape of the dullness is correct for that of the spleen, but differs only in point of size, we may often arrive at the truth by comparative percussion in different positions. The true splenic tumor gives approximately the same relation to the linea costo-articularis on repeated percussion, while the boundaries of the apparent tumor are characterized by their changeableness.

Passive Mobility. — The displacements to which the splenic dullness is subject on change of position have been already mentioned. There still remain the respiratory displacements, which are worthy of brief notice. They have been hinted at above in speaking of the position of the diaphragm. With every inspiration the splenic dullness is diminished in size and brought lower, while the anterior end of the organ sometimes remains undisturbed in its place and sometimes moves forward

and downward one or two centimeters. The descent of the lower border depends on the descent of the whole organ through contraction of the diaphragm; the lower border, after the deepest possible inspiration, is about one centimeter lower, and the pneumono-splenic border about three to four centimeters lower than before. If a deep inspiration is made while in the right lateral decubitus, the splenic dullness disappears completely, except in a narrow line. In deep expiration the splenic dullness ascends and enlarges, because the lower border makes a smaller excursion than the upper border.

PATHOLOGY.

The spleen may be either diminished or increased in size, or it may be dislocated.

In mentioning the difficulties attending the determination of the splenic boundary, we called attention to the fact that sometimes the splenic dullness was wholly absent. In certain diseases, emphysema, gas or fluid in the peritoneal sac, we find it either much diminished or absent, for reasons sufficiently obvious. In wandering spleen absence of dullness in the normal area may assume diagnostic importance, especially when a tumor situated elsewhere in the abdomen can be replaced, and supply the absent dullness.

Splenic Tumor.— The cautions mentioned above will fully illustrate the care necessary in determining the existence of splenic enlargement. A diagnosis of such enlargement, therefore, should not be made from one examination. Moderate enlargements of the organ are shown by increase of the vertical diameter of the dullness from five or six to nine or twelve centimeters; also by the advance of the anterior end to, or beyond, the costal arch. At the same time the pneumono-splenic border moves upward. The increase in the breadth of

the dullness is caused by the descent of the lower and the ascent of the upper border of the spleen. The lower border may then reach in the right lateral decubitus as far as the twelfth rib or even lower, the pneumono-splenic border may stand in the middle axillary line at the eighth rib, seventh intercostal space, or at the seventh rib even.

The intensity of dullness in enlarged spleen is almost without exception greater than that in the normal spleen.

The dislocation resulting from fluid in the chest is forward and downward, or the spleen may be made to assume a more vertical position, and at the same time be depressed.

CHAPTER VII.

THE STOMACH.

Anatomy.—The stomach is so placed in the abdomen that, no matter what changes of volume it undergoes, about three quarters of it lie in the left hypochondrium and one quarter in the epigastrium. Its longest diameter runs obliquely from behind downward and forward toward the right side; the pyloric end curves slightly upward, as a rule, in the median line, so that, on moderate distention of the stomach the lowest point of the organ falls in the middle of the space between the end of the processus xiphoideus and the umbilicus. A horizontal line from this point to the left border of the ribs runs just below the junction of the greater curvature with the costal arch.

The beginning of the stomach, the cardiac portion (Plate I.), or, more correctly, the abdominal portion of the œsophagus, is about on the level of the sternal edge of the left sixth intercostal space, distant at least ten centimeters from the anterior wall of the thorax.

The pyloric portion lies in the right half of the epigastrium, and, as a rule, barely reaches to the right costal arch.

The small curvature hugs the lumbar vertebræ.

The great curvature is turned toward the lateral wall of the left hypochondrium and the inner side of the anterior abdominal wall.

The front, upper side, of the stomach, while in the left

hypochondrium, follows the concavity of the diaphragm, the fundus occupying the highest point of the latter (level of the fifth rib). This surface of the stomach is, to a great extent, overlaid by the base of the left lung; while the portion located in the epigastrium is in part separated from the anterior abdominal wall by the left lobe of the liver.

The lower posterior surface of the stomach, which is in part directed toward the dorsal wall of the abdomen, and in part directed downward, at no place comes in direct contact with the abdominal wall. Along the greater curvature runs the transverse colon, ending in the region of the fundus as the flexura coli sinistra.

NOTICE: 1. The whole posterior and lower side of the stomach nowhere lies next the wall of the body.

2. The cardia, small curvature, a part of the front upper surface, are separated from the anterior abdominal wall by the left lobe of the liver; another part of the front upper side and the great curvature are separated from the wall of the thorax by lung.

3. Only a small portion of the anterior superior surface lies directly against the abdominal wall. (Plate I., W.)

PERCUSSION.

Percussion of the stomach presents certain difficulties due to its varying size, according to the degree of distention with fluid, solid, and gas, and to the tension of the abdominal wall. The sound given forth is, according to these different conditions, dull, tympanitic, or metallic. In addition, there is also the sound of the colon, which we must distinguish from that of the stomach, and which, with the changeable degree of distention, is often difficult.

In percussing the stomach, we assume the organ to be partly filled. In the dorsal decubitus the solid and fluid

contents collect in the posterior portion of the stomach. While the gaseous contents rise anteriorly, and with a moderate degree of distention of the gastric wall, occasion a tympanitic sound. The boundaries of this sound are as follows, under the conditions given above.

1. Above and to the right the gastro-hepatic boundary. (Plate I.)

2. Above and to the left the pneumono-gastric boundary.

3. Below the lower boundary of the stomach, corresponding to the greater curvature.

4. Between the gastro-hepatic and pneumono-gastric boundaries, in cases where the left lobe of the liver is overlaid toward the left by the absolute cardiac flatness, is a gastro-cardiac boundary.

Of these boundaries the only actual one is the lower. This is determined by a change from the tympanitic sound of the stomach to one of a different pitch or clearness, coming from the transverse colon; and it is situated midway between the end of the processus xiphoideus and the umbilicus, and runs thence in a tolerably horizontal line to the left hypochondrium, and crosses the costal arch about on a level with the ninth costal cartilage; thence following very nearly the course of the eighth rib, it disappears behind the lower edge of the lung in the middle axillary line. The lower border of the stomach can be followed but a few centimeters to the right of the median line, because it passes behind the lower edge of the liver. The lower border varies from the above points according to the greater or less degree of distention of the stomach. The middle and right hand portions of this boundary vary but little from the points given; the left, on the other hand, is capable of considerable variation. The less the degree of distention of the organ, the more does it retract from the pneumono-splenic angle, till

it may meet the lung at the sixth rib even. In great distention of the stomach, on the other hand, this entire angle may be filled out. From the above facts, it is plain that we must be content with defining that portion of the stomach lying next the anterior thoracic and abdominal wall.

