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# The Methods of Diagnosis employed in Diseases of the Thoracic Organs

A Thesis for the degree of Doctor of Medicine

by

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I hereby declare that the accompanying Thesis has, with the exception of the quotations marked, been composed by myself.

Also, that since graduating as M.B. and C.M. I have been engaged in Medical and Surgical practice for nearly five years.

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# The Methods of Diagnosis employed in Diseases of the Thoracic Organs

The Thoracic organs are so placed as to be entirely removed from sight and touch: we cannot inspect the lungs or the heart or handle them to the same extent even as the organs situated in the abdominal cavity, and Inspection and Palpation can only be applied to the walls of the chamber in which these organs lie. By a careful study of all the conditions present, these methods of examination may be made to render valuable aid. We are able thus to determine, the rate, character, and sufficiency of the respiration in procuring the aëration of the blood; by the examination of the arteries we determine the rate and force with which the circulation is being carried on, and can form an idea of the condition of the

great central organ of the circulation - the heart; by the thermometer (a valuable aid to palpation) we determine exactly the temperature of the body and obtain valuable information of the manner in which the economic processes of the body are being carried on, but it is only when we employ the purely physical methods of percussion and auscultation that the condition of the organs themselves can be satisfactorily made out, and the information obtained which will enable the physician to arrive at a complete and correct diagnosis.

The word Diagnosis (διά γιγνώσκω) implies a thorough Knowledge of each individual case and it is therefore not sufficient merely to give a name to the disease from which a patient is suffering, but the full extent and effects of such disease not only on the diseased organ, but on the system generally should be clearly made out. It is not Enough for example, to diagnose a case as Pneumonia without determining exactly the extent of lung affected, the stage to which the disease has advanced, the effect of the disease on the system of the patient, and determining as far as possible the recuperative power of the patient, for it must be remembered that though

~~Thirdly~~ the diagnosis is of great importance to the physician, as determining the treatment to be applied, the prognosis is of far greater import to the patient. To accomplish this requires in a physician the possession of no small amount of tact and patience, as well as skill and powers of observation only acquired by careful training and practice. How important then is it that all the faculties of the student should be trained from his first entry at college, and especially during that part of his curriculum spent in the hospital wards, so that he may be possessed of those powers of accurate observation, of an eye trained to observe the natural as well as the morbid appearances of the body, of an ear capable of differentiating the finest inequalities of pitch and tone, and a touch firm yet delicate, as well as a knowledge of the anatomical, physiological, and pathological conditions of the human body.

Of the importance of early clinical teaching nothing could be more decided than the lecture prefaced to Dr. Graves course of clinical lectures delivered in Dublin, in which he says:— *"I am not drawing a picture from my imagination alone; I have had occasion too often to shudder at the original, — too often to

* Graves Clinical Medicine pp. 7-8. (Syd. Soc.)

deplore the sad effects resulting from well meant but totally mistaken treatment employed by young men, and often have I regretted that under the present system, experience is only to be acquired at a considerable expence of human life. There is, indeed, no concealing the truth, that numbers of lives are annually lost in consequence of maltreatment. * * *

This charge of inexperience is not necessarily confined to the beginner; it applies ~~it~~ equally to many an old practitioner, whose errors have grown, and have increased in strength, during a long succession of years; because from a defect in his original education — from the absence of a properly directed clinical instruction, he commenced practice without having previously acquired the power or the habit of accurate observation; because he had not in his youth been taught to reason justly upon the facts presented to his view; because not having learned in the beginning to think accurately he contracted a loose and careless mode of examining the progress of disease and the effects of remedies: and, consequently, the lapse of time has had no other effect than that of rendering them more inveterate. * * * Many circumstances concur to produce this effect; but the most influential is undoubtedly that which now occupies our attention, — I mean a system of clinical instruction radically wrong, because it does not teach the actual practice of Medicine.

since this was written clinical teaching has advanced rapidly but none the less are Graves' words valuable in the present day, when Medical Knowledge has obtained a position of scientific accuracy never before equalled;- the danger exists still lest students should leave our universities, without acquiring that Knowledge of disease and its treatment only to be obtained at the bedside.

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## The Basis of Diagnosis

Although it is without doubt possible in some cases to make a correct diagnosis at a glance, in the majority of cases it is only by having all the facts of the case before us, and then applying our individual Knowledge and power of reasoning that we are able to arrive at a correct conclusion. Speaking broadly our diagnosis may be said to rest on three factors viz:—

First— <u>History</u> (a) of the patients family
(b) of his previous health
(c) of the present attack

Second— <u>The Symptoms</u>, or the Facts told us by the patient of his sensations previous to, and during the attack

Third <u>The Physical Examination</u>. or the facts observed by the physician

In order to obtain the facts of the a case under these heads, it is advisable and necessary to follow a fixed method of case-taking and case-recording such as the following.

Method of Case Taking.

I. Preliminary Facts.

Name, Age - Sex - Married or Single - Occupation Residence (full postal address) - If in hospital, Date of Admission, No. of Ward and Bed.

II Complaints (the symptoms which bring patient to consult physician) (a) as stated by patient or (b) reported by friends.

III The History —

(1) Of the Present Illness :— Date of Commencement; Mode of commencement; Character of the symptoms and order of their appearance, supposed cause Previous treatment, Record Temperature especially in acute cases.

(2) The Health History prior to the commencement of the present attack — Especially of disease or injury likely to be followed by diseases of the Heart, Lungs &c Habits, mode of life, general surroundings, social conditions, special conditions of employment. A comparison of weight at different times when possible.

(3) Family History - The presence or absence of

Heart or Lung affections in near relatives – Hereditary transmission of scrofula, phthisis, rheumatism &c

## IV Present-Condition

(a) General appearance of patient – Gait – Walk – Nutrition – Description of any striking morbid appearance, E.G. Cyanosis – Condition of superficial vessels – Character of the Breathing – Subcutaneous Oedema – Facial expression, indicating pain, anxiety &c. – Whether confined to bed – posture

(b) Symptoms referable to disease

(1) of the Heart or great vessels :– pain or uneasy sensations in cardiac region – palpitation, faintness – breathlessness on exertion.

(2) of the Respiratory organs :– Cough – dyspnoea pain – expectoration.

(3) of remote organs (secondary to disease of thoracic organs) Resulting from disturbance of circulation – venous engorgement – dropsy &c or deficient aëration of the blood – somnolence headache &c

(C) Physical Examination of the Thorax

(1) Of the Heart and Circulatory Organs

(2) Of the Lungs and Respiratory Organs.

# Circulatory System

(Chiefly follows the Method given by Dr B. Bramwell Pp. 53-53 Dis. of Heart)

## Physical Examination of the Heart-

### Inspection of the Praecordial Region:—

(a) Its form and configuration

(b) Position, extent and character of the visible impulse especially the position of the apex beat-

(c) The condition of the integument over the praecordial region

### Palpation of the Heart

(a) The exact position of the apex beat-

(b) The character of the cardiac contractions (force, rhythm etc.)

(c) The presence of praecordial thrills, or friction fremitus.

(d) The presence of pain or tenderness on pressure over praecordia

### Percussion of the Heart-

map out (a) The area of superficial or absolute dulness.

(b) The area of deep or relative cardiac dulness.

### Auscultation of the Heart-

Determine (a) The Rhythm of the Heart-, whether regular or not-

(b) The character of the individual (first & second) sounds in the Mitral, Aortic, pulmonary, and tricuspid areas, as regards:—

(1) Loudness or Intensity
(2) Tone and Purity
(3) Reduplications
(4) Murmers

(c) When a murmur is present- observe:—

(1) Its Rhythm
(2) Its point of differential maximum intensity
(3) The direction in which it is propagated
(4) Its sound characters

The Physical Examination of the Aorta and great Vessels.

Inspection

The conformation of those parts of the thorax which are superficial to the Aorta and great vessels must be observed, particularly the presence of any prominence, pulsation or tumour.

Palpation Note (a) The presence of any undue pulsation in supra sternal notch, in the thorax or abdomen

(b) The presence of thrills, tenderness or pressure in the course of the great vessels.

Percussion

Note - The presence of dulness on percussion in the course of the Aorta or great vessels, its exact outline, extent &c

Auscultation

Observe: The character of the Heart-sounds, and the presence or absence of murmurs over the course of the Aorta or great-vessels (their rhythm, direction of propagation &c)

The Examination of the Superficial Arteries

Note the condition of the superficial arteries such as the Carotids, Brachial, Temporals etc by Inspection and if necessary by Palpation and Auscultation and particularly observe the condition of the pulse —

in the Radial Artery

(a) By the finger (palpation) as regards:—

Its frequency

Rhythm

Volume

Its compressibility or Tension

The special characters of each pulse wave (celerity, dicrotism etc) and the condition of the vessel in respect of fulness during the diastole of the ventricle

The condition of the arterial coats

The comparison of the conditions on the two sides of the body (i.e. the comparison of the two radial arteries).

(b) By the eye (inspection)

(c) By the sphygmograph

The Examination of the Venous system

Inspection

Note:— The condition of the superficial veins, and particularly observe the condition of the jugulars as regards fulness, the presence of pulsation etc.

Auscultation

Note:— The presence or absence of a venous hum in the neck, over the orbit, Torcular Herophylli etc

# Respiratory System

## Physical Examination of the Thorax -

### Inspection

A. Shape of the Thorax - Bilateral symmetry.

1 Development - nutrition - integuments
Muscles - superficial circulation.

2 Dilatation - enlargement - bulgings
unilateral, bilateral, or local

3 Contraction - diminution in size - depressions
unilateral, bilateral, or local

4 Deformities - (not dependent on disease of the respiratory organs)
The Paralytic form
The Rachitic Thorax
That due to vertebral disease.

B. Movements of the Thorax

1 Type of Respiration - Thoracic - Abdominal

2 Respiratory movements - Frequency -
Extent - whether bilaterally equal
Quality - Deep - Shallow - Hurried; Slow; Painful &c
If there is appearance of effort as the muscles brought into action

3 Stethography - The graphic representation of the movements of respiration

4 Spirometry. Estimation of the vital capacity of the lungs

5 Pneumatometry - Measurement of the force of respiration.

## Palpation

A Confirm observations made by Inspection with regard to shape and movement of Thorax

B Mensuration – The circumpranca at different levels – compare measurement of the two sides.

The diameters (a) The long diameter

(b) The transverse (the breadth)

(c) The Antero-posterior (the depth)

By the Cyrtometer – when great irregularity present.

C Examination of painful regions

To determine (1) Diseases of the bones.

(2) Pluritic pain

(3) Neuralgia (Intercostal)

(4) Muscular Rheumatism.

D Vocal Fremitus – Increased or diminished locally, unilaterally, bilaterally.

E Bronchial Fremitus – Vibration caused by the presence of fluid secretions in the Bronchi

F Pleural or Friction Fremitus

G Cavernous Fremitus

H Fluctuation.

## Percussion

A. Limits of the Lungs

Upper, Anterior, and Lower –

B Percussion of the regions of the chest—

(1) Supra-sternal
(2) Upper Sternal
(3) Lower Sternal
(4) Right & left—Supra Clavicular
(5) Right & left—Clavicular
(6) Right & left—Infra clavicular
(7) Right & left—Mammary
(8) Right & left—Infra-mammary

C The Percussion Note

(1) Resonance - Clear—Impaired,—~~Dulness~~
(2) Dulness - Absolute—Impaired
(3) Pitch of Note - High - low &c
(4) Timbre - Quality of Note
(5) Tympanitic Note
(6) Cracked pot-sound
(7) Amphoric resonance
(8) Metallic Resonance

D Sense of Resistance in Percussion

E Phonometry by tuning fork (Baas)

Note In percussion a comparison of the two sides should always be made.

## Auscultation

A Respiratory Murmer - during Inspiration and Expiration

(1) Vesicular

(2) Bronchial or Tubular

(3) Indeterminate

(4) Amphoric

B Accompaniments to the Respiratory Murmur

(1) Râles & Ronchi

(a) Character, sibilant, sonorous, crepitant etc.

(b) Time of occurrence

(c) effect of coughing on these.

(d) Size of Râles - large, small, intermediate

(2) Friction

(3) Splashing sounds (Succussion)

C Vocal Resonance - Increased - decreased

(1) Bronchophony

(2) Œgophony

D The Voice

## Examination of the Sputa

A Naked eye examination

Note the (1) Colour

(2) Consistence - watery, frothing - Viscid -

(3) Presence of casts, mucous masses etc

B. Chemical Examination

To detect - (1) Blood

(2) Pus

To prepare for microscopical examination

C Microscopic Examination

Note (1) Epithelium - pavement, columnar, ciliated.

(2) Pus corpuscles

(3) Mucous corpuscles, fat cells, granular masses.

(4) Blood corpuscles

(5) Elastic fibres of lung tissue

(6) Fibrinous casts

(7) Crystals - of fatty acids - haematoidin - cholesterin
- tyrosin

(8) Fungous Growths
(1) Leptothrix buccalis
(2) Oidium albicans

(9) Vibriones
(1) Bacilli of Phthisis
(2) Sarcinae
(3) Bacteria

(10) Echinococcus - vesicles - hooklets etc.

Examination of the Nervous, Alimentary —
Genito-Urinary and Integumentary systems

The Diagnosis

The Prognosis

The Treatment —

Subsequent course of events

Result — If fatal, and post-mortem examination made, state particulars

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Though in the Method of case taking just described a certain order of procedure is laid down, it is by no means necessary to keep to that order in the examination of a patient. It is merely for the convenience of obtaining a clear record of our cases

Alterations in the Percussion Note -.

Loudness - This depends 1st on the strength of percussion a clearer note as a rule being heard if percussion is made with some force, but it must be remembered that if the lung be thin or a solid body be present beneath the note will be obscured by dull percussion and only brought out by striking very lightly.

2nd On the thickness of the chest wall - If the chest walls be enveloped in fat, or the muscles very well developed the resonance is only feebly heard or in some cases ~~is~~ hardly to be made out at all. When the mammae are largely developed it is impossible to obtain a resonant note over that area. On the other hand when the thoracic walls are emaciated and free from fat the note is loud and clear

3rd On the amount of lung tissue present and the air present in the vesicles. The note is louder when there is a considerable thickness of lung present - thus it is louder below the clavicles than above it, and over the substance of the lung than over the margins. When the lungs are fully inflated and the air cells distended with air the percussion note is increased in intensity and is clearer, and this becomes still more evident when the breath is held and expiratory pressure made, the pitch of the note being then slightly raised.

From the above it will be seen that the absolute degree

of loudness has no special value in diagnosis provided that a decrease is not accompanied by dullness; it is quite possible to have a very soft note which is yet fully resonant.

Impaired resonance, muffling of the note, absolute dulness -

These alterations in the percussion note may be caused by changes in the lungs themselves, in the pleura, or in the thoracic parietes. As resonance is produced by the vibration of the chest walls and of the air in the pulmonary vesicles, it follows that any change which prevents this or damps their vibration will cause either an absence of resonance or an impairment in the note.

The changes which may cause this are :-

1st In the lungs - Exudation into the air cells, which may be the result of inflammation, or of changes in the heart (oedema); Haemorrhage replacing the air and blocking the air cells and small bronchi; degenerative changes in the lung substance; increase or displacement - in the solid thoracic viscera -, and the presence of solid growth or collection of fluid in the lung substance, collapse of lung tissue from any cause.

2nd In the Pleura - Thickening of the parietal or

visceral layer of the Pleural membrane, the presence of fluid, serous, purulent, or haemorrhagic in the Pleural-sac, or the presence of solid growth or collection of fluid beneath that membrane

3rd In the thoracic walls:— Thickening by new growth or increase in the natural elements of the chest-wall will if of sufficient extent cause an impairment in the resonance or in extreme cases absolute dulness

1st Changes in the lung substance — The diseases of the lungs in which dulness occurs are,— pneumonia croupous and catarrhal, caseous degeneration, oedema of the lungs, haemorrhage (pulmonary apoplexy), cirrhosis of lungs (variable), and collapse.

The most marked changes occur during the different stages of pneumonia; beginning with a normal note, as the disease advances percussion produces all varieties of impaired resonance until dulness is reached, and then the series is reversed until the note becomes clear when absorption is complete.