PATHOLOGY.

Diminution of the gastric area of resonance may occur from enlargement of the left lobe of the liver, from splenic tumor, from an enlarged heart, or from emphysema of the lung; the stomach in each instance remaining of normal size, but being overlaid by the pathological organs.

Increase of the gastric area of resonance, gastric dilatation is of greater importance. When the patient is examined while lying on the back, the lower border corresponding to the greater curvature, is found to be lower than normal, either at the umbilicus, below it, or, in extreme cases, near the symphysis pubis. When the patient is examined in the erect position, a dullness is obtained, the lower border of which is somewhat lower than that of the tympanitic resonance found in the horizontal position, and is due to the gravitation of the contents of the stomach.

CHAPTER VIII.

THE KIDNEYS.

Anatomy. — The kidneys lie on each side of the vertebral column, close to the posterior abdominal wall, at the level of the last dorsal and two or three upper lumbar vertebræ. The right kidney is usually a little lower than the left (Plate III.) The concave edge is toward the spine, the convex edge is directed outward. The upper end of the right kidney extends under the liver, so that about a third of it is covered by the latter. The left kidney touches the posterior lower border of the spleen, as described above. Viewed from behind, the kidneys are overlaid and about half covered by the eleventh and twelfth ribs. The duodenum and ascending colon are in front of the right kidney, and the descending colon is in front of the left kidney. The colon encircles the outer edge of each kidney. Behind, the kidneys lie on a thick layer of muscle, the pillars of the diaphragm, quadratus lumborum, transversus abdominis, sacro-spinalis, and latissimus dorsi. The lower end of the kidneys is two to six centimeters above the crest of the ileum. The outer edge extends ten centimeters from the median line, so that the two outer edges are twenty centimeters apart.

PERCUSSION.

In the normal condition, the kidneys are not accessible to percussion, owing to the thickness of the muscles of the back, and to the resonance of the neighboring

intestines. The dullness obtained in the renal region, and usually attributed to the kidneys (Plate VII., H I and K L), has been found by Weil to be the same after extirpation of one kidney; and in a case of floating kidney this dullness was the same both before and after reposition of the organ.

Extreme cases of hydronephrosis and very large tumors of the kidneys may produce a distinct flat area of their own.

CHAPTER IX.

THE BLADDER.

Anatomy. — The bladder is situated in the pelvis, behind the pubes. In the male, the rectum is directly behind it; and in the female, the uterus and vagina. The shape and position of the bladder are greatly influenced by age, sex, and the degree of distention of the organ. In infancy, the bladder is conical and projects into the abdomen above the pubes. In the adult, when empty, it is a triangular sac (three centimeters in diameter usually) flattened from before backward, with its apex reaching nearly as high as the upper border of the symphysis pubis. When slightly distended, it has a rounded form; when greatly distended, it is oval. Its longest diameter in the latter condition is vertical and curved slightly forward. In the female, the bladder is larger in the transverse than in the vertical diameter, and is said to be more capacious than in the male. When contracted, it has two lateral sinuses, which override the vagina like saddle-bags. This fact, together with the greater roominess of the female pelvis, permits a considerable accumulation of urine in the bladder without any appearance of the organ above the pubes.

The average capacity of the bladder, in health, is 500 cubic centimeters.

PERCUSSION.

The empty bladder in the adult cannot be reached by percussion. How large a quantity of urine is requisite to

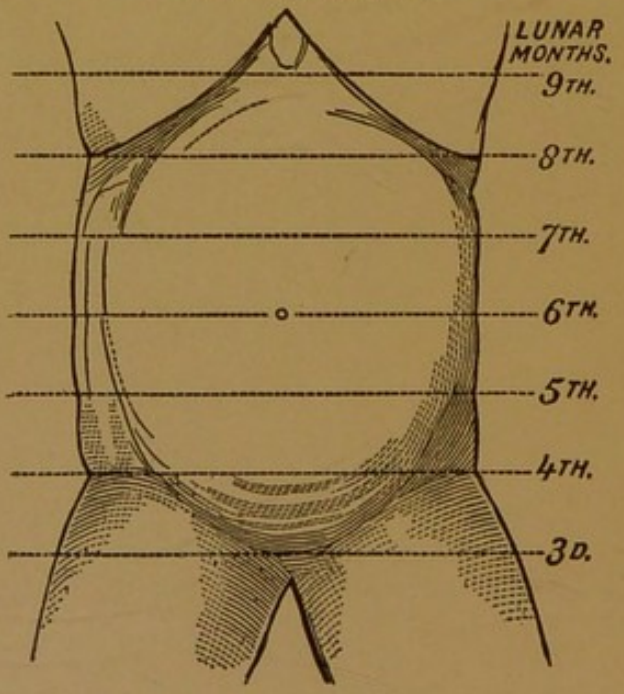
render the bladder accessible depends on the curve and and thickness of the abdominal wall, and on the condition of the neighboring intestine. The first effect of the collection of urine within the bladder is to render the organ spherical; and it is not till a considerable quantity is present, even in the most favorable subjects, that anything like certainty can be attained on percussion. We have found that an area of flatness extending ten centimeters above the pubes and nine centimeters in breadth, coincided with six hundred and seventy cubic centimeters of urine drawn immediately after the measurements were made, in a man with emaciated and relaxed abdominal wall. In another man, with a moderately prominent abdomen, four hundred cubic centimeters did not give any evidence of its presence.

CHAPTER X.

THE UTERUS.

In the unimpregnated condition, the uterus lies below the brim of the pelvis. During pregnancy, after the fourth month it begins to rise above the brim, and may be outlined under favorable conditions. At the fifth month, it stands half way between the symphysis pubis and the umbilicus, in the median line. At the sixth month it has reached the umbilicus. At the seventh month it extends one third the distance between the umbilicus and the processus xiphoideus. At the eighth month, it is two thirds the distance between the above points ; and at the ninth, it touches the lower end of the processus xiphoideus.

Fig. 4. (Chadwick.)



The resonance of the surrounding intestines often obscures the percussion outlines of the impregnated uterus, and more information can usually be obtained by palpation than by percussion.

CHAPTER XI.

THE PERITONEUM.

Ascites. — The amount of fluid within the peritoneum must be considerable to give evidence of its presence by percussion. If it lies next the abdominal wall we obtain dullness or flatness, according to its quantity. Free fluid gravitates to the lowest part of the sac, so that the boundaries of dullness or flatness vary with the position of the patient. With moderate effusions, the lower border of the lungs, heart, and liver stand higher than normal. The hepatic flatness appears to be decreased in size, because the intestines are displaced upward, and, where the collection of fluid is large, the liver is tilted on its axis. The splenic dullness is also found to be higher than normal and smaller, unless the ascites depends on a condition which gives rise to splenic tumor. When the patient is in the supine position the upper border of flatness is crescent-shaped, with the concavity directed upward. In the erect posture it is horizontal. In the lateral decubitus the flatness changes to the lower side, and is replaced in the opposite flank by the clear resonance of the intestines. When the amount of fluid is very great a flat sound is obtained everywhere, except in the epigastrium, near the processus xiphoideus, where it remains somewhat tympanitic.

The points of differentiation from Ovarian Tumor are as follows : —

In Ascites, in the dorsal decubitus, the sound is tym-

panitic, in a curved line with the concavity upward, the epigastrium being resonant and the flanks flat. Furthermore, change of position gives modification of the curve.

In Ovarian Tumor, the tympanitic resonance remains longest in the flanks; while, as a rule, the highest point of flatness is in the middle line of the body, and change of position, unless the tumor be small, gives rise to less modification of the flatness. (OLSHAUSEN.)

The above distinctions are not absolute, since strong percussion may bring out a deep-seated resonance in colon or cœcum, or deep pressure may displace ascitic fluid.

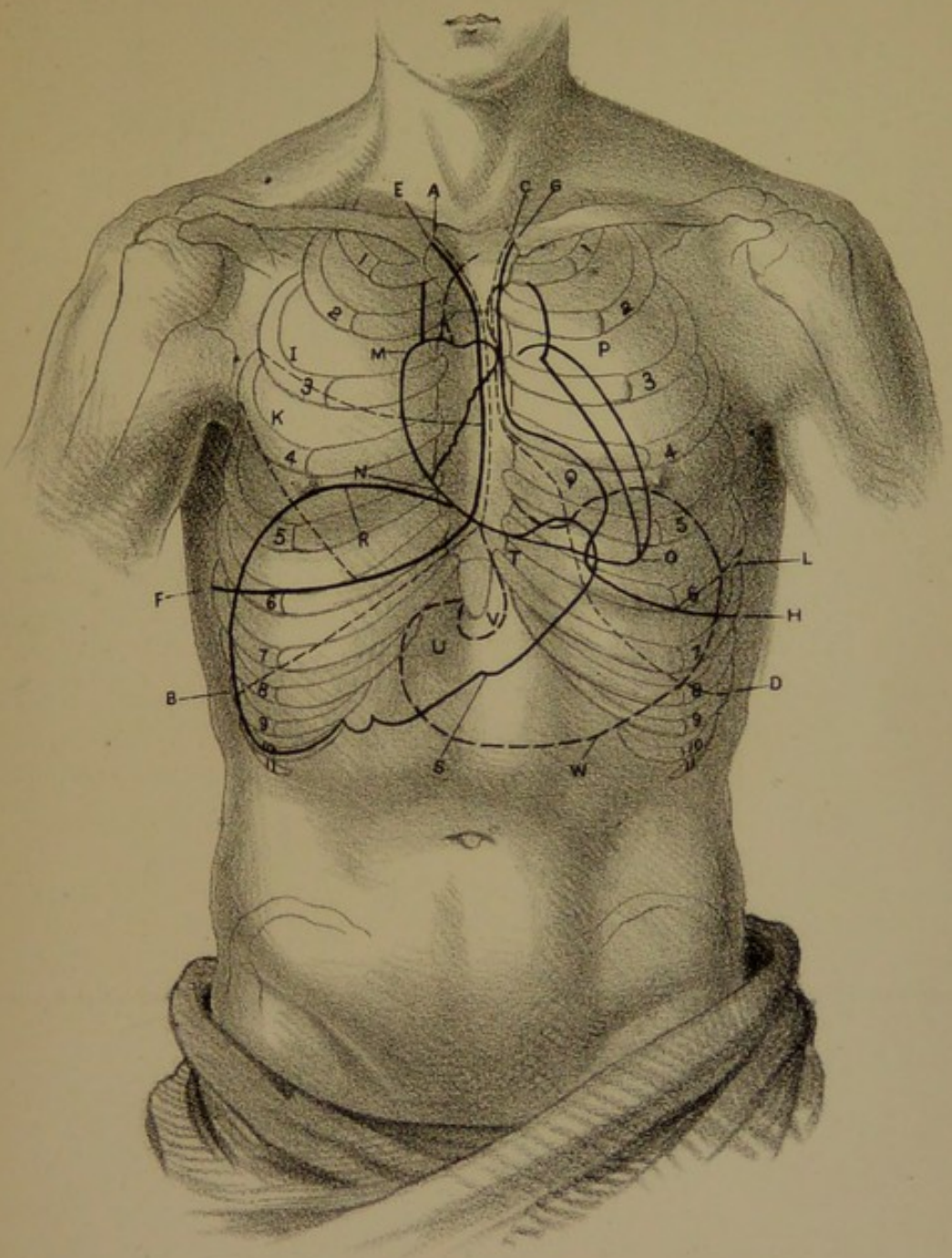
In a patient with considerable ascites, we found that in the dorsal decubitus, the line of flatness commenced at the costal arch in the parasternal line on each side, and swept round in a gentle curve to two and a half centimeters below the umbilicus.

GAS IN THE PERITONEUM.

If there is free gas in the peritoneum the sound has the same pitch and distinctness throughout the whole abdomen; this is, according to the degree of distention of the abdomen, tympanitic, or metallic.