In the first stage, that of engorgement before any exudation has occurred the note is normal and remains so for some time after the commencement of the disease. At the earliest part of the second stage, the sound, ~~according to Guttmann~~, becomes diminished in intensity and acquires a tympanitic character, due to

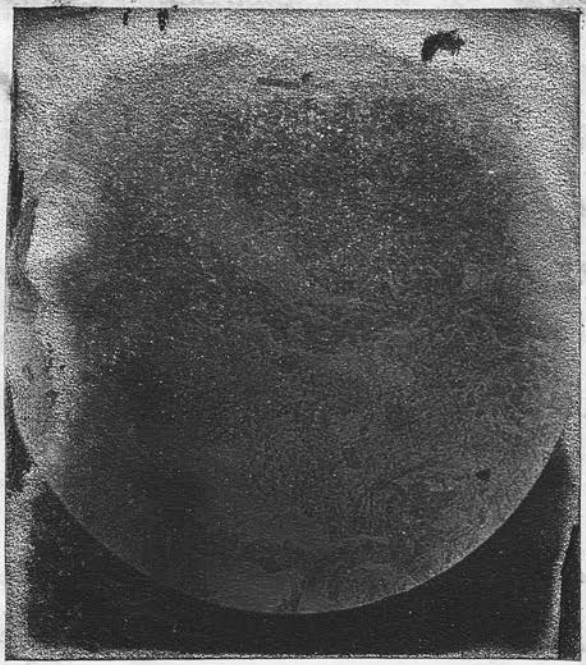


Fig 27 Microphotograph of the 2nd Stage of Pneumonia
× 300

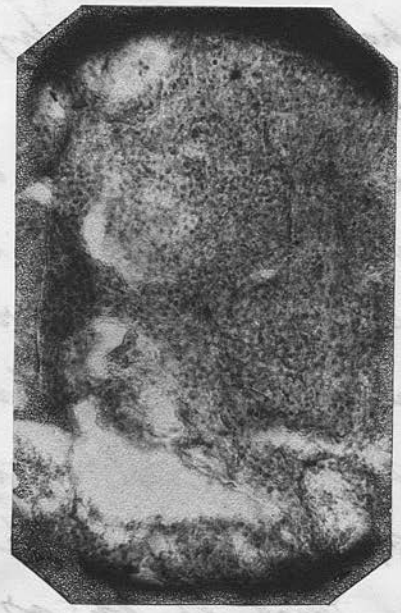


Fig 28 Microphotograph of the 3rd Stage of Pneumonia
× 200

according to Fullmann

to the diminution in the tension of the air in the pulmonary tissue. This is not often heard but it occurs sometimes at the beginning of exudation and at the period of absorption. As the second stage (Fig 27) advances the note diminishes in resonance and becomes dull and muffled in character. The area of the lung affected can be mapped out, and it is generally found to affect the lower lobes on one side only. This distribution is not invariable, and occasionally the apices are affected to the exclusion of other parts, and the disease sometimes affects both lungs at the same time. Absolute dulness does not occur till the third stage, that of grey hepatisation, is fully developed (Fig 28). The note then is devoid of resonance and resembles the sound produced by percussing over the liver - the consistence of the lung is liverlike, due to the exudation completely filling the air cells, which now are entirely devoid of air. As the disease subside the exudation becomes absorbed and the dulness disappears and the normal note returns, occasionally a tympanitic note being heard before absorption is complete. This is the normal course of pneumonia but the disease may not follow so regular a course. It may become chronic, abscesses may form, part of

the lung may become gangrenous, or caseous degeneration occur and cavities form. In such cases the character of the percussion note is various; in chronic pneumonia the dulness lasts longer but is rarely absolute and the area affected is not so large as in the acute form; in abscess there will be dulness over its seat provided it is large enough & near enough the surface to be detected. a gangrenous area is dull until part of the putrid matter is expectorated, but will vary according to whether air or fluid predominate in the affected area. When caseous degeneration occurs, until cavities are formed the note on percussion is dull, but as excavation occurs the note will vary with the contents of the cavity, being dull if it is filled with fluid, but tympanitic or amphoric if air be present and what is known as the "cracked-pot" sound may be elicited.

In catarrhal pneumonia the disease occurs in patches and it is only when they are comparatively large or several patches coalesce, that they become recognisable on percussion. This disease is known by the name of lobular pneumonia, which expresses its habit of affecting isolated lobules, and also broncho-pneumonia which indicates its causation, as in many cases the disease is an extension of catarrh from the bronchial tubes. Dulness is rarely detected till condensation is complete or until

the lobule is collapsed owing to the attendant bronchitis blocking the tubules. It often varies from day to day as the lobule is collapsed or expanded. The basal portions of the lung are most frequently affected but any area may become the seat of disease. A chronic form of catarrhal pneumonia occurs in the apices and is then described as catarrhal phthisis.

Caseous degeneration with formation of cavities has been noticed as occurring in pneumonia. The results of percussion are the same when the disease occurs as a distinct affection, but the apices are most often affected and the disease creeps on more insidiously.

Oedema of the lungs does not cause very well-marked dulness, as the air cells are not entirely filled with fluid and air is always present, but absolute dulness is not infrequently present, due to the exudation of serous fluid into the pleura. The oedema affects both lungs, and the alteration in the percussion note is best marked at the bases, to which region the fluid gravitates.

Haemorrhage into the air cells, haemorrhagic infarction and pulmonary apoplexy. The presence of blood in the air cells or in the lung tissue will cause dulness on percussion, just as pneumonic exudation does, provided that the area affected is large enough to be detected and is consolidated, for a considerable amount of blood may

be present without causing any alteration in the percussion note.

The changes in the lung due to cirrhosis are various. There is a great increase in the fibrous tissue of the lung and the organ is greatly contracted and the chest-wall is drawn in to meet it. By the contraction of the cirrhotic tissue the bronchi are dilated often into distinct cavities. With such conditions it is obvious that the percussion note must vary in different situations. Over consolidated areas the note is dull, over other parts where the lung tissue is not so much affected the note is only impaired, while in others (dilated bronchi) it is tympanitic or may have a cracked-pot sound.

Solid growth in the lungs (carcinoma) if near the surface and of sufficient size will cause dulness which will vary in extent and amount according to the size & situation of the tumour, being more marked the nearer the tumour lies to the surface, but if the new growth is situated deep in the lung substance, and be small in size it may cause a very slight impairment of the normal resonance, or remain undetected by physical methods, though its presence may be indicated by the symptoms.

Collapse of lung & Atelectasis - These conditions, if

they affect the lung to an appreciable extent will give rise to dull areas. Collapse of the lung is most often seen in pleurisy and empyaema; it also occurs in pneumothorax the presence of air allowing the lung to collapse as it does when removed from the body. Another form of collapse is seen in some cases of bronchitis where the tubules have become blocked by secretions, and the patient's strength not being sufficient to expel the plug, the area behind contracts. The condition is apt to occur in all cases of extreme debility, where the bronchial secretions are of a very adhesive character. Atelectasis, that is, non-expansion of parts of the lung after birth, may be detected in young subjects, and if of slight extent may give rise to no symptoms.

With the exception of the cases first mentioned (pleurisy etc) the collapsed portions are of small extent and are scattered over the lung. Both sides may be affected and the dulness is almost always of very limited extent. The dulness caused by the collapse of the lung in pleurisy or empyaema is concealed by the presence of the exudation, but if after its absorption the lung fail to expand the chest still gives a dull note owing to the presence of non-resonant carnified lung beneath.

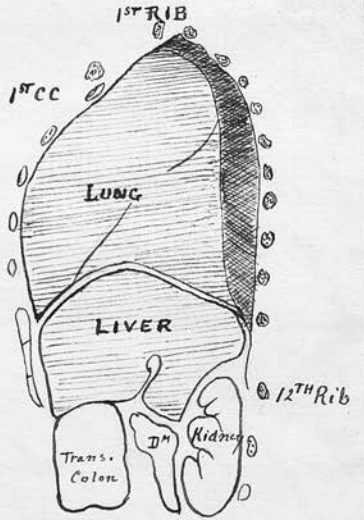



Fig 29 Pleurisy
dark shaded indicates the position of exudation.

From a Sagittal section one inch to the right of the mesial plane of a child aged about six years - Organs (lung liver, Kidney & bladder). The fluid has gravitated to the posterior parts.

(Symington Edin. Med Journal March 1896 P. 836)

Collapse due to pneumothorax does not cause dullness but the side being filled with air the note is hyperresonant - or tympanitic.

2 Affections of the Pleura - Pleurisy with effusion - and Empyaema - Hydrothorax

In the early stage of pleurisy the resonance remains unaltered and if no effusion occur (dry pleurisy) may remain so throughout the course of the disease. Usually however a copious exudation of serous fluid takes place into the affected sac and the side becomes absolutely dull. A large amount of fluid may be present without causing dulness and a layer of half an inch in thickness interposed between the lung and the chest wall does not prevent resonance from being heard though the note is muffled.

As the fluid increases the dulness becomes absolute over the area occupied by fluid, which of course gravitates to the lowest parts and consequently the dulness is first and for the longest time heard at the bases posteriorly, on the left side being heard where normally the resonance of the stomach was heard, and on the right above the level of the hepatic dulness. Fig 9

The line of dulness is not straight but rises somewhat posteriorly towards the spinal column, and if there should be adhesions present between the two

surfaces of the pleurae the area of dulness will be variously altered, the fluid rising only in those parts that are free from adhesions, the parts of lung bound down being resonant or only slightly dull. When the lung is free to move in the thorax it is possible to change the level of dulness by changing the position of the thorax, thus if the patient lies on the side not affected the lung will rise to the highest point and if percussion be made in the axillary line the note will be found resonant while towards the spine & middle line dulness is evident. As the fluid is absorbed, the lung expands and the chest again becomes resonant, but when the pleura has become much thickened, the note remains muffled for some time after the fluid has all been absorbed. The lung may not expand, and the thoracic wall be drawn down to its level, and in such a case the percussion note is either muffled or absolutely dull. Local pleurisies occur with the presence of exudation in limited areas being shut off from the pleural cavity by adhesions; the area affected is dull on percussion and all the physical signs of pleurisy may be detected.

that such order has been adopted, the points themselves being gradually ascertained in the course of the examination of the patient. In some of the London hospitals it is customary to place the History of the patient after the physical examination and in practice this is generally done:— for instance when a patient comes to us or is visited in his own home, we naturally begin by asking what are his complaints, and we ask a few necessary questions, we have time to notice the general appearance of the patient; the state of his nutrition, expression, and then proceed to the examination of the system to which our attention is called by the patients statement of his case, and afterwards enquire into his History circumstances &c and put such questions as relate to hereditary disease. In general practice a great deal of this is known to the medical attendant owing to his acquaintance with the family and here the 'family doctor' has a great advantage over the consultant who has to learn all these particulars and draw his conclusions in the course of a short interview.

In Empyaema the fluid present, instead of being simply serous, is purulent. As a rule it comes on slowly, increases less rapidly, and is only removed by absorption to a very small extent. As in pleurisy only one side is affected and the dulness corresponds to the area occupied by fluid. The lung is much more apt to remain unexpanded after the withdrawal of the fluid & therefore depressities and permanent impairment of the percussion note are more apt to occur.

Hydrothorax or thoracic dropsy occurs in the course of some cardiac cases, and forms part of a general dropsy. The fluid in the pleural sacs causes the same percussion phenomena as in pleurisy. Both sides are however affected and frequently fluid is present in the pericardium as well and there is general dropsy of the serous cavities and cellular tissue.

Dulness from changes in the position or size of the heart or pericardium will be discussed later.

Bronchial or tracheal affections never cause dulness provided the lungs are healthy and the air cells are not collapsed

but as noticed above, areas of the lung do become collapsed and dulness in patches is heard over the thorax.

3 Changes in the thoracic walls - As already noticed thick walls will cause a diminution in the loudness of the percussion note, and may greatly impair the resonance and in some cases cause absolute dulness. It is obvious that dulness from this cause, which is generally bilateral does not indicate pulmonary disease, but sometimes it may be a cause of difficulty, as when the muscles and tissues on one side are wasted, owing to certain nervous lesions, the note on one side is less resonant than on the other. The absence of symptoms and the other physical signs of pulmonary disease, and the presence of atrophy and paralysis in other parts will generally clear up any doubts.

Increase in resonance -

With healthy lungs the percussion note is more resonant when the thoracic walls are thin and consequently more easily thrown into vibration, also at the end of inspiration when the air cells are distended the area of resonance is increased, the apices are higher above the clavicles, the heart more overlapped by lung tissue and the resonance at the bases

descends lower. In emphysema - whether affecting the whole of the lungs, or only limited areas, the note over the diseased part is more resonant than normal and is generally pitched higher and approaches and occasionally is truly of a tympanitic character. Over cavities too small to give an amphoric or tympanitic note, the resonance may be increased unless the cavity be filled with fluid or other products when the percussion note will be rather impaired.

Tympanitic Percussion Sound. This is the name given, from its drum-like character to the note produced by percussing over the stomach and other abdominal viscera which contain air. In the thorax it is never heard when the lungs are healthy and the pleural sacs do not contain air or gas, but in disease it is present under several different conditions. It is best marked in -

(1) Pneumothorax where air is present in large amount in the pleura.

(2) In some cases of emphysema but never to the same extent.

(3) Over cavities in the lungs which contain air.

(4) Under certain conditions of consolidation or partial collapse of the lungs.

(1) Pneumothorax. Air may enter the pleura either through a wound in the thoracic parietes or through a fistulous opening from the lungs which may be produced by the bursting of an abscess into the sac or by destructive processes going on in the lungs. The tympanitic area varies with the amount of air present; the whole side may lose its normal vesicular character, the lung being collapsed, or the air may be confined by adhesions to a very limited site, and this is especially the case where the pneumothorax has been caused by the entrance of air through a fistula in the lungs. When due to an external wound nothing further may follow, and the air be gradually absorbed and the note become normal as the lung expands, but under the other conditions already named, the pneumothorax is generally rapidly followed by irritative or inflammatory processes in the pleura with the exudation of serous or more frequently purulent matter and hydropneumothorax is developed. In this case there is dulness or percussion over the region occupied by fluid while above this the note is tympanitic.

If the air and fluid be free to move and not confined by adhesions between the pleural surfaces the percussion note will vary with the change of position of the patient, the fluid gravitating to the lowest part while the higher region is always tympanitic. As the fluid increases the air becomes less and may disappear altogether. In some cases when the affected area is small and there is a free communication with a bronchus, the fluid becomes mixed with air bubbles, and on pressing into an intercostal space, a peculiar crepitant sensation is produced owing to the bursting of the air bubbles.

(2) Emphysema - In some cases the note is distinctly tympanitic, though more often of a character which Prof. Flint describes as vesiculo-tympanitic (Clinical Medicine P. ), that is, the note has some of the features of tympanicity, but is altered by the vesicles, which may be said to 'damp' the musical sound. The percussion note is generally tympanitic over regions where large bullae exist, which sometimes simulate an excavated cavity in their percussion phenomena.

(3) Cavities. Excavations in the lung substance or cavities due to dilatation of the bronchi, if of sufficient size and near to the surface of the lung, and their walls smooth, will give a tympanitic note on percussion unless at the time they should be filled with fluid or lung detritus. Deep seated cavities cannot be detected and even when superficial, if they are much less than a pigeons egg in size, the tympanitic note cannot be demonstrated. If the walls be ragged and destruction is going on rapidly in the lungs the note is not generally tympanitic but the resonance is increased if air be present and dull if the contents be fluid. The pitch of the note is higher in small cavities than in large, and higher than in pneumothorax. It is altered with respiration being higher during inspiration than during expiration owing to the alteration in the tension of the air. When the mouth is open the note is also higher and in some cases has a "cracked pot sound, or "bruit de pot fêlé".

(4) Condition of condensation or collapse of the lungs.

A tympanitic note is sometimes heard at the beginning of pneumonia, or when consolidation has occurred, over the normal lung, in contact with the

hepatized tissue (b) in consolidation at the apices. (c) In oedema of the lungs (d) in pleurisy above the dull area.

The explanations of this phenomenon are various. Thus Prof. Flint (Clinical Medicine) ascribes the tympanitic sound to the vibration of the air in the larger bronchi, under the consolidated tissue, through which the vibrations are transmitted from the external walls to the bronchi, and the sound so produced not being impaired by consolidated tissue, as it is by the normal vesicular ~~tissue~~, is in character tympanitic. This would account for the production of a tympanitic note in the infraclavicular regions, while the stomach note heard through the condensed tissue of pneumonia would explain its presence at the base on the left side at any rate.

Guttmann on the other hand ascribes the tympanicity to lowering of the tension of the air in the vesicles. The tympanitic note is lost in any air containing cavity if the tension be too high and is regained when the tension is lowered to a certain degree, being again lost if lowered too much. The tension is lowered in the air cells in the neighbourhood of condensed tissue or when the vesicles are only partially filled with exudation (beginning of Pneumonia), in oedema

of the lungs and in the collapsed lung of pleurisy. This affords a satisfactory explanation of the tympanitic quality of the note, but a lowered tension would be accompanied by a lowering in the pitch of the note which in all cases of tympanicity is somewhat raised. This elevation however will be explained by the decrease in the area of resonance as Bristowe remarks, — "Knowing that (other things being equal) the smaller the "vibrating area becomes the higher will be the fundamental "tone it yields, and seeing that such a diminution of "vibrating area necessarily takes place when there is extensive "consolidation or fluid effusion, and not improbably occurs "in the first stage of pneumonia over the affected "portion of lung; it seems reasonable to assume that "mainly in these considerations is to be sought the "explanation of the acoustic phenomenon in question. It "must not be forgotten, however that the increase of "tension which in pneumothorax, and in a less degree "in pleurisy with effusion, the thoracic walls experience, "also tends to the production of a higher note" — (Bristowe Practice of Medicine P. 350 Third Edition).

Metallic percussion sound - Amphoric Resonance. This is a variety of the tympanitic sound and resembles it in most of its characters but is more metallic. It can be imitated by striking the cheek when the mouth is closed and distended with air, or by striking an

* or when two coins are used one as hammer the other as pleximeter

empty jar or bottle. The conditions necessary for its production are a cavity of large size containing air, with smooth walls, and close to the thoracic surface. It is heard in phthisical cavities where destructive processes are not going on and sometimes in those of bronchitic origin, and also in pneumothorax. In cavities in the lung substance it is best heard when the patient lies on his back with his mouth open and when the pleximeter is struck by some hard body at the unprotected end of the percussion hammer*. In pneumothorax it is heard when the tension of the air is increased and the walls thin but it is only in some cases that the metallic sound is heard, the note generally being tympanitic.

Cracked pot sound. Bruit-de pot-fêlé.

This is a sound produced by special conditions of the lung with reference to the escape of air from its substance or from a cavity in its substance. The sound heard on percussion, is exactly that produced by striking the hands clasped together on the knee. The resonant- or tympanitic sound of an air-containing cavity is heard, and along with that a "chink" or metallic hissing sound produced by the sudden escape of air. It is heard even when there is no disease of the thoracic

viscera, when the chest is thickly covered with hair or when percussion is made through a woollen garment, disappearing when the hair is moistened or the garment removed.

In disease it is heard under the following conditions:—

1 When there are cavities of a certain size in the lung substance which communicate freely with a bronchus. The walls of the cavity should be firm and smooth and near the surface and the bronchus communicating with the cavity free from obstruction. When firm percussion is made, (and here the hammer is most useful) over such a cavity, and the patient keeps his mouth wide open, the air will be forced out suddenly through the narrow opening of the bronchus with a sound such as is described above. The cracked pot sound will disappear if the bronchus be obstructed and will return when the obstruction is removed.

2 In Pleurisy above the level of the fluid, it is sometimes heard and especially when the note assumes the tympanitic character. It is probably due to air forced out of a large bronchus by percussing forcibly over the collapsed lung.

3 In Pneumonia it may also occasionally be heard when the percussion note is tympanitic, and the explanation is similar to that given in pleurisy.

Rules to be observed in the Examination of a patient:—

I Endeavour to gain the confidence of the patient. With children this is of more importance than with adults, but in all cases we are more likely to get a true statement of the patients symptoms and to form a correct opinion as to his case if at an early period we are admitted into his confidence

II Allay as far as possible the Patients nervousness and anxiety.

The nervous agitation occasioned by the Physicians visit, or by the dread of serious illness, not unfrequently causes the appearance of symptoms misleading, and altogether foreign to the case, which may mask the true nature of the symptoms present, and possibly lead to an erroneous conclusion. A few cheering words will often suffice to reassure the Patient and the Medical attendant should always be careful that nothing in his own conduct or words is likely to cause the patient unnecessary alarm.

III Make the examination as thorough as possible. While doing this be careful not to go beyond the necessities of the case, avoiding all questions which

Cracked pot-sound may be easily produced in the healthy chests of young children where the walls are yielding and consequently the air is easily forced from one part to another.

The occurrence of this sound will point to the presence of a cavity in the lungs, but care is required to exclude those cases in which it is due to other causes.

Sense of Resistance.

In percussing a perfectly normal chest a yielding or springing sensation is felt due to the elasticity of the thoracic walls. It is felt to a certain extent all over the thorax, but is much less over the areas occupied by solid viscera, than it those occupied by the lungs. Over the exposed surface of the heart and over the liver a sense of resistance is met with — the chest wall does not vibrate so freely, but feels as if a dead weight were struck.

The elasticity of the chest walls may be altered under various conditions affecting the walls themselves or the contained organs. Thus when the bones are thickened, the cartilages ~~fusty~~ ossified and the chest-walls drawn in or rigid the sense of resistance is greatly increased and the sensation of yielding is lost.

Also when consolidation occurs in the lungs from any of the causes which have been mentioned as causing dulness on percussion, when fluid is present in the pleura or even when the membrane is much thickened the sensation experienced resembles that produced by percussion over the liver or by striking a drum which has been damped by placing a resistant body below the parchment.

Increase in the sense of resistance corresponds to decrease in resonance or to dulness, and is experienced over those areas where the percussion sounds are impaired, but cannot be relied on to the same extent as the production of sound, in forming an opinion of the condition of the organ below.

Diminished resistance does not often occur but in cases where the quantity of air in the thorax is largely increased as in Pneumothorax and Emphysema it is sometimes observed. It is probably due to the fact that air in large amount is more easily compressed or thrown into vibration than when contained in the normal pulmonary vesicles. As so much depends on the condition of the thoracic walls, diminished resistence has no great diagnostic importance.

The Pitch of the Percussion-sound remains to be noticed

The pitch varies in different individuals so that no standard can be set down as normal. It also varies slightly with the condition of respiration and with the position of the individual, being higher at the end of deep inspiration and lower at the close of extreme expiration, while during ordinary quiet respiration it remains practically unchanged. The pitch, at least in the front of the chest, is lower when lying than when sitting or standing, probably due to the diminished tension in the thoracic wall in the recumbent position. The pitch is also different at different points in the chest, being slightly higher over thin portions of lung as over the apices and at the thin margins, especially those near solid organs, so that the note is higher near the liver on the right side, & over the thin borders of the lung overlapping the heart, on the left side.

In Disease the pitch may be lowered or raised. Lowering of the pitch occurs when the tension of the lung tissue is diminished, and the diseases causing this are "pneumonia & pleurisy of moderate intensity" (Traube, quoted Guttmann. loc. cit. P 89). In Pleurisy it occurs over partially collapsed lung above the exudation, and Pneumonia over the healthy tissue above the

consolidated area. This condition of the pitch is not invariable and occasionally it becomes raised over the same area from the increase in the tension of the chest wall, or from the decrease in the amount of resonant tissue.

Elevation in the pitch, accompanies tympanicity and also the approaches to absolute dulness, and never occurs alone. It is thereon of itself of no importance.

Phonometry - This is a method of testing the condition of the organs by tone produced when a vibrating tuning fork is placed, handle downwards in contact with the chest-wall. It was contented that the sound was loudly heard over organs permeable to air and feebly over solid organs. This method has never come into general use, as the results obtained were always open to doubt - and the amount of information gained, could easily be obtained by the other more convenient measures we possess.

Auscultation of the Thorax -

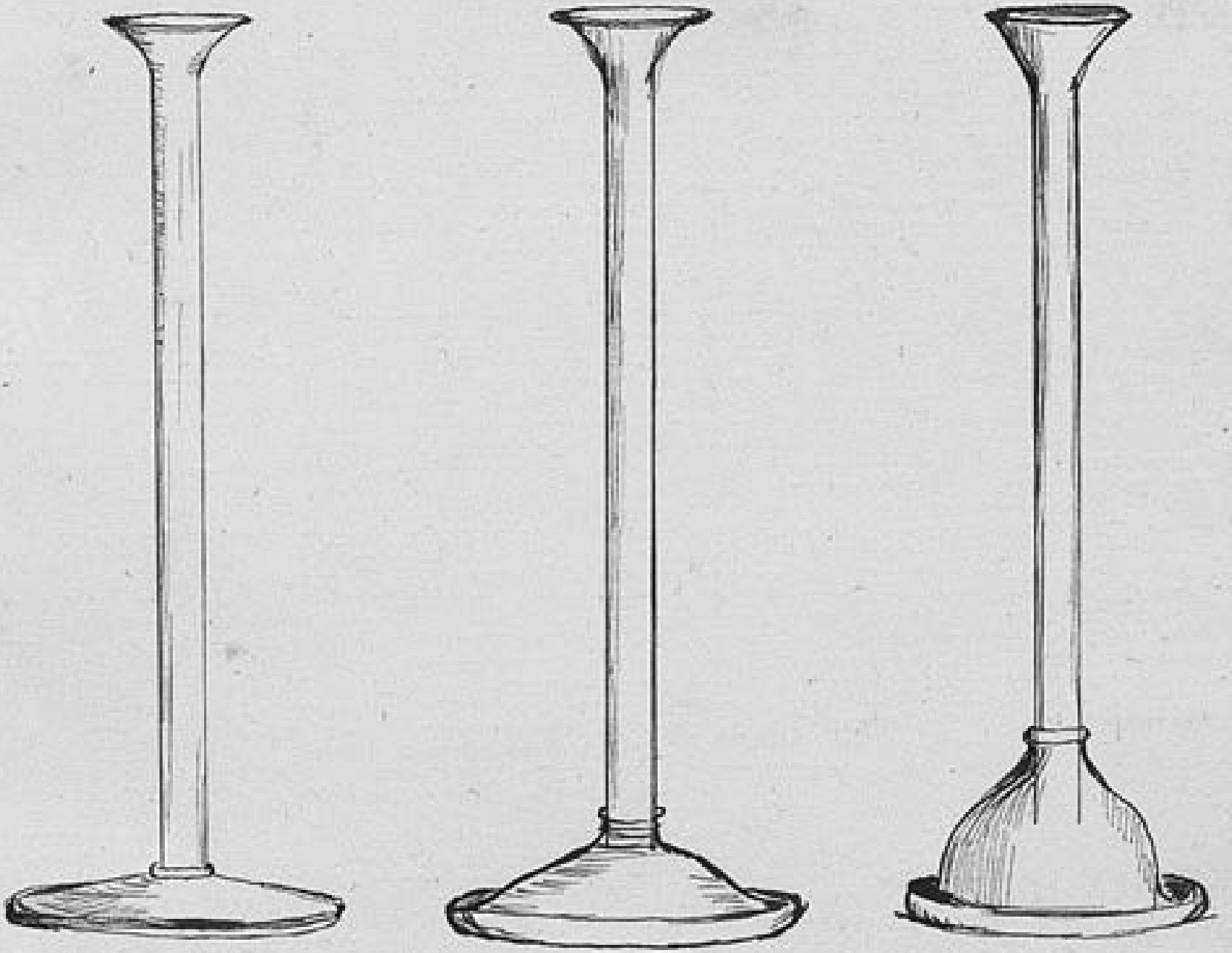
"By Auscultation is meant listening to the sounds produced in the thorax either with the unaided ear, or with some conductor". (Bristowe loc. cit P.351)

The patient should be so placed that the auscultator

can apply the ear or stethescope easily, and with precision, to the part under examination. He may be sitting, standing, or lying - the latter being very convenient for the examination of the front of the chest - but in auscultating the posterior surface, it is better that the patient should be seated or standing.

The skin should in all cases possible be uncovered but occasionally it is necessary to have some covering; when this is the case it should be thin and of some clinging material which will not occasion much noise by rustling or rubbing when the patient breathes.

Auscultation with the unaided ear - This method of examination possesses many advantages, but there are also many objections to its use which have caused it to be superceded by the stethescope. The sounds produced in the thorax are better heard and more correctly estimated when the ear is applied directly to the chest and there are fewer extraneous sounds produced with this method than when any instrument is employed. It is very useful when rapid examination is necessary especially of the posterior surface, when the weakness of the patient prevents his sitting for any length of time. Also when the patient is not fully undressed the ear applied to clothed surface does not cause the creaking and rubbing noises which the stethescope does, so that we are enabled to make a superficial examination, at all events, with less trouble to



Stethoscopes with various forms of ear-piece

Fig. 30

& the patient and a saving of time to the physician, a great point in general practice; in all cases, however, making a complete examination, when any abnormal or suspicious sounds are heard.

The disadvantages of using the unaided ear are that it cannot be applied to all surfaces as for instance to the apices, and cleanliness will often forbid its use in a class of patients and matters of delicacy in another.

The Stethoscope Fig 30. Discovered in the year 1816 by Laennec whose first stethoscope consisted of a roll of paper. The different forms of this instrument have now become innumerable. The chief objects aimed at in its construction are - good conduction lightness and portability.

There are three chief varieties of stethoscope

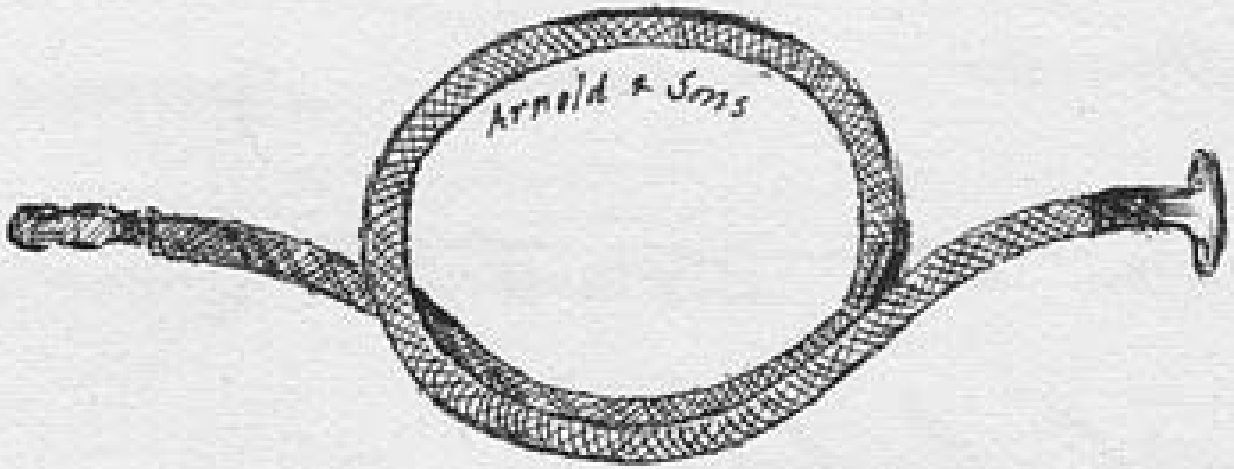
1 The Uni-aural for use with one ear of which there are (a) the rigid stem stethoscope and (b) the flexible.

2 The Binaural Stethoscope

3 The Differential stethoscope.

The rigid stem stethoscope in its simplest forme (Fig 30) consists of a column of wood or other material with expanded ends, one of which is applied to the chest, the other to the ear. From this simple form have arisen the multitude of varieties now in use. The stem is generally made thin and hollow, but some consider the solid stem to be a better conductor. The piece

Fig. 31




Flexible Clinical Stethoscope (Reid & Morrison's)

to be applied to the chest - is expanded, trumpet-shaped, the rounded extremity being about the size of a shilling, the edges of which must be carefully rounded, and in some instruments are protected with india rubber. The shape of the ear piece is a special point - with some physicians. The size of the disc should be sufficient to rest comfortably on the ear and may be flattened, slightly concave or bell shaped, the latter form being a favorite with some as the sounds are said to be amplified and more easily heard. The instrument is made of different kinds of wood, of ivory, caoutchouc, metal, celluloid &c but it doubtful whether one material or one particular form has much advantage over the others, each observer as a rule hearing best with that form of stethoscope to which he is accustomed.

The flexible stethoscope - This instrument consists of a chest-piece similar to that of the rigid instrument - to which is attached a flexible tube ending in a rounded extremity which fits into the entrance of the meatus. It has the advantages that the ear piece remains in position while the chest piece can be moved rapidly from point to point; and auscultation can be performed without moving the patient, except for the posterior aspect of the chest; and the physician has no difficulty in applying the end of the stethoscope exactly, and little pressure is made on the surface.