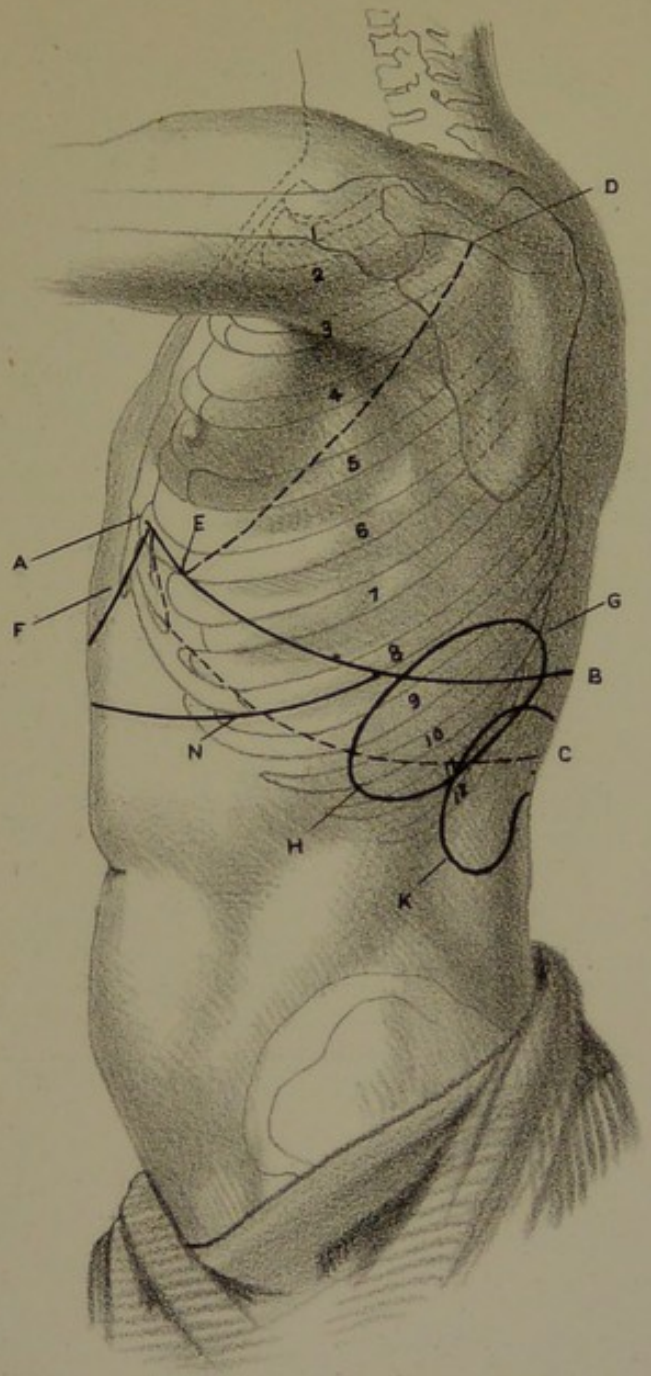
The hepatic flatness and splenic dullness may be absent when the amount of gas is large, and there are no adhesions of these organs to the abdominal wall.

In Meteorism similar results to the above may be obtained by percussion, but usually the different clearness and pitch of the sound in various parts of the abdomen indicate that the gas is contained in coils of intestine of different size, and not in a single cavity. More important data for distinguishing between these two conditions, however, are obtained by other methods of investigation.



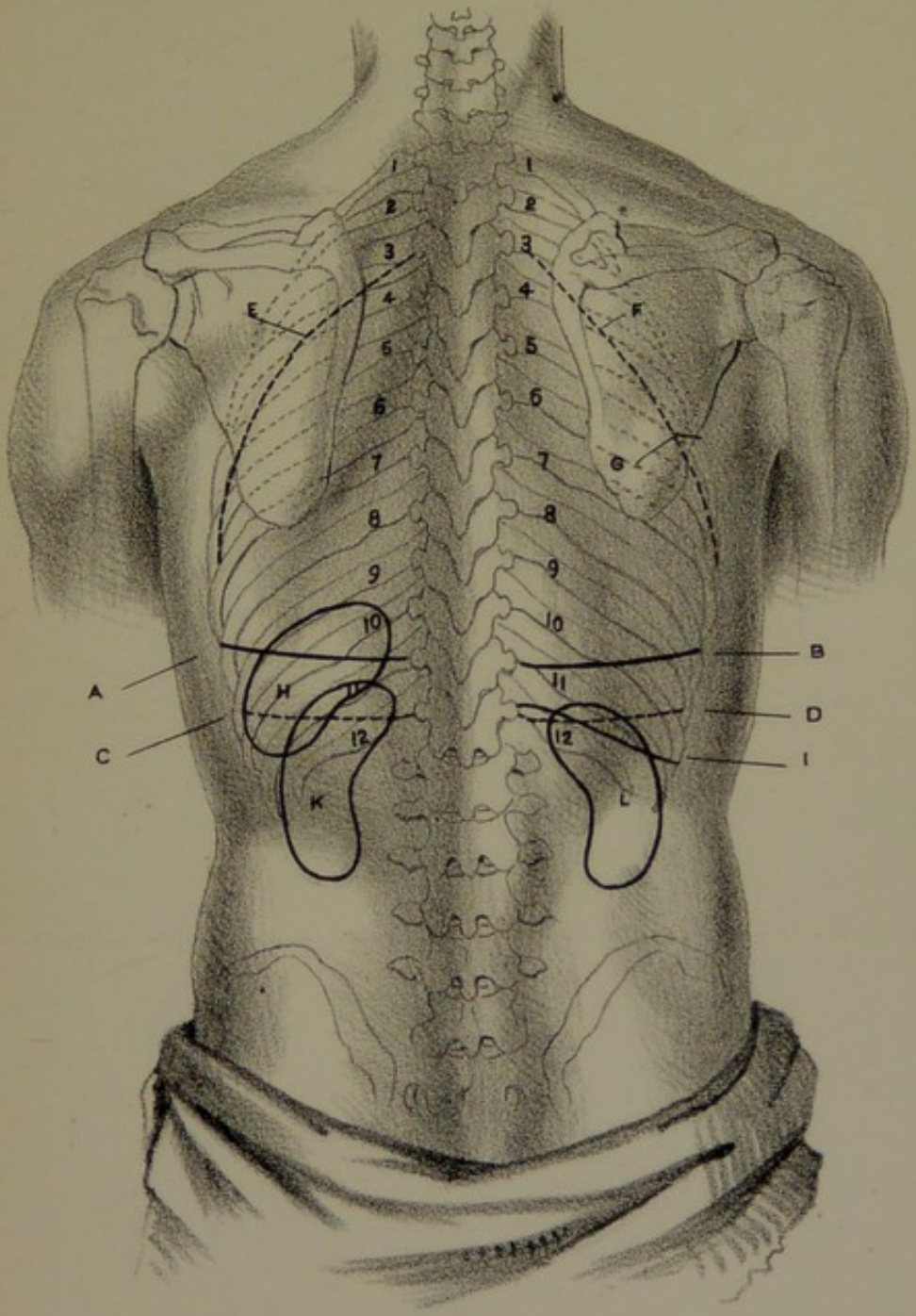
Anatomical Borders — Anterior View. (WEIL.)