Fig 32

Binaural Stethoscope

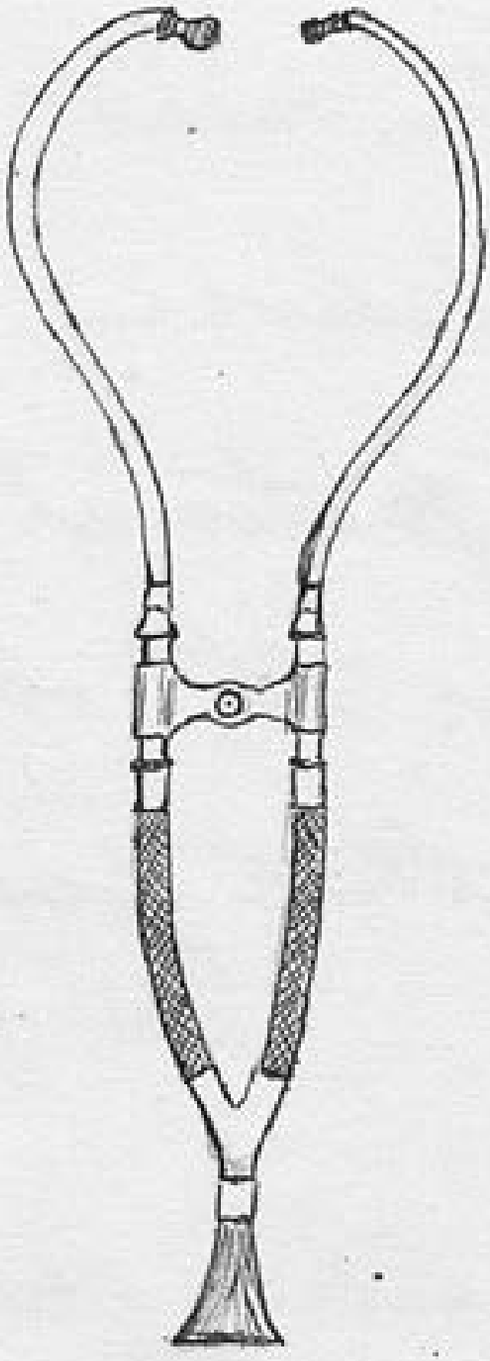
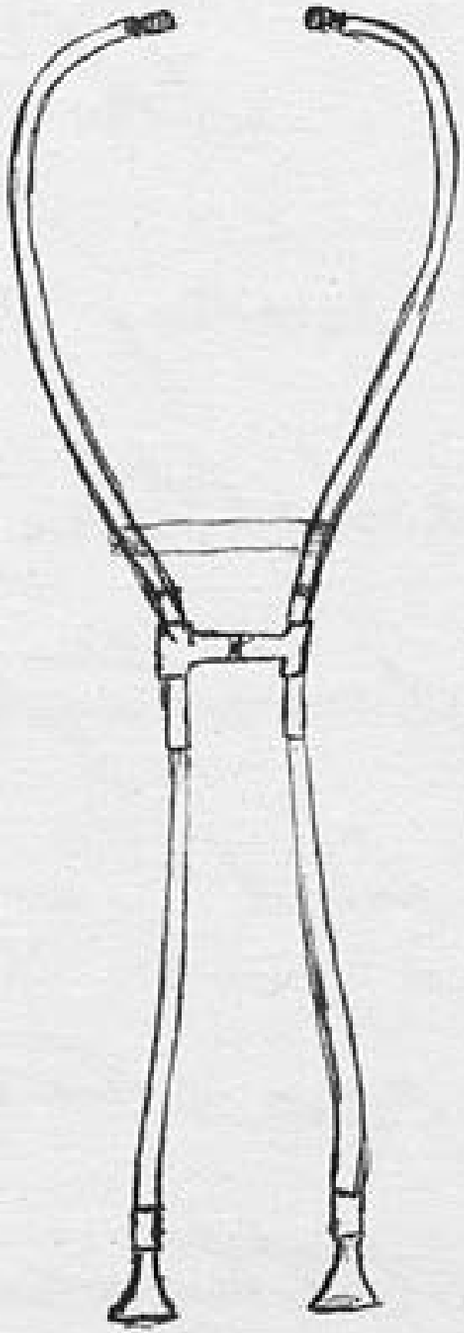


Fig 33

Differential Stethoscope



The Binaural Stethoscope (Fig. 32) This instrument consists of a single chest piece as in the last form to which is attached a short flexible tube connected with a metal tube which divides into two branches, which when the instrument is in use lie one on each side of the head, their extremities being curved inwards and embraced one into each ear. Of this instrument there are many modifications and it is made so as to be convertible into the differential stethoscope

The advantages of the binaural stethoscope are — Ease and rapidity of examination, greater intensity of sound and greater nicety in the localisation of sound.

The disadvantages are — noises are occasioned in the ears by the presence of the tubes; and extraneous sounds are very apt to be generated by the slightest movement of the instrument or by the hand holding the chest piece.

The differential Stethoscope (Fig. 33) resembles the last instrument but each ear tube is continued separate and provided with a distinct chest-piece. With this instrument it is possible more exactly to differentiate the relative intensity of sounds, and also the time of their production, it is therefore of more value in the examination of the heart than of the lungs.

Rules to be observed in auscultation.

1 The room should be as quiet as possible, and if silence cannot be obtained it is useful to block the ear to which

the stethoscope is not applied.

2 The chest should be uncovered except where exposure would be likely to injure the patient.

3 Make as little pressure with the stethoscope as possible

4 Make the examination in a regular and systematic manner, always comparing the sound on each side, with that opposite.

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Normal Phenomena of Auscultation

There are two distinct types of sound heard in auscultating the normal chest - namely (a) the tubular or bronchial murmur and (b) the vesicular murmur.

(a) The Tubular Murmur. If the stethoscope be applied at any point in the course of the trachea or over the division of the bronchi a loud, harsh murmur of a blowing character is heard, similar to that produced by pursing the lips together and blowing with sufficient force to make a noise but not so strong as to produce a whistling sound. The intensity of the sound diminishes slightly as we proceed downwards, and is lost over the substance of the lungs. The Inspiratory sound is louder and rather longer than the Expiratory sound being heard up to the close of Inspiration, while the Expiratory sound is heard only at the beginning of Expiration and dies away towards its close, a distinct pause separating the Expiratory from the Inspiratory

murmur —

Production of the Tubular murmur. Air passing through a tube at a low pressure, and if there be no inequalities in the walls of the tube, produces no sound, but if the air enter forcibly through a narrow orifice, either a distinct musical sound is produced or a noise of a rough blowing or hissing character. In the Trachea and Bronchi so long as their walls are healthy no sound can be produced, unless the air be driven through them at a much greater pressure than occurs during respiration, when their walls might be made to vibrate and produce a sound, but as the air passes through the narrow opening of the glottis, it is thrown into indefinite waves by the lax vocal cords and the blowing sound above described is produced. This sound is heard loudly and clearly over the Larynx and there can be little doubt that the Tubular murmur is simply the conduction of the laryngeal murmur along the tubes. The greater intensity of the Inspiratory murmur is accounted for by the fact that in inspiration the sound is drawn towards the observer by the current of air and during expiration it is carried away from him.

(b) The Vesicular murmur.

The sound produced over the regions of the thorax occupied by the substance of the lungs, by the air entering the air cells is a gentle sighing character and has often been likened to the sound produced by the "rustling of the

may appear to the patient of a prying nature and if any such should be necessary their object should be explained.

V Avoid by word or deed offending the modesty of the patient.

V If the result of the examination be favourable the patient should be told at once, but if not it is better to give a guarded reply to the patient himself, ~~not than by~~ (for the physician) taking away hope, to aid in bringing about the fulfilment of his own prophecy. "It is cruel to banish from the sick man's bedside, his sole remaining comfort; it is unmerciful to scare away hope - his only consolation during hours of pain and watching. We ought never to allow any expression to escape from us which could possibly add the terrors of apprehension to the weight of actual suffering" (Graves' Clinical Medicine P. 9 Syd. Soc.). If danger be present, one of the relatives or attendants may be informed, and only when the patients affairs are not settled should the dangerous nature of his case be laid before him, or when, as in some cases of heart disease, it is necessary to warn him, so that he may exercise due care and caution in his mode of living.

VI The Length of visit and frequency of visits are questions which must be settled on the merits of

leaves in the evening breeze". It can be produced by gently drawing the air inwards with lips almost closed. This sound is heard with slightly varying intensity over the whole substance of the lungs. With quiet respiration the sound is very faint and heard only on inspiration, but if the respiration be deeply drawn and with some force, the vesicular murmur is increased in intensity and is heard with expiration at its commencement, but always faint and partlyceases, as it were, then the inspiratory murmur and only if the chest wall be thin and capable of conducting sound well. The presence of the vesicular murmur shows that the part of the lung over which it is heard is permeable to air and if symptoms of pulmonary disease are absent it is fair to conclude that the lungs are healthy, but disease may advance considerably without causing alteration in the sound, if the area affected be small.

Production of the Vesicular murmur.

The various theories as to the causation of the vesicular murmur may be briefly stated.

1st That it is produced by the conduction of the laryngeal sound along the bronchi and bronchioles, unaltered in character but diminished in intensity and that the sound is broken up in passing through the air cells.

2nd That the sound is produced in the finer air tubes and modified by the movement of the air in the vesicles as they expand. It is not improbable that the cause of the murmur is to be found by combining these two theories and that both enter into the production of the murmur

3rd That it is due to the sudden tension of the walls of the air cells as they expand. The air is drawn into the lungs by the expansion of the pulmonary vesicles and the tension produced thus will with the entrance of the air throw them into vibration and produce a murmur, just as the heart sounds are produced by the tension of the valves.

4th That it is caused by the friction of the air against the walls of the alveoli

5th That it is caused by the vibration of the air entering the ~~wide~~ comparatively wide alveoli from the narrow bronchioles.

It is impossible to say certainly which of these theories is the correct one, as the amount of sound produced by each of the different causes mentioned cannot be estimated as it is impossible to test them separately. The sound is loudest and best heard when the chest walls are thinnest and the lungs most fully expanded, as in the infraclavicular regions. It is feeble in those places where the amount of lung present is small and not well expanded, as over the apices in the supraclavicular regions, and where the covering of the thoracic walls is thick, as over the scapulae. It varies according to the strength with which respiration is carried on, the sound being soft when the respiration is quiet and placid, but harsher and louder if the breathing be deep & hurried. In children the murmur is always much harsher than in adults, the normal soft murmur being acquired about the time of puberty or even later.

Alterations in the vesicular murmur.

Increase in loudness - This occurs when the coverings of the chest become thin, but is of no diagnostic importance in the absence of other signs -

Roughness or Harshness - This character is developed in the murmur when the bronchial mucous membrane is thrown into folds which by their vibrations produce a murmur in the tubes, heard over a large or small area of the chest - according to the extent of the bronchial catarrh. The vesicular murmur is either obscured by this fresh sound, or if the "conduction" theory of its production be true, it is simply altered in character.

A harsh murmur occurring equally over the two sides of the chest - in an adult - points to catarrh of the bronchii — the presence of cough &c will generally suffice to make the diagnosis certain

A rough murmur over a limited area, as in one apex is a sign strongly suspicious of incipient phthisis. Experience shows "that catarrh of the apices has a peculiar tendency to attack the walls of the bronchi and their lateral and terminal alveoli" The catarrh extends along the bronchi and a harsh murmur is sometimes produced long before the condensation has extended sufficiently to be discovered by percussion or auscultation (bronchial breathing or râles).

A harsh murmur is also heard with expiration in cases of bronchial catarrh and indicates that there is some difficulty in the air leaving the lungs, and for this reason

the murmur is prolonged, and may equal or even exceed the length of the inspiratory murmur. Rales and Rhonchi are generally present with both sounds.

Prolonged expiratory murmur is heard in condensation of the lungs, and in emphysema when bronchial catarrh is present.

Diminished vesicular murmur - The sound is diminished in loudness when from any cause the thoracic walls fail to conduct the sound clearly. Thus when fat is present in large quantity or the muscles largely developed, the murmur is only faintly heard. Similarly when the pleurae are thickened or a thin layer of fluid or air separates the two surfaces the vesicular murmur though still heard with inspiration is greatly diminished in intensity, but if the amount of fluid or air be large the vesicular murmur is abolished.

The sound is likewise lessened when any obstruction to the entrance of air exists as when the trachea or bronchi become contracted by cicatricial tissue. The presence of a plug of mucus in a bronchus will diminish, and, if the obstruction be complete, abolish the sound altogether.

Interrupted or waving respiration.

Even when the lungs are perfectly healthy if the breathing be very slowly, the murmur heard with inspiration instead of being continuous, is broken and jerking; the explanation being, that the lobules of the lung do not expand equally one part being fully distended before the air has begun to enter the other. This phenomenon is absent when the

inspirations are made quickly so that the whole lung becomes expanded almost simultaneously.

Interrupted respiration occurs in disease when the apices or other limited area of the lungs becomes partially infiltrated and the air passages slightly obstructed. The air does not enter the air cells fully but in a broken and jerking manner. After coughing this disappears and after a time returns. It is not absolutely diagnostic but if heard over a particular area for some time it points strongly to commencing caseation in the part when it is heard, and is especially important in members of a family where phthisis has occurred.

Bronchial or Tubular Respiration

Sounds of a blowing, rushing or 'tubular' character, as it is termed, have already been described as occurring over the trachea and primary bronchi. As soon as the tubes becomes embedded in the vesicular structure of the lungs the sound is lost, but doubtless were the ultimate bronchial divisions exposed and some conducting apparatus applied between them and the ear, similar sound but diminished in intensity would be heard. Under certain circumstances this tubular or bronchial sound can be heard over extensive or small areas of the lungs. In the normal lung the bronchial sound is obliterated or altered in character by passing through the vesicular substance but when bronchial breathing is heard, the

condition is reversed the vesicular murmur is lost and the tubular sound is conducted to the ear.

The suppression of the vesicular murmur is not the only condition necessary, for this occurs in pleurisy when fluid is present without the production of tubular respiration, but a good conducting medium between the bronchial tubes and the chest wall must be present and this occurs under the following conditions:—

1 In condensation of the lung substance, as in Pneumonia, croupous, catarrhal or interstitial. In the caseous degeneration of Pneumonic Phthisis.

2 In Compression or carnification the result of pressure - Pleurisy, Empyaema, pneumothorax and Collapse of lung substance from other causes.

3 In pulmonary cavities - Bronchiectasis and excavation of lung substance.

4 Tumours in the lung substance

(1) In croupous Pneumonia and in the more chronic varieties, the sounds on auscultation are bronchial in character, so soon as the air cells are filled with exudation. In acute croupous Pneumonia it is heard as red hepatisation advances and so long as the stage of grey hepatisation lasts - passing off as resolution occurs. In catarrhal and interstitial pneumonia it is not so evident as in the croupous variety and is only present when the areas infiltrated are sufficiently large. In cirrhosis of the lung the respiratory murmur

over some areas is bronchial while over others it is cavernous or amphoric showing the presence of dilated bronchi or excavations. The distribution of bronchial breathing is often distinctive. In pneumonia (croupous) the area where it is heard is generally confined to the lower lobes of one side - In catarrhal pneumonia the areas of bronchial respiration are scattered and often surrounded by regions where the auscultatory sounds are normal. In phthisis the apices are the parts most affected and therefore it is in these regions we most frequently find bronchial breathing.

(2) When the lungs is collapsed owing to the presence of fluid or air in the cavity of the pleura, tubular breathing may sometimes be heard over the compressed lung. The bronchial tubes must however be patent, not blocked by secretions or collapsed by pressure and the carnified lung must be in contact with the chest wall. The sound can only be heard above the level of the fluid and is most often heard when the lung is partly bound by adhesions to the chest wall. Bronchial breathing is heard subject to the same conditions as regards the bronchii and position of the lung in pneumothorax and empyema. The lungs may be partially collapsed by other causes

such as the presence of a tumour either mediastinal or in the lung substance, by great hypertrophy or dilatation of the heart, or by the presence of an enormous pericardial effusion. Here the area when bronchial breathing is heard is limited to the parts surrounding the cause of compression, and the quality of the respiratory sound will depend greatly on the relation of the larger bronchi to the condensed area

Pulmonary cavities — Tubular breathing or one of its varieties - cavernous or amphoric breathing may generally be heard when excavation has taken place. ~~In~~ ~~[illegible]~~. For the sound to be purely tubular the cavity must not be too large, the walls must be firm and smooth, ~~[illegible]~~ the condensed tissue surrounding it must reach to the surface of the lung, and the cavity must be in free communication with a bronchus. If the cavity be of large size the sound is generally cavernous, if the walls are ragged and uneven the sound loses its tubular character and is of an indefinite nature, while if the cavity lies under a layer of healthy tissue or the bronchial tube be plugged, the sound is lost —

altogether. Tubular breathing is not absolutely diagnostic of a cavity as it may be produced by a bronchus passing through a mass of condensed tissue, but, when heard in the apices, it forms an important item amongst the phenomena which indicate the existence of a cavity.

Production of Tubular Respiration.

(1) Conduction of the Laryngeal sound – Under ordinary conditions the tubular sound, propagated through the tubular parts of the lungs, is lost in passing through the vesicular substance, but when condensation takes place by collapse of the air cells or by their distension with exudation the breath sounds are conducted unchanged to the ear. That the condensed tissue is a better conductor of sound is shown by the heart sounds being heard over regions where normally they are inaudible.

(2) That the sound is produced by the movement of the air through the tubes in the condensed tissue.

When the tissue of the lung is consolidated little or no air is drawn into the affected part, so that the current of air cannot be sufficiently strong to cause the loud sound which is heard, for example over a pneumonic lung.

3rd Skoda's Theory - That the laryngeal sounds are taken up by the bronchial tubes and increased in intensity by their consonance. The theory rests on the fact that if a note be struck in the neighborhood of a resonator or body capable of vibrating in the same Key, the sound is reproduced and in some cases increased in intensity. This may be true of musical tones but the laryngeal breathsounds have no musical value and the bronchial sounds, heard over the thoracic surface, except in the metallic sounds heard over some cavities, have none either, and the sound is not louder than that heard over the larynx.

The first explanation is probably the correct one - The air tubes serve simply as sound conductors, as a speaking tube or a stethoscope does, and the consolidation of the lung tissue obliterates the normal vesicular murmur and conducts the sound practically unaltered to the ear.

Cavernous, Amphoric, or Metallic Breathing. This is a variety of Bronchial breathing and is more or less tubular in character, with the addition of a distinctly metallic or musical ring. The sound resembles that produced by blowing over the mouth of a jar or bottle - hence the term "Amphoric"

of each individual case. A visit should be long enough for a thorough examination to be made, without appearance of hurry or carelessness, and after the necessary instructions are given, the sooner he leaves the house the better, though a few minutes of general conversation are a kindly conclusion to a physicians visit. Visits should not be so frequent as to deserve the imputation of making more than are required, nor so few as to give suspicions of neglect - but no definite rules can be given.

"The liability to err in the number of visits is in making too few rather than too many for the reason that Physicians are generally sensitive in regard to an imputation of making more than are required" (Flint. Clin. Med. P58).

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## Sources of Error in Diagnosis.

(1) Insufficient facts:—

As a rule the difficulty does not lie in the patients reticence but rather in his verbosity. He has a tendency to give too much information, though often not of the kind that is wanted, but puts forward his own ideas of the case, and does not give straight forward answers to the questions asked.

Exaggeration of symptoms is another difficulty, some people delighting in talking of their sufferings

It is heard with both inspiration and expiration, but generally better with one than the other, most often with inspiration alone. The metallic sound heard as an addition to tubular breathing is diagnostic of the presence of a cavity, but its absence does not disprove the existence of such a cavity.

The sound is produced either entirely by the reverberation of the sound produced by the air entering the cavity, or by consonance of the walls of the cavity with the laryngeal sound. It is best heard over large cavities but may be produced in those of small dimensions such as the size of a walnut, and for its production, a free communication with a bronchus is necessary especially if the sound be due to the resonance produced by air entering the cavity; — if it be due to consonance alone such a communication is not necessary.

The sound is lost or modified by the presence of a large quantity of fluid, and ~~in some instances it is lost~~ by the plugging of the bronchus leading to it or passing near the cavity, the sound returning when the plug is removed by coughing.

Cavernous breathing may sometimes be heard in

pneumothorax where the opening from the lung is free and the current of air sufficient to throw the air in the pleural cavity into reverberating waves. Its occurrence is rare.

This sound has also been heard in dyspnoea by the respirations being made with the mouth wide open, the sound being lost when the mouth was closed.

"Friedreich asserts that in some aged persons an "amphoric respiratory murmur may be heard "between the shoulder blades unconnected with "dyspnoea — no cavities being present" Guttmann (loc. cit. P. 141)

The sounds heard on Auscultation cannot always be classed as vesicular, bronchial, or cavernous but may partake of the characters of one or other of them; thus we have an "impaired vesicular" murmur or a sound "somewhat bronchial", or broncho cavernous, or the sound may be obscured by the accompanying sounds (râles'). These indefinite sounds are sometimes classed separately as 'Indeterminate murmurs'.

They may be due 1st to imperfect expansion of the lungs. This will account for the impure vesicular murmur, and if some consolidation be present, for the bronchial sound being imperfect.

2nd To complete or partial obstruction of the

bronchi - This will be sufficient to obliterate the sound altogether, diminish the intensity of the sound, or cause some additional sound to be produced.

3rd Abundance of the accompanying sounds - When these are present in great amount and loud in character the breath sounds may be obscured. Coughing by clearing the tubes and vesicles, followed by a deep inspiration will often serve to clear up the nature of the sound

"The Entamorphosing Respiratory Murmur" (Gottmann P. 138)

"This is a modification of bronchial respiration and occurs with inspiration only. It is characterized at first by extreme harshness resembling the sound heard in stenosis of the bronchi." This harshness lasts about one-third of the inspiratory period, when it suddenly ceases and gives place, during the rest of the inspiration to bronchial breathing accompanied by a metallic echo, or to ordinary râles" - It occurs in cases of cavity, and is probably due to air entering the cavity through a narrow orifice diminished by mucous secretion which are removed by forcible inspiration dilating the orifice. It is not a constant symptom of cavity and in the majority of cases is absent - "Much more frequently than in excavation of the upper lobes a respiratory murmur which resembles it thus far, that it begins with a short, sharp hissing sound, followed by râles and indeterminate respiration"

The Accompaniments of the respiratory sounds.

Râles and Rhonchi

In the healthy lungs there are no sounds heard except the Bronchial and Vesicular murmurs already described but when pathological changes occur which increase the amount of fluid present in the tubes or air cells, or cause swelling of the mucous lining other sounds are added. Râles, crackling or bubbling sounds, are produced by the bursting of air bubbles, which are produced whenever the tubes or alveoli contain fluid and it is a matter of indifference whether the fluid be mucus, serum, pus, or blood. Rhonchi, snoring or whistling sounds, are produced by narrowing of the lumen of the air tubes and may be the result of swelling of the mucous membrane or of viscid mucus adhering to the walls of the bronchi.

Râles are described according to the apparent size of the air bubbles producing them, large, medium or fine râles; or according to the character of the sound produced, bubbling, gurgling, crepitant, subcrepitant and mucous râles -

The stage of respiration in which they occur - Rales produced in the larger tubes, when fluid is of large amount - and the breathing strong, are heard both with inspiration

and expiration and throughout the whole of both acts; when fluid is not so abundant they are only heard towards the close of inspiration and at the commencement of expiration. In the smaller tubes this latter is also the time at which the râles occur, Sometimes they only occur with inspiration and occasionally only with expiration Râles produced in the alveoli are heard at the end of inspiration only, and sometimes only when the respiration is deep.

Fine râles - Fine crepitation. This sound produced in the alveolar cells or finest bronchioles resembles the noise made by rubbing a piece of hair between the fingers. For the production of this sound the presence of fluid and the bursting of bubbles is not necessary, but it is often caused by forcible expansion of the air cells, whose walls are rendered adhesive by secretion. Sometimes it may be heard on very deep inspiration, over the apices or thin margins of healthy lungs. Fine crepitation uniform in size is heard during the first stage of Pneumonia before condensation is complete, and during the stage of resolution, and may be regarded as diagnostic of that disease. This form of crepitation is unaffected by coughing during the 1st

stage, but during resolution ~~they~~ may be lessened or increased slightly. In the first stages of condensation in Phthisis fine crepitation is heard but the râles are not uniform in size, and only a few are heard at once, Bronchii and larger Crepitations, produced in the tubular structures, being heard at the same time.

A few isolated crepitations in one apex are always highly suspicious of commencing phthisis especially if cough & emaciation are present, but as already mentioned these sounds may sometimes be heard in healthy lungs.

Fine crepitations are also produced in the larger tubes ~~from~~ by the bursting of minute air bubbles but the majority of the sounds are larger in size, when produced in the finer tubes are also of a mixed character.

Medium sized râles, or sub crepitant râles, are often heard over the greater part of the chest in bronchial catarrh. They are caused by the presence of fluid in tubes of medium size and in the larger bronchii. In the smaller tubes the lesser râles predominate and only few of larger size are heard while in tubes of larger calibre the râles are almost all of large size.

Large or coarse bubbling râles - Gurgling. These sounds are produced in the trachea and large bronchii, and are heard in those situations, but from their loudness can

sometimes be heard at some distance from their source. They may be heard previous to act of coughing when a large amount of fluid has accumulated, but are of more importance in those cases where from extreme weakness the patient cannot expectorate.

Medium sized and large râles are heard whenever fluid is present in the bronchi but are most often produced by bronchial catarrh when the secretions have become fluid. They are also heard in cases of pulmonary cavities in which there is a collection of fluid.

The amount of crepitation and number of râles depend greatly on the quantity of fluid present in the tubes, - if the amount of fluid be large the number of râles will be increased, and when little fluid is present only a few râles can be heard. In Pneumonia the crepitation will depend on the expansibility & freedom from secretion of the vesicles, the râles being lost when the air cells are filled with exudation.

The abundance or scantiness of the râles depends also on the character of the respiration the number being always greater if the respiration is deep and energetic, and scanty when the contrary conditions are present.

Position in which they are heard. In listening over

the chest, it does not follow that the sounds heard are produced in that part of the lung over which the stethoscope is placed. Generally speaking the sounds are best heard, the nearer the stethoscope is placed to their source, but they may be conducted with scarcely diminished intensity to some distance. The râles produced in one lung are rarely if ever heard on the opposite side, and if râles are heard on both sides it is probable that they have been produced in both sides. The loudness or intensity of the râles is affected by the same conditions as other sounds. They are louder when the parietes are thin, than when they are thick & loaded with fat, and if a good conductor of sound, such as condensed tissue, lie between the surface and the bronchus when the sound is produced, they are always louder than when the sound passes through cellular tissue. The râles conducted through consolidated tissue often have slight musical resonance and are somewhat higher in pitch than those conducted through air containing tissue, when they are low, and without musical quality. The most resonant râles are those heard over cavities.

Metallic Râles. These sounds resemble in miniature the sounds produced by water dropping from the roof of a cavern into a pool beneath. They only occur in cavities and most frequently in those of large size

For their production the walls of the cavity should be firm and smooth and the cavity near the surface, communication with a bronchus is not necessary. The rales have a distinct musical value and pitch. All the sounds over the cavity in which they exist have a similar sound, the breathing is amphoric, the percussion sound is also amphoric, both having a metallic ring and the voice sounds have the same character. Metallic sounds, when heard, indicate the presence of a cavity but their absence does not exclude the possibility of the existence of a cavity

Metallic Tinkling. This sound may be heard in large cavities, by the bursting of isolated bubbles, but most frequently it occurs in pneumothorax with pleuritic effusion or in hyp-pneumothorax. It resembles metallic crepitation but the number of sounds is less and they are generally louder and deeper.

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Rhonchi. When the bronchi are narrowed by contraction of their muscular fibres, by the constriction of fibrous bands round them, by swelling of their mucous membrane or by the adhesion of viscid secretion, the air passing through them frequently produces a somewhat musical note. The sound produced in the larger tubes is deep and of a rough snoring character, that, in tubes of less diameter, of a whistling, sibilant nature. They are heard both with inspiration and expiration and are often loud enough to be perceived by the patient or

those at a little distance from him. The sound varies with the size of the tube and the size of the aperture through which the air passes. Besides the varieties mentioned they sometimes have a cooing, sighing or moaning character. The sounds are wanting when the lumen of the tube is entirely closed and if the vesicular tissue to which it leads is infiltrated and not pervious to air. Most frequently bronchi are indicative of the 1st stage of bronchitis, but they are present in asthma and various stages of catarrh. They are often altered or obliterated by coughing.

The Cough as an aid to Auscultation -

As incidentally noticed, the act of coughing by clearing the tubes, causes marked alteration in the sounds heard. The number of râles heard may be diminished, or râles not previously heard may be recognised. This is due to several circumstances. By coughing the fluid may be driven together into a smaller space, the respiration after coughing is deeper and so the fluid is more agitated. In cavities also the metallic râles may be heard only during the act of coughing as in the case where no communication with a bronchus exists, or the cough by clearing out the accumulated secretions from

the number of Doctors they have seen and wilfully invent ailments in order to provoke sympathy. An incorrect version of a previous Medical attendants views is so often seen that many physicians make a rule to disregard these unless they see positive evidence of their correctness.

2) Incorrect or insufficient observation

This is not infrequent in young practitioners and is due to want of care in examination generally, but may be owing to want of familiarity with the physical signs in health and disease, which can only be attained by careful clinical study. The most common error is to overlook the presence of disease, more chronic and less marked, perhaps, than that for which the physician was consulted, and which may have remained unknown to the patient himself. For example a small aneurism might easily be overlooked by any one examining a case of Bronchitis.

(3) Incorrect deductions.

To lay more stress on one set of symptoms, and to neglect the evidence of others, are not uncommon sources of error, and are generally due to a too hurried examination of the facts of the case. By taking time to consider

the cavity will allow amphoric sounds to be produced which before were absent. The act of coughing also by removing an obstructing plug of mucus will cause the breath and voice sound to be heard over the area supplied by that bronchus. In Pneumonia for example the breath sound may be absent because the bronchus leading to the affected area is occluded by mucus; an energetic cough will sometimes dislodge the plug and allow the tubular breathing to be heard.

A cough is also useful to determine the conduction of sound through the lungs. This is generally estimated by the voice (vocal resonance) but sometimes it is difficult to get patients to speak, especially with children, and the cough sounds, either voluntary or involuntary, may be used instead.

Auscultation of the Voice – Vocal Resonance.

The distinctness with which the sounds produced by phonation are conducted to the ear is important, from the differences that occur in pathological conditions. When the lungs are healthy the articulated words cannot be distinguished when the stethoscope is applied to the chest; but the laryngeal note

is heard as an indefinite humming sound of various intensity, over the different areas of the chest - Over the larynx the sound is loud and startling, over the trachea the same sound is heard but diminished in intensity, and over the vesicular substance of the lungs the note is faint - but is more clearly heard in front than behind. and at the upper part of the chest than lower down - The conduction to the ear depends on the same conditions as vocal fremitus does to the hand. It is better heard when the walls are thin, when the voice is deep and loud; and only faintly heard with a high pitched weak voice especially if the parietes are thickened. The vocal resonance heard over the trachea & large bronchi is termed Bronchophony - the articulated words heard when the patient whispers is termed Pectoriloquy.

The Voice sound in disease - Bronchophony, Pectoriloquy and Aegophony.

Under certain circumstances the laryngeal note is heard with almost the same distinctness as when the stethoscope is applied to the larynx. When this occurs as in the production of bronchial breathing one of two

conditions must be present – either condensation of the lung substance, or a cavity. The sound is conducted along the tubes, through the consolidated tissue and thence to the ear. The two sides of the chest should always be compared, especially if the bronchophony be only heard in a minor degree and it is important to observe whether the increase in the sound corresponds to those areas where naturally the laryngeal sounds are well heard, or whether it is heard where normally the sounds are only faintly heard as at the bases.

Bronchophony over a cavity may be due either to good conduction of sound by the dense tissue round it, or to consonance of its walls with the laryngeal sound.

Bronchophony is heard in all forms of consolidation in pneumonia, phthisis, or tumours of the lungs or when there is a cavity.

Pectoriloquy – The articulate words may be heard when the patient whispers, as then the sound of the laryngeal note is omitted, the whispered words being formed entirely in the mouth. The sound is so distinct that it appears as if it were

spoken directly into the extremity of the stethoscope. It is generally heard over those cavities which contain little exudation and where the bronchus has a free communication; but may also be heard when these conditions are absent, and is heard over consolidated lung tissue.

Ægophony – The "goat-voice"

This peculiar modification of the voice sound appears to be produced by the sound passing through a thin layer of fluid – In cases of pleurisy as the exudation rises, the lung becomes collapsed, and over the unexpanded tissue bronchial breathing is heard with bronchophony or pleuration, but just at the upper limit of the fluid where the layer is very thin, the voice sound to assume a peculiar bleating character, like the bleating of a goat, or the squeak of "Punch". The sound disappears when the fluid increases, and may sometimes be heard again as absorption occurs.

Friction Sounds – The sensation perceptible by the hand, is audible to the ear on auscultation. Friction commences as soon as the pleural surfaces become roughened and ceases when exudation is established – The sound heard is a to-and-fro

murmur, sometimes rough and crackling, at-
others only of a slight crackling nature easily
confused with larger râles-

The points of difference are the following
Pleurisy is accompanied by pain in the side when
a deep respiration is taken
Catarrh or the presence of a cavity does not cause pain
and pneumonic crepitation is not likely to be mistaken.
In Pleurisy there is no evidence of the presence of
moist sounds and the friction sounds are
unaltered by coughing; while in the other conditions
moist sounds are always to be heard, and these
and the rhonchi which might be mistaken for
friction are altered by coughing.
When Pleurisy is complicated by catarrh the râles
may hide the friction sound and it is only by
the pain that we are led to suspect pleurisy & by
the rise in temperature which occurs, until the
presence of fluid & dulness on percussion render
the diagnosis certain.
The friction sound is increased by pressing the
end of the stethoscope into an interspace, and can
sometimes be heard thus when otherwise inaudible,
other sounds resembling friction and likely to be
mistaken for it are not intensified by
pressure

Succussion Shaking the patient

Splashing sounds similar to those heard when a vessel containing fluid and air is shaken, are heard in the thorax under similar conditions. No splashing is heard when air or fluid ~~are present~~ alone is present; but when the pleural cavity contains both, as in pyo-pneumothorax, or in pneumothorax with serous exudation, it is distinctly heard when the patient changes his position or shakes himself. The sound is generally audible without applying the ear or stethoscope to the thorax, but in doubtful cases this procedure should be adopted.

Splashing sounds are also heard over large cavities but not very frequently & the sounds produced by shaking differ little from those produced by violent coughing.

Diagnostic Puncture —

In cases where the existence of fluid is doubtful, or when it is uncertain whether the fluid present is fluid or pus, puncture with a fine needle enables a correct diagnosis to be made. A fine needle attached to an ordinary hypodermic syringe may

be used and the puncture made in an interspace below the level of the fluid - In the seventh space near the angle of the ribs is a very common situation. The operation should be done with all antiseptic precautions, and if pus be suspected, it is as well to be prepared either to draw off the fluid by aspiration or to make a free opening and drain the cavity.

In pericarditis where pus is suspected, puncture with a needle or fine trocar is useful. The point of insertion of the needle lies in the fifth interspace just above the junction of the sixth rib with its cartilage. Others recommend the puncture to be made between the xiphoid cartilage and the costal margin. It may be sometimes necessary (when the diaphragm is much lowered) to puncture in the sixth space. Care is necessary not to wound the heart or the internal mammary artery.

Physical Examination of the Heart.

Inspection of the Praecordial Region

The position of the heart with its relations to the lungs & has already been noticed in the anatomical description. The Praecordial Region extends roughly from the second space to the level of the sixth rib at its junction with its cartilage, and laterally from about an inch to the right of the right sternal border to the nipple line on the left side, that is about two-and-a-half inches external to the left sternal margin

On Inspection we notice the form and configuration of the Praecordial region; the position, extent &c of the apex beat; the condition of the integuments.