A B, border of the right pleural sac.
C D, border of the left pleural sac.
E F, edge of the right lung.
G H, edge of the left lung.
I, upper incisura interlobularis of the right lung.
K, lower incisura interlobularis of the right lung.
L, left incisura interlobularis.
M N, right border of the heart.
N O, lower border of the heart.
P O, left border of the heart.
Q, sinus mediastinocostalis, situated between the edge of the pleura and incisura cardiaca of the anterior border of the left lung.
R, highest point of the portion of liver covered by lung.
S, lower edge of the liver.
T, cardiac portion of the stomach.
U, pyloric portion of the stomach.
V, small curvature of the stomach.
W, greater curvature of the stomach.



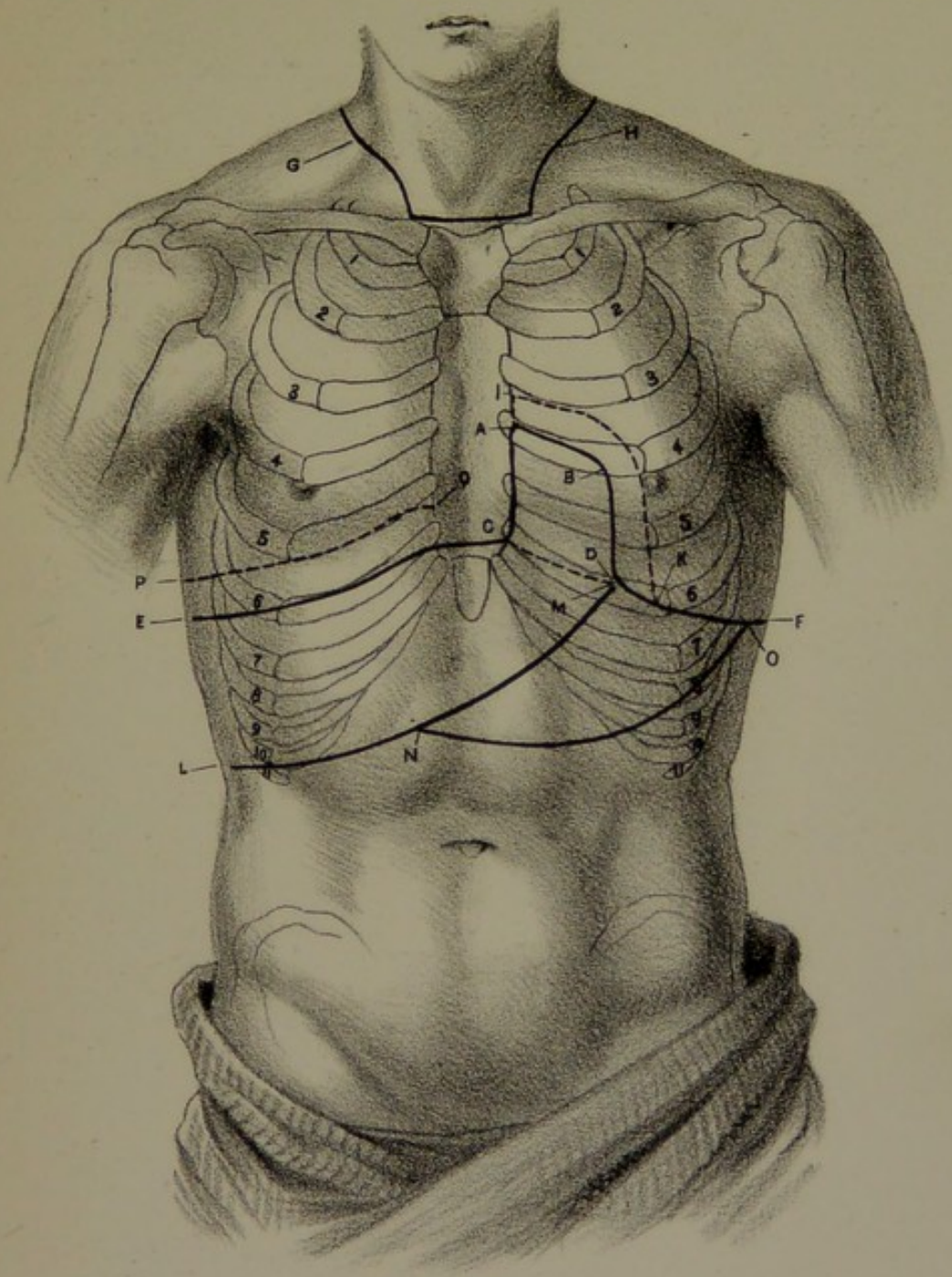
Anatomical Borders on Left Side. (WEIL.)

A B, lower border of the left lung.
A C, lower boundary of the pleura.
D E, incisura interlobularis.
F, edge of the left lobe of the liver.
H G, anterior and posterior ends of the spleen.
K, kidney.
N, stomach in moderate distention.