1st The Praecordial region — The presence of the heart in the thorax is not marked, in the normal condition, by any change in form, no bulging or contraction, no expansion of the interspaces — the left side is absolutely symmetrical with the right, and the only indication of the presence of the heart is the Apex beat.

Pathological Alterations — Bulging of the Praecordia.

This may be caused by changes in the heart or pericardium or in the lungs or other structures —

(1) The changes in Heart and Pericardium are:—

(a) Distension of the Pericardial sac by fluid in—

Pericarditis - If the amount of fluid be great the thoracic wall in front of the heart may be bulged forwards the intercostal spaces widened and distended, and if the walls be yielding, as in young or rickety subjects, the alteration will be increased - Bulging is only seen from this cause, if the pericardial sac is greatly distended, a moderate amount of exudation will not cause any displacement.

(b) Increase in the size of the Heart - The heart is increased in size by dilatation and by hypertrophy - Bulging of the praecordial regions is more apt to occur as a result of the over action of the heart in the latter, and is rarely of great extent.

(c) Forward displacement of the heart - When the heart is pushed forward by a tumour growing behind it, the pressure may be sufficient to cause the chest wall to bulge, but such an event is rare.

(2) Praecordial bulging from other causes.

(a) Pleurisy with effusion has been shown to cause enlargement of the whole ~~or~~ part of one side of the thorax and will involve the praecordial region, but a small localized pleuritic effusion may cause bulging of the wall in front of the heart.

(b) Mediastinal tumours may cause a forward protrusion of the praecordial region of the thorax, but this is seldom seen

(c) Superficial abscess, oedema, or tumour.

Swellings over the praecordial region of course cause local bulgings - Abscesses are painful, generally reddened, and usually present signs by which they may be easily distinguished. Oedema may be the result of local irritation such as inflammation of the bone, or it may be part of general dropsy - its cause is rarely difficult to determine.

Tumours may grow from the bones, cartilages or in the fatty tissue - their connections are easily made out - and of course no cardiac symptoms are present -

The matter from Empyaema may point at the praecordial region and might cause some doubt as to its nature especially if pulsation was communicated to it from the heart below - The history of the case, extended dulness on percussion and other signs will generally clear up the nature of the case.

(d) <u>Aneurism</u> - Aneurism of the first part of the arch may cause swelling about the level of the 3rd interspace or lower down - The swelling will pulsate and show the ordinary auscultatory phenomena of aneurism.

(e) The bulging may be congenital or the result of rickets

<u>Contraction</u> or <u>Depression of the Praecordial region</u>.

Contraction is not caused by any change in the heart itself

(a) Pericarditis - After the effusion of pericarditis has subsided if there be any adhesions between the two surfaces of the pericardium, a depression may be caused

all the points of the case and by making repeated examinations in cases of doubt or difficulty, such errors should be avoided.

4) Difficulties from other sources.

The presence of Complications, the absence of distinctive symptoms, obscure or false symptoms such as arise from Hysteria or the administration of drugs, idiosyncrasies on the part of the patient; will all tend in some cases to make the diagnosis more or less difficult; but by a painstaking physical examination and careful consideration of the symptoms present, such difficulties may generally be overcome; but cases occasionally occur which remain doubtful during the greater part of their course and some are only cleared up in the post-mortem room.

which is always most marked in young subjects, and if it occurs in adults, will be confined to the cartilaginous part of the chest-wall.

(b) Pressure from outside - continued use of a shoemakers last or some such instrument - will cause depression.

(c) Pluritic contraction -

(d) Congenital malformation.

The Position, extent and character of the cardiac impulse - The Apex beat.

With each systolic contraction of the ventricles a slight elevation is seen in the 5th interspace at a distance of two to two and a half inches from the left sternal border. This pulsation is known as the 'apex beat' though the apex of the heart very often lies behind the sixth rib, the difference however is so slight that the pulsation indicates with sufficient accuracy the position of the apex. The position of the Apex beat is most frequently in the region stated but varies slightly and may be found as low as the sixth interspace or as high as the 4th space, the latter being most frequent in children in whom also the beat often lies further to the left, sometimes as much as a quarter to half an inch beyond the nipple line. As the heart rests on the diaphragm, it falls and rises with the contraction and relaxation of that muscle and therefore the apex beat is lower at the end of inspiration, and higher at the close

of expiration. With inspiration sometimes the heart-s impulse disappears either because the pulsating area is drawn behind a rib or because the lungs expand and cover it. When the patient lies on his back it is not uncommon to find no pulsation, but if we place him on his left side or incline him on his face the heart can generally be seen.

Cause of the apex beat — The pulsation at the apex is due to a combination of circumstances and to one cause only. That the beat occurs at the apex and not over the whole heart is due to the fact that the apex of the heart lies close to the thoracic parietes and that part of its area occupies the position beneath a yielding interspace. If the heart be exposed during life, the whole surface heaves as the contraction occurs, but the base of the heart lies deeply in the chest and the greater part of the surface is covered by the lungs. As each systole occurs the muscular walls of the ventricles become thickened and the yielding tissue at the apex is pushed forwards, at the same time as the blood is propelled through the arch of the Aorta, that vessel tends to straighten itself and tilts and partly twists the apex against the chest wall. Both of these facts enter into the production of the pulsation at the apex. The thickening of the walls will account for the diffuse heaving which is seen in some cases of hypertrophy.

## Alteration of the Position of the Apex beat

The position is altered by changes in the situation or in the line of the whole heart, the result of alterations in the surrounding tissues or viscera; or to changes in the shape of the heart the result of alterations in the cardiac walls or cavities.

1st Change in position of the apex beat from causes outside the heart.

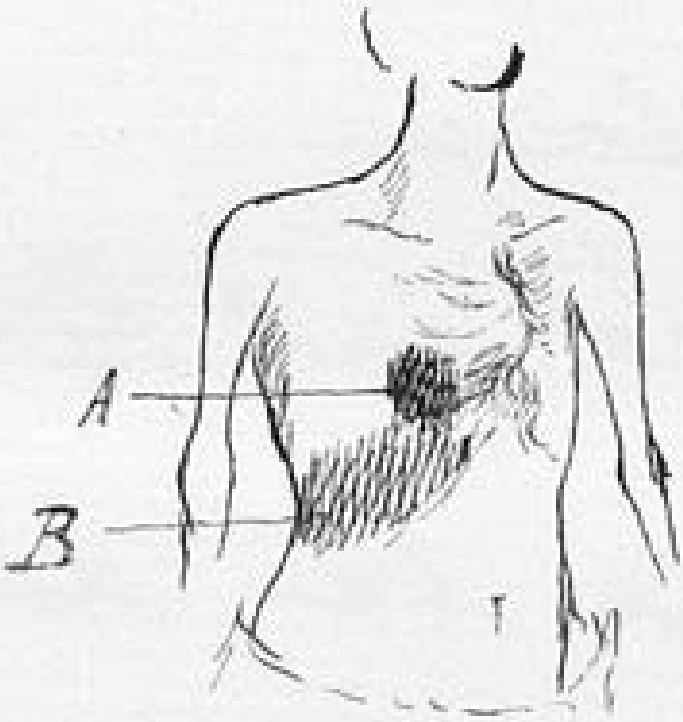
Upward or downward displacement depends greatly on the position of the diaphragm.

The Diaphragm is raised and carries the heart with it by enlargements in the abdominal cavity, tumours, ascites, enlargements of the liver, spleen &c, or it may rise as the thoracic wall contract in cases of non expansion of the lung after pleurisy & empyema. The heart itself may be raised when contraction occurs in the lung above it, as in the apices in phthisis.

Displacement of the apex beat downwards occurs when the diaphragm is thrust down by the accumulation of fluid in the left pleural sac, the heart at the same time being pushed to the right; or the apex beat may be lowered by the diaphragm falling in consequence of collapse of the abdominal viscera; the growth of a solid tumour above the heart will also displace the organ downwards.

The Diaphragm and heart with it, is displaced downwards by emphysematous lungs.

Fig 34




Case of right-sided heart-

The chest was much deformed, ribs thin and joints enlarged

A = Heart dulness

B = Liver dulness

displaced to the right or left - either by contraction of tissue which will pull it to the affected side or by swelling which will push it to the opposite side.

By effusion into the right pleura, or by solid growth on the same side the heart will be pushed to the left and the apex beat will be observed to the left of its usual position.

Fluid in the left pleura or solid growth will cause similar displacement to the right side.

By contraction of the lung on one side, such as occurs in cirrhosis or after the absorption of pleuritic effusion, when the lung remains unexpanded and adhesions have formed with the pericardium, the heart is drawn to the affected side while the compensatory expansion of the lung on the opposite side will push it in the same direction.

Congenital Malformation. The whole of the organs may be displaced the heart lying to the right side the liver to the left - such a case is related by Dr S. Bramwell in his work on the heart. Recently, I saw a case of right sided heart - a boy aged eight, who had been cyanotic from birth, in whom the heart lay on the right side above the liver. The lungs were fairly healthy and apparently the position of the heart was congenital. (Fig 34)

Backward or forward displacements are rare. A tumour in front of the heart or a volume of emphysematous lung will cause the former, while the latter will be caused by a tumour growing behind the heart, or contraction of the lungs pulling it forward.

Displacement of the apex-beat by changes in the heart-itself—

Alterations in the auricles do not cause any change in the position of the apex beat.

Hypertrophy or dilatation of the left ventricle will cause the pulsation to be seen more to the left and lower down than the normal position. In cases of very great hypertrophy the apex beat may be visible as low as the seventh or even eighth intercostal space and considerably to the left of the nipple line.

Enlargements of the right ventricle will also move the apex beat to the left, but never to the same extent as it is with enlargement of the left side, and at the same time pulsation will be visible further to the right of the normal position, and not consequently it is visible in the epigastrium.

## Extent of the Cardiac Pulsation

The normal extent of the pulsation does not generally occupy more than one square inch, or an area measuring one inch in the horizontal direction by the width of the interspace in which it occurs in the vertical direction. The extent of the pulsation may

be altered by changes in the heart itself, by changes in its relation to the chest-wall, or by changes in the surrounding parts.

Hypertrophy of the right or left ventricle will cause an increase in the extent of the impulse, which as a rule is proportionate to the amount of enlargement present. The pulsation may be distinctly visible in two or three spaces, while in extreme degrees of hypertrophy of the left ventricle, the whole of the praecordial region may heave. The impulse also extends to the left beyond the mammillary line, in hypertrophy of either ventricle, but most markedly in enlargement of the left side, and may appear in the epigastrium when the right cavity is hypertrophied or dilated.

When the heart lies further forwards or is so placed that more of its surface is in contact with the chest-wall the extent of the visible impulse is apt to be increased without any change in the heart, and is generally due to one of the displacements before mentioned.

Changes in the surrounding parts may increase or decrease the extent of the pulsation. Thus the voluminous lung of emphysema may diminish or abolish altogether the visible impulse, and the

may be unnoticed. When the lungs are contracted and more of the cardiac walls is uncovered the extent of the pulsation may be increased, but it is never, while the heart is normal in size, visible beyond the normal limits of the praecordial region.

In pericarditis with effusion a diffuse pulsation is frequently seen over the heart and the interspaces are bulged out or the thoracic wall prominent over the heart after the fluid is absorbed, if adhesions have formed between the two layers of the pericardium, the cardiac systole may be indicated by a retraction of the interspace instead of a protrusion.

Character and Force of the Apex-beat:

The strength of the cardiac pulsation cannot be fully estimated by inspection and its force is better observed by palpation. It varies even in perfect health between weakness and great strength. Changes in the strength of the heart's beat may be apparent or real, the former as a rule being due to changes external to the heart, while the latter are caused by changes in the cardiac economy.

Weakness of the apex beat. Apparent weakness of the impulse is due to similar causes to those on which the invisibility of the apex beat is dependent. These are - thickening the chest wall, backward displacement of the heart, overlapping

of the chest by lung distension (Emphysema), pleuritic effusion.

Real weakness arises from weakening of the cardiac muscle as in fatty degeneration, dilatation, myocarditis, general debility such as occurs in wasting diseases, syncope, or after great loss of blood. In all these cases the heart's impulse is weakened, because the muscular fibres, either from changes in themselves or in their nervous supply, cannot contract properly, and the impulse on the chest-wall is weakened.

The heart's impulse is also weakened in pericarditis when effusion in any great amount is present, and after fluid has disappeared, if adhesions have formed between the pericardiac surfaces, the heart's action is hampered and the visible impulse lessened in force.

Increased force of the Apex beat.

Apparent increase is caused by those conditions which favour the conduction of the cardiac impulse. When the interspace is wide & the tissues thin, provided the heart be healthy, the beat will be apparently stronger. Also when the lungs are retracted so that the heart is more exposed, or the heart lies nearer the chest wall the apparent strength of the impulse is increased.

Real increase in the strength of the heart's beat is due to all changes which strengthen the heart's action. Thus from over action, after severe bodily exertion, mental excitement, functional disturbances &c, in all of which cases

Some permanent increase of strength is caused by hypertrophy of either side of the heart or of the whole heart. The greatest increase however is caused by hypertrophy of the left ventricle, when not only the force of the apex beat is greatly increased, but the whole praecordial area seems to be heaved up at each contraction.

—

Regularity or Rhythm of the Heart—

The regularity of the hearts contractions can be made out by inspection or palpation but are much more conveniently estimated by the examination of the pulse. In intermittency of the pulse it is frequently necessary to compare the actual beats of the heart, as sometimes the pulse may intermit owing to the cardiac wave not reaching the artery in the wrist, while the heart is acting regularly, but owing either to a weak contraction or to an insufficient amount of blood being propelled from a poorly filled ventricle, the impulse has not reached the wrist.

Rate of the cardiac contractions. This also is always observed by examining the pulse but the slow systematic beats of hypertrophy, or the quick sharp beats of the excited or irritable heart are generally noticed on inspection.

The Praecordial Integument—

Scars over the praecordia are suggestive of cupping for a previous peri-carditis or endocarditis.

to interference with the circulation, but is also caused by respiratory affections, and may be present in condition of perfect health.

Swelling, redness, or in the praecordial region are generally due to affection of the chest wall, but may proceed from irritation going on beneath, such as the growth of a malignant tumour; the skin may be thin and shining over an aneurism, and when present indicates a great amount of tension.

Pulsations other than of the Heart seen on Inspection

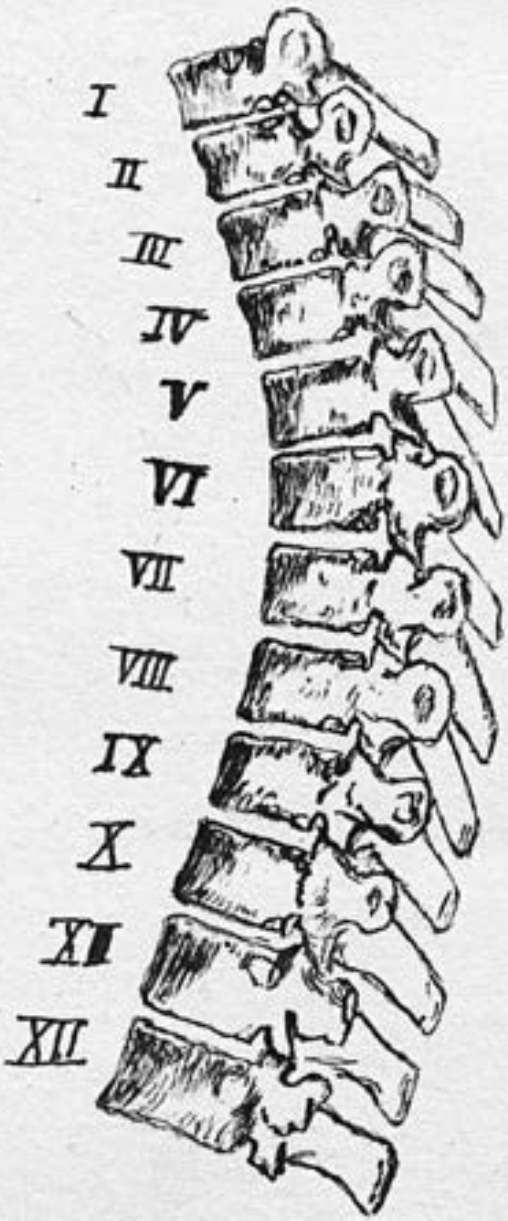
Pulsation of the Aorta in the thorax is never visible in health but when dilatation occurs a slight movement of the chest wall may be seen by looking from the side along the surface of the chest in a good light. The large swelling of some aneurismal cases are easily detected.

The Pulsation of the carotids can be seen in the neck and sometimes may call the attention of the physician to the heart by the character of their movement when symptoms are absent.

Epigastric Pulsation.

This may be due to dilatation of the right Ventricle, or to downward displacement of the heart. When the heart is displaced to the right as by the presence of fluid in the left pleura the organ first lies almost vertically and the apex beat will be felt in the epigastrium. As the fluid increases the apex is pushed round to the right and at length

*Fig. 1*




*Dorsal region of the spine*
*(Quain)*

the pulsation is seen to right of the sternum and at a higher level than the normal position of the apex on the left side.

The Pulsation of the abdominal aorta may be visible in the epigastrium, being communicated to the surface through an enlargement of the liver, or a solid growth lying over the vessel.