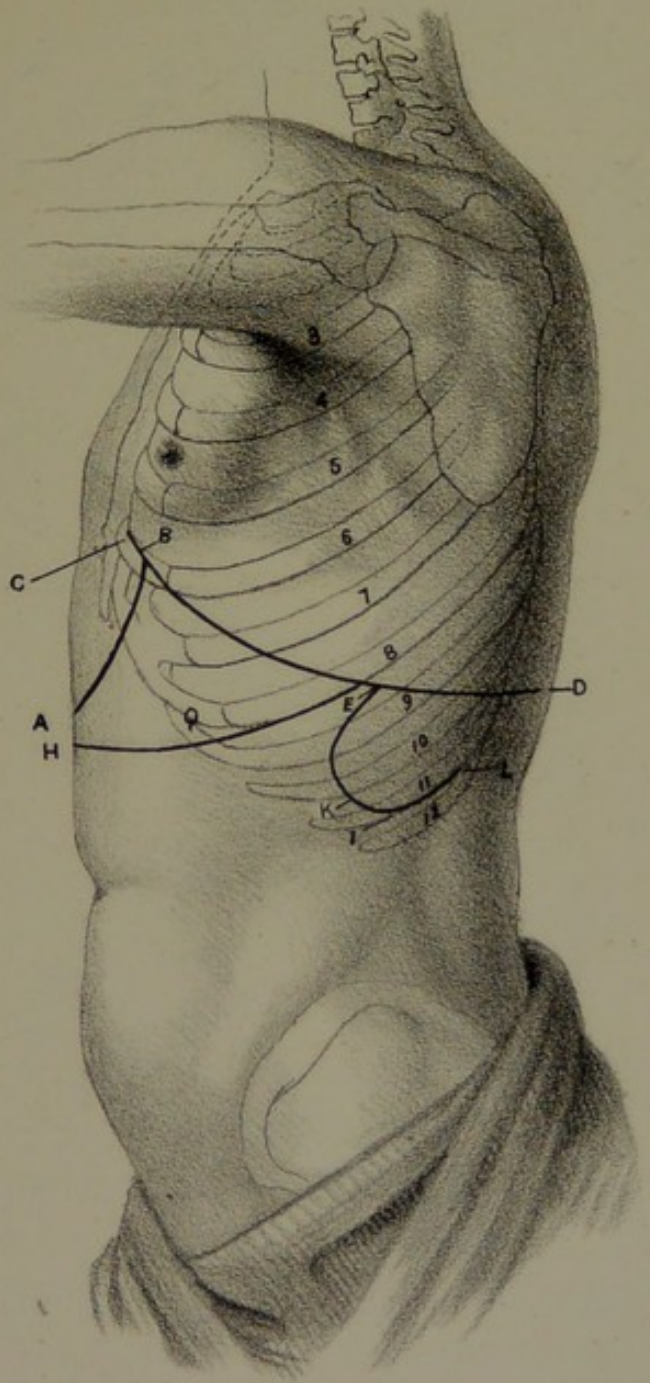
Anatomical Borders — Posterior View. (WEIL.)

A, B, lower borders of the lungs.
C, D, lower borders of the pleuræ.
E, F, incisuræ interlobulares.
G, point where the right incisura divides into the sulc. interlob. dext. super. and infer.
H, spleen.
I, lower border of the liver.
K, L, kidneys.



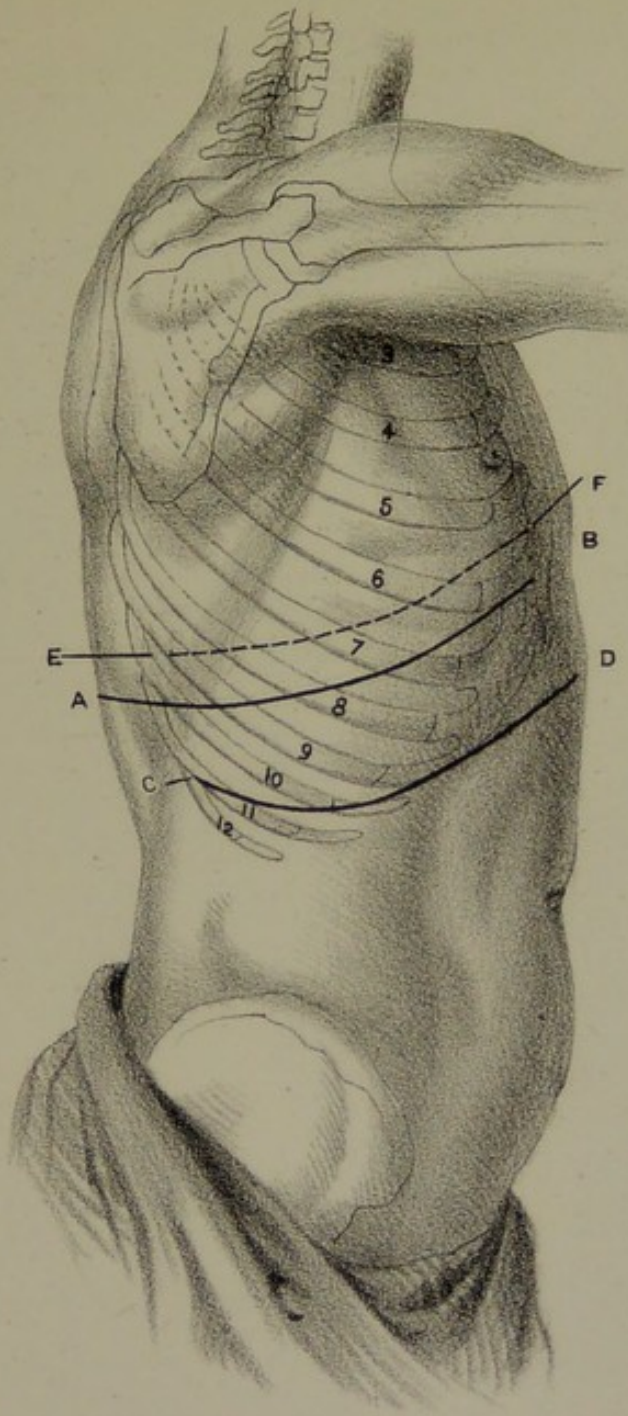
Percussion Borders in Middle Age. (WEIL.)

A B C D, area of cardiac flatness.
A I K, area of cardiac dullness.
C E, lower border of right lung.
D F, lower border of left lung.
G, H, upper borders of lungs.
P Q, upper border of hepatic dullness.
L M, lower border of hepatic flatness.
N O, lower border of stomach in moderate distention.