An abdominal aneurism sometimes pulsates in the epigastrium, and the true pulsation which occasionally occurs in the liver is seen there, but all these causes of pulsation cannot be differentiated without the aid of Palpation

Pulsation of the veins at the root of the neck

This may be apparent or real.

Apparent pulsation occurs when the jugular veins are abnormally distended, by obstruction to the flow of blood which may be due to simple pressure, to lung affections or to cardiac disease; the veins are emptied during inspiration, the pressure within the thorax being negative, and become distended when the intrathoracic pressure is positive in Expiration

A similar wave is seen in some forms of pericarditis,

but the ~~pulse~~ distension of the vein takes place during inspiration, and the vein is emptied during expiration.

An apparent pulsation is also sometimes communicated to the veins, when distended from the carotid arteries.

True pulsation of the veins occurs when the tricuspid valve is incompetent. At each contraction of the right ventricle a stream of blood is thrown backwards into the veins through the openings in the auricle, the imperfect valves of which have become incompetent also.

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## Palpation of the Praecordial region.

The points which have been observed during inspection are investigated and confirmed by palpation. The position and extent of any bulgings or irregularities of the surfaces are made out more accurately, and the position, strength and extent of the apex beat and any other pulsations present can be more definitely determined. In addition, any tenderness on pressure is discovered, and the question whether pain is due to intrathoracic or superficial changes can often be settled.

The abnormal sensations felt on palpation are

Cardiac or valvular thrills and friction fremitus.

Thrills - In the normal heart, the blood in passing through the valvular opening and cardiac chambers causes no vibration perceptible to touch, over the Chest-wall, but when the valvular openings become contracted or the cusps thickened by disease, a distinct tremor is felt when the blood passes through the affected orifice. The sensation communicated to the hand resembles that produced by the purring of a cat - it is soft and fine and differs greatly from the rough vibrations of friction.

Thrills may be produced at any of the valves and by either a direct or regurgitant current, but are generally produced by the direct stream passing through a contracted opening. The most common causes of cardiac thrill are Mitral stenosis, and Aortic stenosis, and only very rarely is a thrill caused by disease of the tricuspid or pulmonary valves.

A thrill synchronous with the ventricular systole is most commonly caused by Aortic stenosis, and is felt best at the base of the heart and over the

sternum; a mitral systolic thrill is not common but when it does occur is felt best over the apex.

A Pulmonary thrill would be felt over the position of the valve, that is at the 3rd left costal cartilage close to the sternum — it is rarely felt.

A thrill caused by tricuspid regurgitation is felt along the sternum, and is accompanied by pulsation of the jugular veins. A thrill at this valve is not often felt.

Presystolic thrill. This is the most common thrill felt over the praecordia. It is caused by contraction or roughening of the cusps of the mitral valve. It is felt with greatest intensity over the position of the Apex, but is generally communicated to a considerable area of the chest wall.

The thrill may be felt during the whole time that blood is passing through the mitral orifice, but is most frequently felt and always with greatest intensity during the auricular systole, which occurs just before the ventricular systole, and therefore the thrill is called presystolic

Stenosis of the tricuspid valve might possibly cause a presystolic thrill, but the condition is so rare that a

a thrill felt just before the ventricular systole may be regarded as diagnostic of Mitral stenosis.

A diastolic thrill may arise in Aortic or Pulmonary regurgitation but is rarely felt.

Friction [illegible] over the precordia

Friction felt over the praecordial region may be due to pericarditis or to pleurisy.

Pericardial friction is caused by the rubbing together of the roughened surfaces of the pericardium. It commences early in the course of the disease but is not felt at its commencement. Friction may continue during the whole course of the case, if the exudation be very limited in amount, but as a rule it follows the course of pleuritic friction, disappearing with the presence of exudation and returning when absorption of the fluid takes place.

Pericardial friction frequitus is generally rough and not easily confounded with a cardiac thrill, but sometimes the vibration is quite soft and the two sensations are very much alike - Friction frenitus is a to-and-fro vibration and occurs twice in the cardiac cycle, a thrill is felt only once during the cycle.

friction may be felt over the whole praecordia and is frequently most intense at the base, while a thrill is generally confined to a small area, and in the pericystetic thrill, where it is felt over a large area the point of maximum intensity is at the apex.

To distinguish pericardial friction from pleural friction, it is only necessary to ask the patient to stop breathing:- pleural friction ceases, pericardial friction goes on.

Epigastric pulsation - The causes of pulsation in the epigastrium have already been noticed on inspection. By palpation it is possible to localise the pulsation more exactly, especially if the finger be pressed upwards beneath the ribs. The impulse of the pulsation is felt to come from above in those cases where it proceeds from the heart; when the pulsation arises from causes within the abdomen (aortic pulsation or aneurism) ~~it pulsation is less~~, the impulse is a little later than the ventricular systole, and is directed upwards or forwards, rather than downwards. Pulsation in the liver can generally be felt diffused over the whole organ which is enlarged, and there are always other signs pointing to the valvular lesion in the heart which is the cause of the pulsation, viz. tricuspid regurgitation.

## Percussion of the Praecordial region.

The points to be made out on percussion are the size, shape and position of the Heart, the extent to which the heart is covered by the lungs; the presence or absence of fluid or air in the pericardium, the presence of tumours.

## Normal Cardiac Dulness.

The relations of the heart to the surrounding organs have been already described, and its position with regard to the chest-wall must be briefly noticed. The base of the heart lies deeply in the chest, covered by the lungs, while the apex and a small margin of the left ventricle, and about two-thirds of the right ventricle are in contact with the chest wall or only slightly covered by lung.

The margin of the left ventricle corresponds to a line drawn obliquely upward from the apex in the 5th interspace, on the left side, behind the 6th rib, to the 2nd left interspace, where it joins the left auricle, which continues the border of the heart to the middle of the sternum at the level of a line joining the lower margins of the 2nd ribs at their sternal attachment.

Beginning from the apex the right border of the heart runs to the right and slightly upwards to the 5th right costal cartilage, which is the lower margin of the right ventricle, & from this point the right auricle continues the cardiac border, curving upwards and inwards to the sternum, where it joins the margin of the left auricle.

With slight differences caused by the physical condition this line corresponds to the limit of cardiac dulness observed on percussion.

In percussing the outline of the heart, several difficulties are met with — 1st that the greater part of the area is occupied by lung substance and therefore the note made out differs according to the strength of the percussion, a resonant note being heard on light percussion and a modified or muffled note on deep percussion. 2nd That over the sternum a more or less resonant note is always heard. 3rd The lower margin of the heart is in contact with the liver and it is impossible to distinguish any difference between the percussion note of the heart & of the liver. The upper and left border can be marked out with fair exactness by percussing from the resonant tissue of the lung at some distance from the heart and gradually

Fig 35

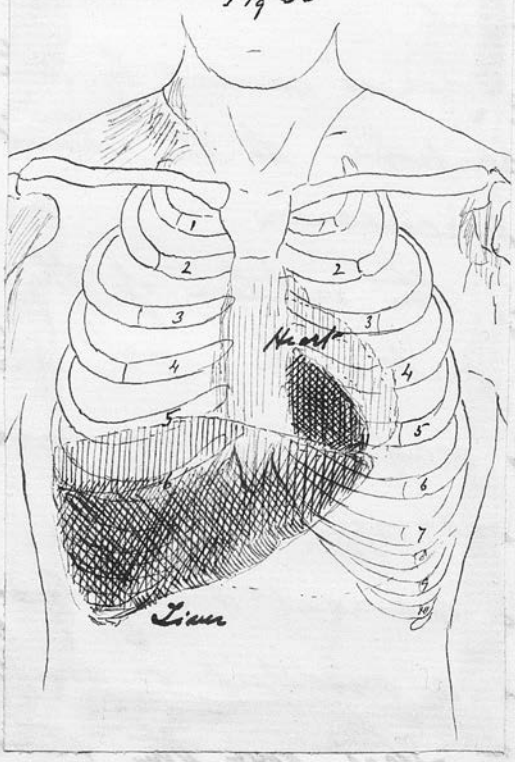



Diagram showing the superficial and absolute cardiac dulness with reference to the chest-wall and the hepatic dulness - Darker shading represents the area of absolute dulness

approaching the supposed limit, when the note will become impaired. Percussion must be deep, that is, made with sufficient force to allow of the dulness, caused by the heart lying below the lungs, to be heard.

The right limit of the lung cannot be made out with such precision but corresponds to a curved line whose greatest convexity lies about three quarters of an inch to the right of the sternum.

The lower limit corresponds to a line drawn from the apex (the lowest limit of pulsation) to the upper limit of liver dulness on the right side, the line of course varying with the rise and fall of the diaphragm during respiration. The limit of the heart, made out by percussion, is smaller, generally, than the actual size of the heart, the line being often about a quarter of an inch within the actual border.

The upper border of the heart is continuous with the great blood vessels and therefore it is extremely difficult to make out the exact outline with correctness.

35) Area of absolute dulness - Superficial cardiac dulness

This corresponds with the area of the heart not covered by the lungs. It can be defined with fair exactness, but here the percussion must be light, or

the resonance of the thin layer of air-containing tissue will be lost. The size of the area of dulness is altered during respiration being diminished when the lungs are expanded, and increased when they contract with expiration.

The lower border, is the lower margin of the heart, and cannot be determined by percussion. The right margin of the dull area is represented by the left side of the sternum, though the right lung does not extend beyond the ~~limit~~ middle of that bone, but owing to the resonance of the percussion note over the sternum, the dulness cannot be made out. The upper and left limit of the area of absolute dulness begins at the sternal articulation of the 5th left costal cartilage, and extends outwards, and then obliquely downwards, to the lower margin of the heart just inside the apex beat.

Alterations in the Cardiac dulness

Slight deviations from the normal outline of dulness are of constant occurrence, and it is not always possible to come to any definite conclusion as to the significance of any variety of shape.

Anatomical description of the Thorax

The Thorax consists of a bony and cartilaginous framework, clothed by muscles, fasciae, and skin, which form a closed chamber containing the heart and thoracic portions of the great vessels, the lungs and their conducting air tubes, glands, nerves and lymphatic vessels, and affording passage for the oesophagus & some nerves & vessels.

The supporting framework of the thorax is made up of the 12 dorsal vertebrae articulated & bound together by ligaments which allow of a limited range of movement in antero-posterior, lateral, and rotatory directions. The vertebral column in the erect position is slightly curved, and in the dorsal or thoracic portion is concave forwards. Fig. 1 is a lateral view of the spine and shows the normal curve and the facets for the articulation of the ribs. The 12 pairs of ribs articulate with the bodies of the vertebrae by the facets on their heads, and with the transverse processes by a small facet on the tubercle of each rib. The ribs are firmly secured to the vertebral column by ligaments. The movement at this costo-capitular articulation is of a rotatory character, while that at the tubercle is altogether sliding, from which it will be seen that the only movements possible are an upward & downward movement of the sternal extremities of the ribs & rotation of the ribs on themselves.

The area of precussion dulness may be increased or diminished or altered in shape either by alterations in the heart, pericardium, or surrounding tissues.

Increase in the Area of Cardiac dulness.

This is caused by increase in the size of the heart- which may be general or local.

General enlargement- depends on hypertrophy or dilatation of all the cardiac walls and affects all the cavities.

Local enlargement- results from hypertrophy or dilatation of the walls of one or more of the cardiac chambers

Enlargement- may also be due to the deposit of fat- on the outer surface of the heart-

-Fluid in the Pericardium (Pericarditis with Effusion, serous or purulent, hydropericardium, or haemorrhage into the pericardium) will also cause an increase in the dull area -

Dulness from these causes may be obliterated or obscured, by changes in the surrounding parts- Thus Emphysematous lungs, pneumothorax, air in the pericardium, will interfere with or render impossible the discovery of the increased dulness.

The Praecordial dulness, as distinguished from the

cardiac dulness may be increased by the following conditions outside the heart.

1 Consolidation of the lung bordering on the heart- pneumonia, caseous degeneration, pulmonary apoplexy &c

2 Pleurisy with Effusion, Empyema,

3 Solid growths, abscesses in the lungs or mediastinum &c

4 Enlargement of the liver.

Or the area of superficial dulness may be increased the heart- remaining normal in size.

This is due to retraction of the lungs as in cirrhosis, contraction of cavities in Phthisis, non-expansion of lungs after Pleurisy &c, or to displacement forward of the heart- itself.

## Hypertrophy of the Heart-

Definition By Hypertrophy is meant- increase in the muscular elements of the Heart either in size or number.

Causes- The cardiac muscle corresponds in its state of nutrition with the condition of the rest of the body; when the tissues are healthy and well nourished the cardiac muscle (no disease being present) is firm and healthy, but- when the system becomes reduced and the body ill nourished the heart- becomes wasted and flabby. The size of the heart is increased by bodily exertion and in those whose voluntary muscles are hypertrophied by training the whole heart- is increased in size. Hypertrophy is not-

a disease, but is the result of a healthy endeavour of the heart to overcome obstruction in the circulation.

All the cavities may be enlarged and their walls hypertrophied, or one or more cavities only may be affected. the relative frequency of the hypertrophy of the various cavities being in the following order – (1st) the left ventricle, 2nd the right ventricle, 3rd the left auricle, and lastly the right auricle.

Hypertrophy is brought about, when the cardiac muscle is in a healthy condition, by over-work, or increased stimulus to the heart. Overwork is due to obstruction in any part of the circulatory system, the part of the heart affected being that which lies immediately behind the obstruction. An increased stimulus may be given to the heart by nervous influence, or by increasing the flow of blood into any of the cavities.

The chief causes of Hypertrophy are

1st Changes in the Heart

(a) Valvular obstruction causing increased work

(b) Valvular incompetence (regurgitation)

(c) Adhesion of the pericardium

2nd Changes in the systemic circulation – obstruction to the flow of blood from any cause (Kidney disease); increase in the size of any organ (uterus in pregnancy); Morbid element in blood.

3rd Changes in Pulmonary circulation obstructing flow of blood through the lungs e.g. Chronic Bronchitis – emphysema.

4th Nervous changes – continued over-action, palpitation Exophthalmic goitre.

## Hypertrophy of the Left Ventricle

The hypertrophy may be simple that is the muscular tissue is increased, and the walls thickened, while the size of the cavity remains natural; or it may be eccentric the ventricle being dilated and the walls increased in thickness. The so-called "concentric hypertrophy," when the cavity is decreased in size with greatly hypertrophied walls, is probably due to the heart having stopped during systole and is merely a post-mortem change.

Causes - (a) Aortic Stenosis - The blood is prevented from fully leaving the cavity and more pressure is put on the ventricle - The hypertrophy is generally simple with no dilatation

(b) Aortic regurgitation - The ventricle is distended and stimulated by the increase in the flow of blood into the cavity, blood being received from the mitral orifice and backwards from the aorta. The heart is dilated and often enormously hypertrophied, and have been found post-mortem to weigh as much as 46 Oz.

(c) Mitral regurgitation. The hypertrophy is eccentric. Increased force is required to carry on the circulation, and owing to the insufficient supply of blood for the nutrition of the heart, dilatation occurs, and an increased nervous impulse is given to the heart, either on account of the comparatively anaemic state of the central nerve centres or to the condition of the dilated end organs in the heart.

(d) Pericardial adhesions - The heart is hampered in its movements and increased energy is required and thereupon hypertrophy occurs.

The causes external to the heart, namely affections in the systemic circulation must be simply named.

(a) Bright's disease - all varieties except the waxy form.
(b) Atheromatous degeneration of the arteries
(c) Constriction of large vessels
(d) Pregnancy
(e) Chlorosis

(Fig 35) Percussion dulness in Hypertrophy of the Left Ventricle

The area of dulness is increased towards the left - and the transverse measurement of the heart is larger than the normal. The greater part of the left border of the heart lies to the left of the middle line and the outline is more pointed at the apex than in health. The lower margin, as estimated by the position of the apex, is also lower, the extent varying with the amount of hypertrophy present.

As the lung is pushed aside by the increase in the size of the heart, it follows that both the superficial and deep areas of percussion dulness are increased. Fig. 36

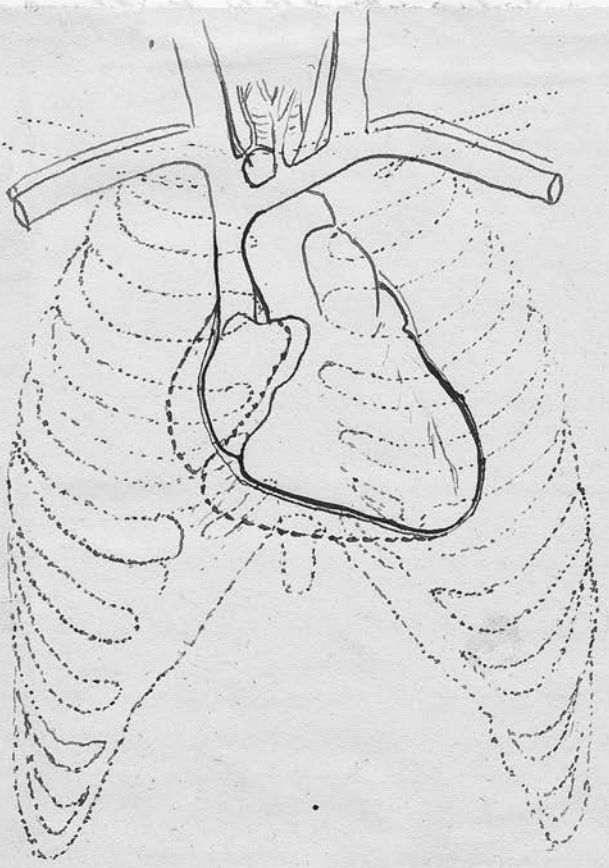
(2 pages further on)

Hypertrophy of the Right Ventricle

This is rarely simple, but nearly always associated with some degree of dilatation.