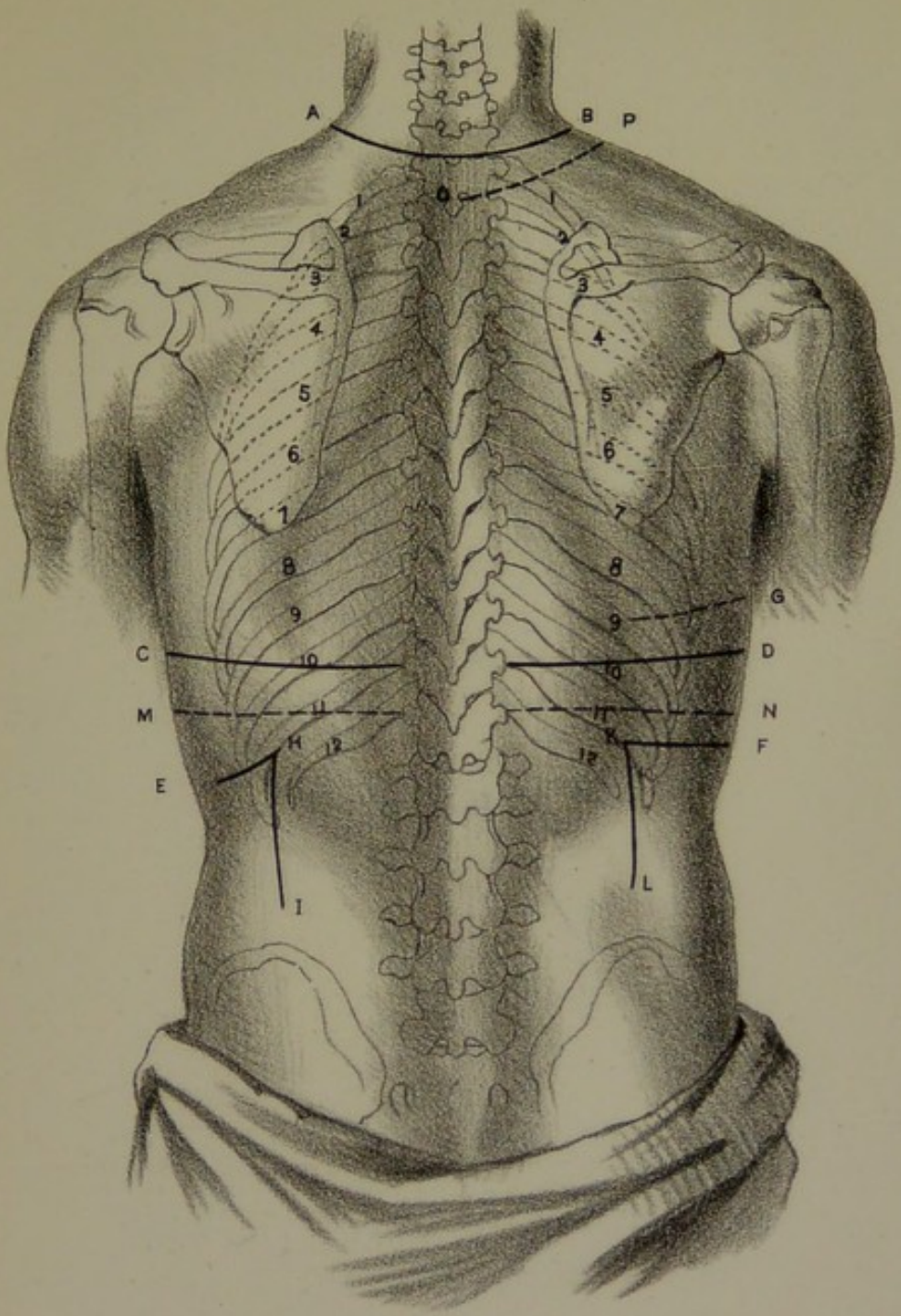
Percussion Borders on Left Side. (WEIL.)

A B, lower border of hepatic flatness.
C D, lower border of left lung.
E I L, splenic dullness.
Q, lower border of stomach.



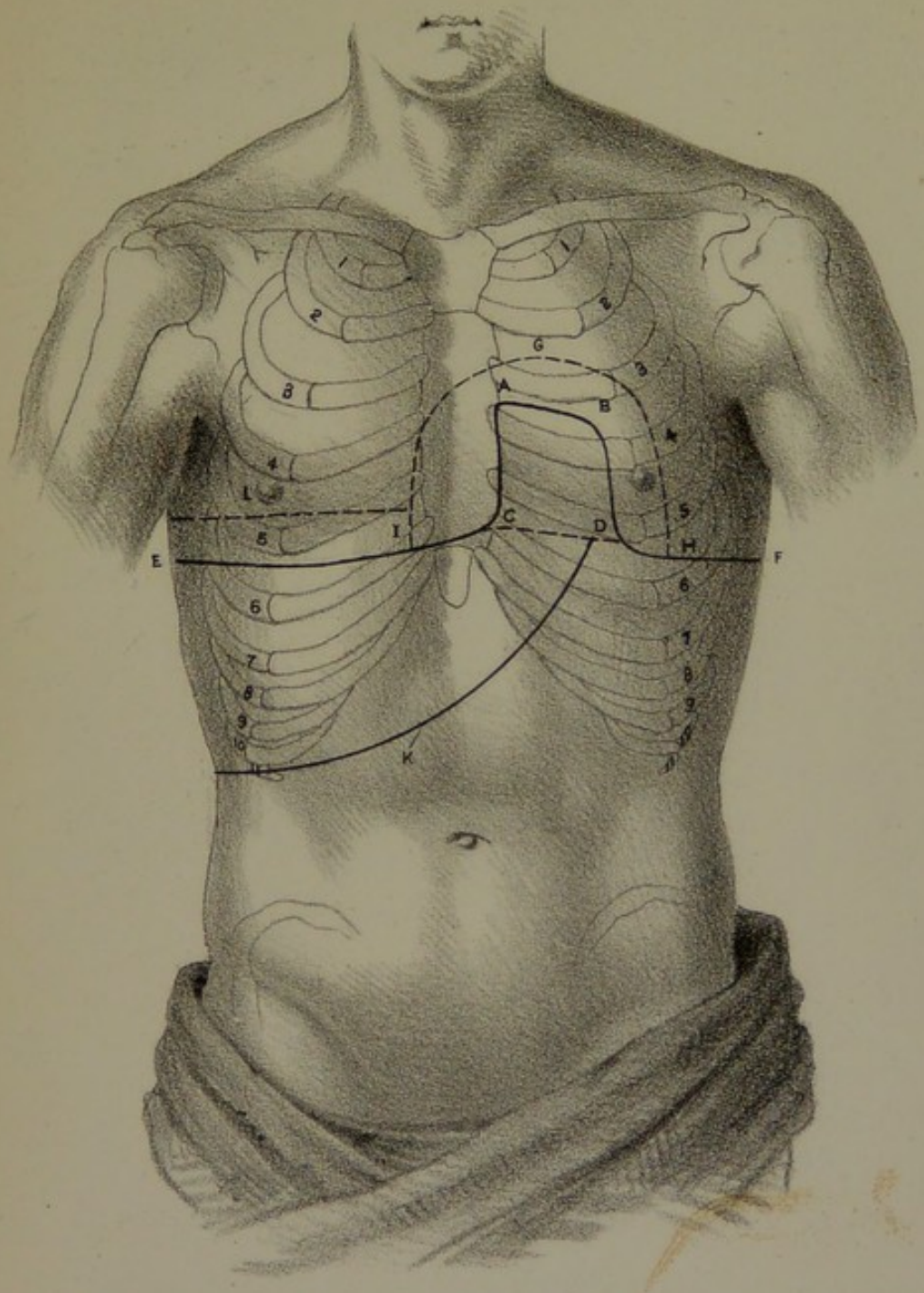
Percussion Borders on Right Side. (WEIL.)

A B, lower border of the right lung. C D, lower border of hepatic flatness.
E F, upper border of hepatic dullness.



Percussion Borders on the Back. (WEIL.)

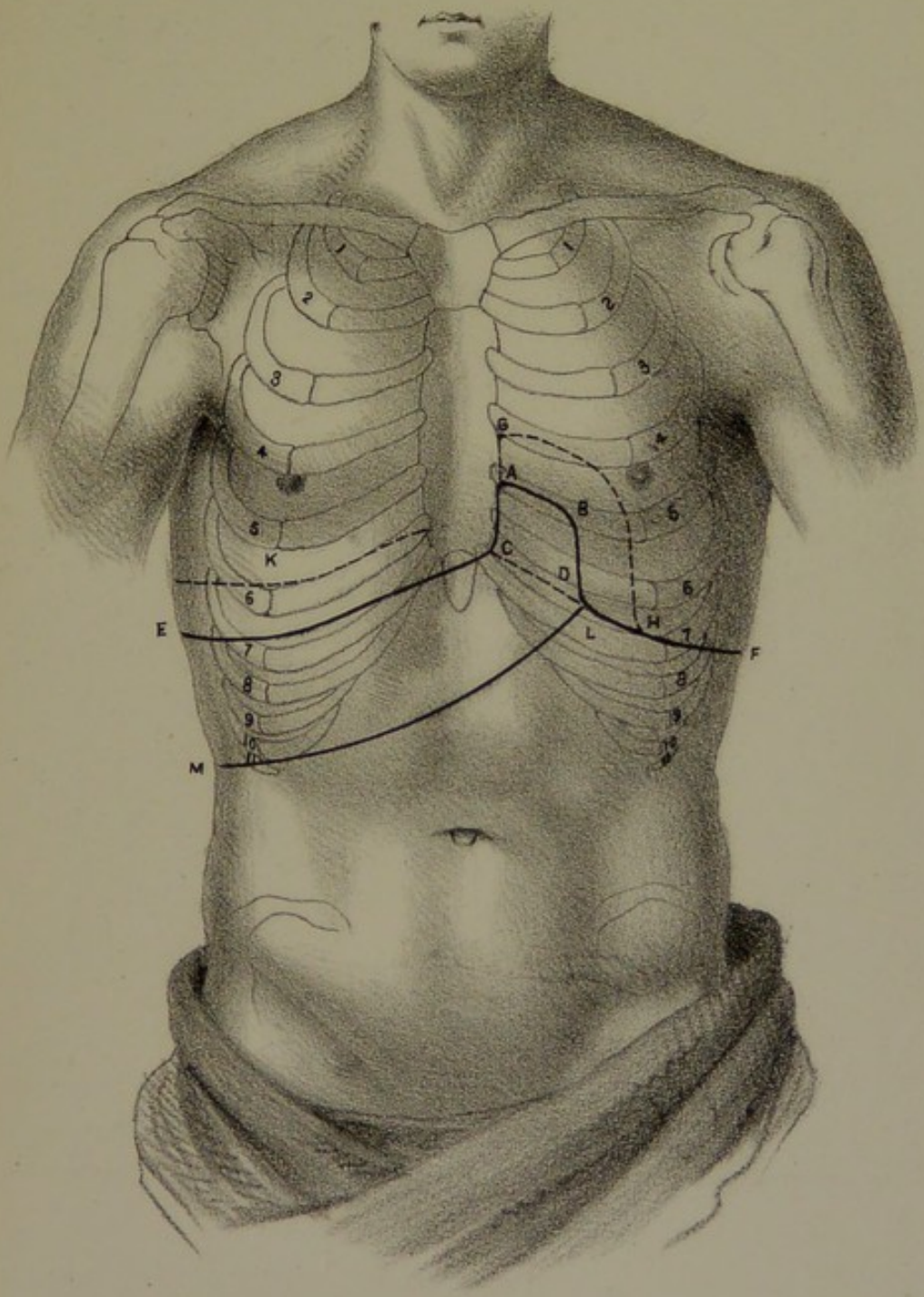
A B, upper border of lungs
C D, lower border of lungs.
E H, lower border of spleen.
H I, K L, outer borders of the so-called renal dullness.
M N, lower borders of the lungs in deepest inspiration.
O P, shrinkage of upper border of lung in phthisis.
K F. lower border of hepatic flatness.



Percussion Borders in Childhood. (WEIL.)

A B C D, cardiac flatness.
I G H, cardiac dullness.

E C, F D, lower borders of the lungs.
K, lower border of the liver.



Percussion Borders in Old Age. (WEIL.)

A B C D, cardiac flatness.
G H, cardiac dullness.
C E, D F, lower borders of the lungs.
M L, lower border of hepatic flatness.
K, upper border of hepatic dullness.