Causes (1) On the right side of the heart

(a) Pulmonary stenosis - This is rare as an adult



Hypertrophy of right ventricle – (after von Dusch)
The dotted line shows alteration in the cardiac outline.

[copied from Bramwell
Diseases of Heart]

Fig. 37

condition, but occurs in young children associated with patency of the foramen ovale, so that in this condition the amount of hypertrophy is small owing to the escape of blood through the patent orifice of the foramen.

(4) Pulmonary Incompetence. Theoretically this may be given as a cause of hypertrophy, but the lesion is extremely rare.

(5) Tricuspid regurgitation - This occurs most frequently as a result of dilatation due to cardiac failure and is therefore in such cases unattended with hypertrophy - should the condition occur as the result of primary valvular disease, hypertrophy would occur just as it does in the left ventricle the result of primary mitral disease.

(6) Pericardial adhesions will cause hypertrophy of the right ventricle, for the same reason as it does, hypertrophy of the left ventricle

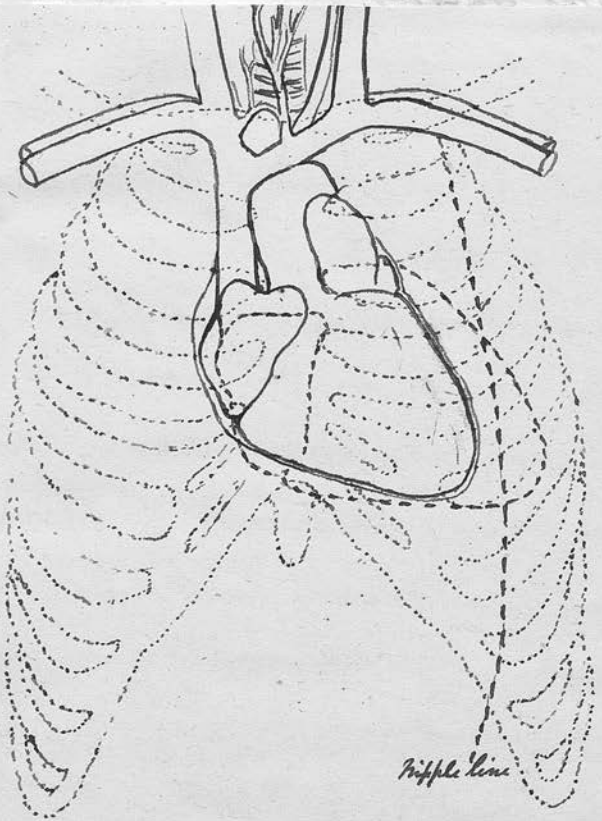
(2) Changes on the left side of the Heart

Lesions of the mitral valve by causing some increase in the pressure on the right ventricle, backwards through the lungs, will cause hypertrophy.

(3) Changes in the lungs.

(a) Cirrhosis - Emphysema - chronic bronchitis &c and all conditions in which the circulation through the lungs is obstructed will tend to produce hypertrophy of the right ventricle by throwing more work on the walls of that cavity

(b) Compression of the pulmonary artery by a tumour will produce the same result as stenosis of the pulmonary orifice will




Hypertrophy of left ventricle, showing altered position of apex. (after von Dusch)
The dotted line represents the hypertrophied left ventricle.

[Copied from Bramwell on the Heart]

Fig 36

Percussion dulness in Hypertrophy of the Right Ventricle.

The dulness is increased in the transverse diameter and slightly also in the vertical. The outline on the left side remains in its normal position, but on the right it extends some distance to the right of the sternum, and from the pulsation in the epigastrium, the lower margin is lower than in health, especially towards its right extremity Fig 37

Hypertrophy often occurs on both sides so that it is not always possible to make a precise diagnosis as to the amount of enlargement present on either side.

Hypertrophy of the Left Auricle

Causes Mitral Stenosis or regurgitation

The hypertrophy is never very great and is best seen in cases of stenosis and only slightly in those of regurgitation.

On Percussion no change is found in the outline of the heart; owing to the slight increase in size that takes place, the position of the auricle behind, and its nearness to the great vessels.

Hypertrophy of the Right Auricle

This condition is rare and when it does occur cannot be discovered by percussion. It is caused by tricuspid stenosis a comparatively rare lesion.

# Dilatation of the Heart

Causation

For dilatation of any of the cavities of the heart to occur, either the blood pressure within the chamber must be abnormally increased, or the resisting power of the walls must be diminished

With healthy muscular tissue it is impossible for dilatation to occur alone; some amount of hypertrophy is always present. When however the muscular fibres are weakened by disease, or replaced by fibrous tissue, or even have been taken unawares, so to speak, by suddenly increased pressure, dilatation occurs without hypertrophy.

(1) The pressure in the heart is increased by all those causes which have been noticed as leading to hypertrophy. For dilatation to occur without, or in excess of hypertrophy, the increase of pressure must occur suddenly. Strain, such as is often produced by over exertion will if kept up for any length of time cause the dilatation of the cavity or cavities on which the pressure is thrown. A slowly increasing pressure on the other hand, will be compensated for by hypertrophy, if the muscular

tissue is healthy; if however the fibres are degenerated ~~then~~ a slight increase of pressure even when occurring slowly will cause dilatation.

When the blood pressure is increased throughout the heart naturally the cavity with the thinner walls gives way, the auricles are dilated sooner than the ventricles; the cavities on the right side of the heart before those on the left.

The condition of the wall of the heart, whether contracted or in diastole, when the increase of the pressure occurs, is important. Dilatation of the left ventricle occurs more rapidly in aortic regurgitation than in Aortic stenosis, because in the former case the over distension of the heart, by the double stream from the aorta & through the mitral valve, occurs during the diastole; while in Aortic stenosis, the pressure is increased only during the systole.

2 Diminished power of resistance

This is produced by all causes tending to weaken the muscular fibres of the heart. Thus in simple debility the heart is weakened, and a slight increase of blood pressure might cause it to become dilated. Inflammatory

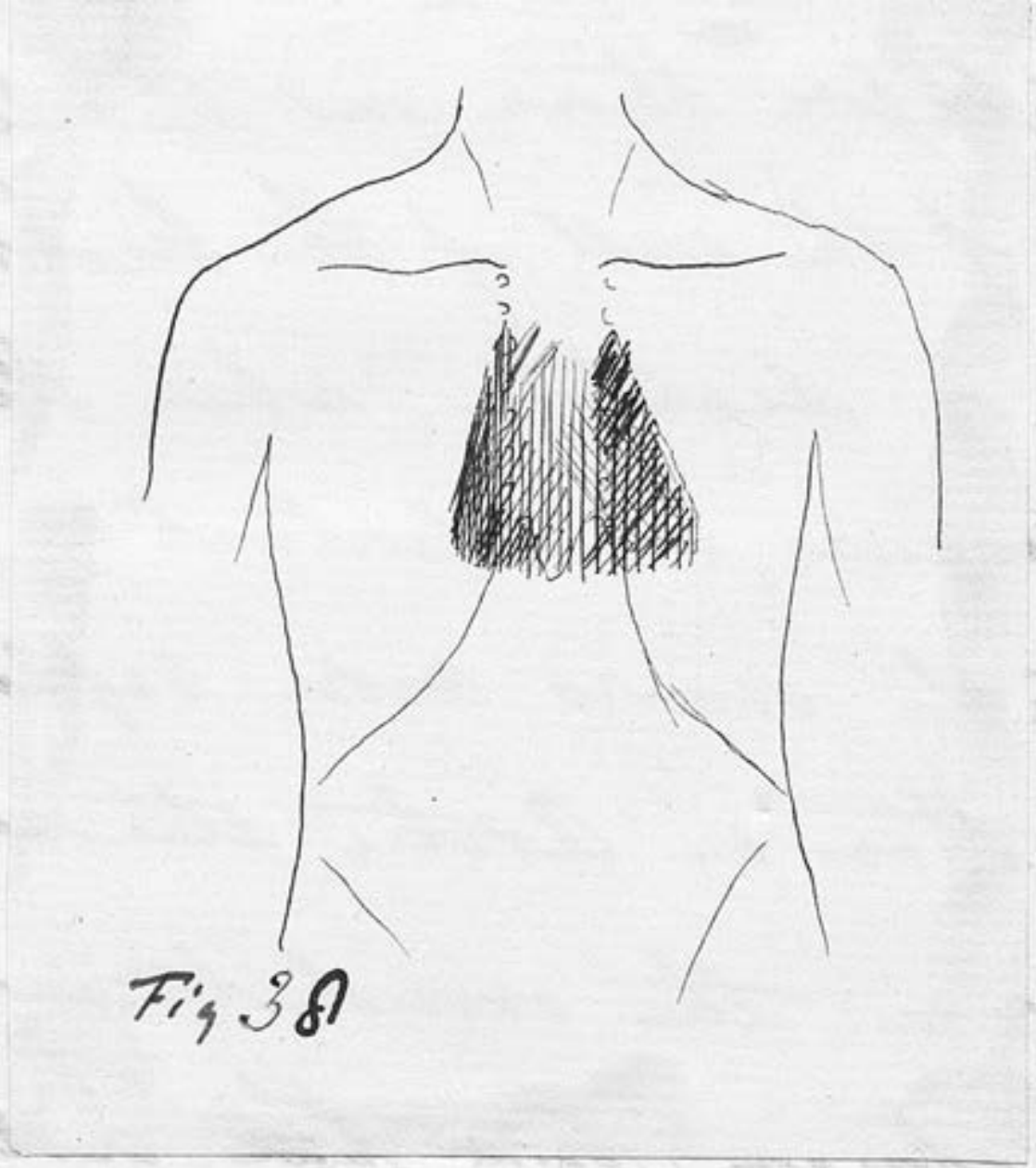
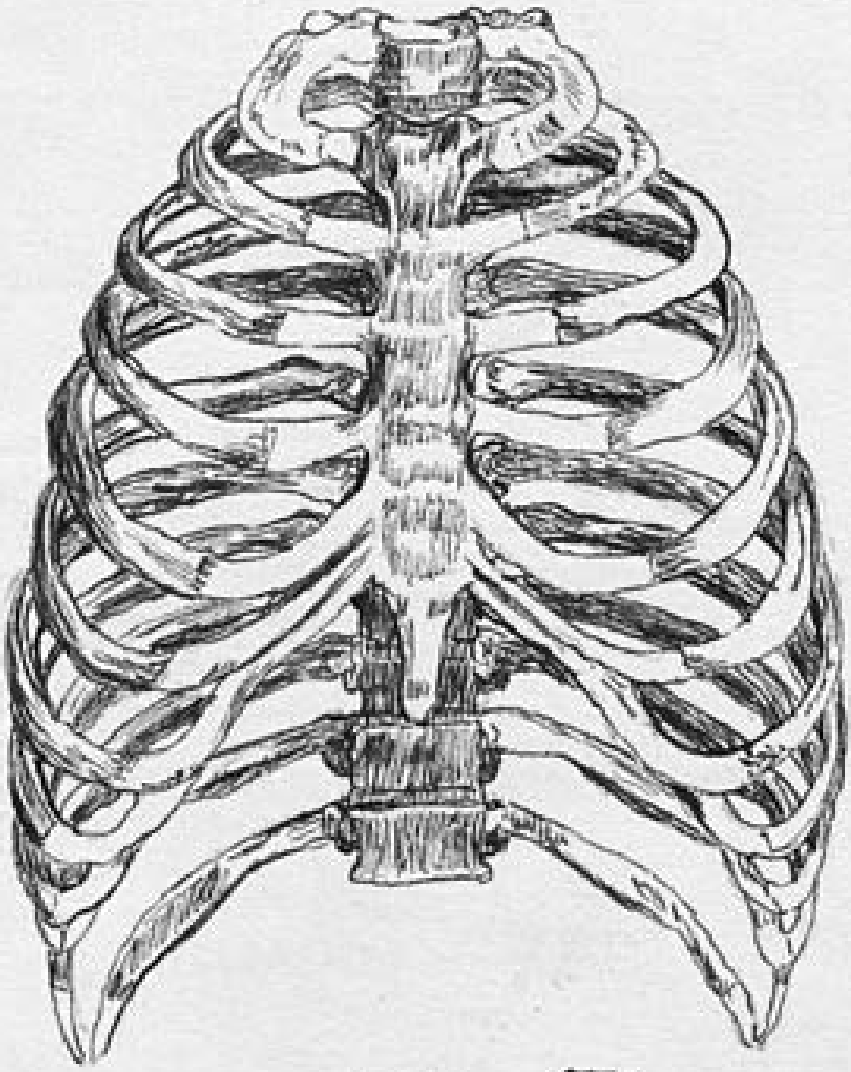



Fig 38 Area of dulness from a case of pericarditis with effusion and great thickening of pericardium.

Fig 2



Front view of the Thorax showing Sternum, Costal Cartilages, Ribs, and Dorsal Vertibrae. 1/5

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changes, myocarditis or endocarditis; degenerative changes, such as fatty degeneration, will all diminish the resisting power of the heart, and even under the normal pressure dilatation may occur; and if the blood pressure be raised dilatation will be more rapid, and in extreme cases rupture of the heart might occur.

The results of percussion are similar to those produced by hypertrophy, and by percussion alone, it is impossible to say whether the heart is dilated or hypertrophied, the diagnosis depending on a careful consideration of the symptoms, the other physical signs, strength of cardiac impulse, nutrition of patient &c.

The dulness caused by Pericarditis with Effusion

In the early stages of Pericarditis, before the effusion of any fluid into the sac, the cardiac dulness is unaltered, and it is possible for a considerable amount of fluid to be present, without any increase in the area of dulness, especially when the patient lies on his back. When the pericardium is distended with fluid, the outline of dulness on percussion assumes a pyramidal or pear-shaped form, the blunt apex of the pyramid being upwards, and formed by the portion of pericardium deflected over the great vessels, while the base rests on the diaphragm. Fig 38

The dull area is expanded both to the right and left of the normal limits, and the pear shaped form of the dulness is very characteristic. The lungs, unless in those cases where they are emphysematous, are pushed aside by the increasing fluid, and the area of absolute dulness is largely increased.

In cases when the fluid is not of large amount, the dull area is not so distinctive, and may be confused with that caused by hypertrophy or dilatation.

Pain, friction, a diffused cardiac impulse, rapid pulsation & dulness extending beyond the apex beat will generally characterize the dulness arising from pericarditis.

Hydro-pericardium, that is dropsical effusion into the pericardium, will also cause increased praecordial dulness. This affection is simply part of a general dropsy and is accompanied by other effusions in the other serous cavities. Pain is absent, there is no friction and the signs of valvular disease (Mitral) or Bright's disease are present.

Dulness from other causes (consolidation of lung, pleurisy solid tumors &c) is rarely confined to the praecordial region, and is accompanied by symptoms and other physical signs, which serve to distinguish them, and the symptoms

and physical signs of cardiac disease are absent.

## Diminution of the Praecordial Dulness

This may be due to decrease of the heart itself, or to conditions in the surrounding tissue obscuring the Cardiac dulness.

1 Atrophy of the heart does not as a rule depend on disease of the heart, but occurs in the course of wasting diseases, cancer, phthisis, suppuration &c. It may however occur from degenerative changes, the result of local disease such as fibroid degeneration, fatty degeneration, or obstruction, in the coronary arteries. The dulness is diminished in both the vertical & transverse diameters, and if the lungs are voluminous or emphysematous, the dulness may be absent altogether.

2 Gas in the Pericardium - Pneumo-pericardium.

Air or gas may enter the pericardium from the outside by wounds or by paracentesis, or from some of the air-containing organs, most frequently through a fistulous opening from the lungs - At first the air or gas is present alone, but, as in the case of pneumo-thorax, fluid is formed & a condition of hydro-pneumo-pericardium ensues. On percussion the note over the air-containing sac is tympanitic, and if fluid be present

dulness is heard over the lowest part. If the patient lie on his back, the whole of the praecordia may be tympanitic, but if he lies on one side or sits up, the fluid gravitates to the lowest part and dulness is heard.

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Changes in the surrounding air-containing organs may cause diminution of the area of dulness. In Emphysema the superficial dulness may be almost or entirely abolished, and the deep dulness with difficulty made out. Pneumothorax, distension of the stomach or intestine, will occasionally lessen the cardiac dulness, but these conditions rarely cause any difficulty in the diagnosis.

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## Auscultation of the Heart

This is the most important method of examination, as by it alone, can we determine the condition of the valves of the heart, upon the efficiency of which the working of the heart as a muscular pump depends.

During every cycle of cardiac contraction, certain

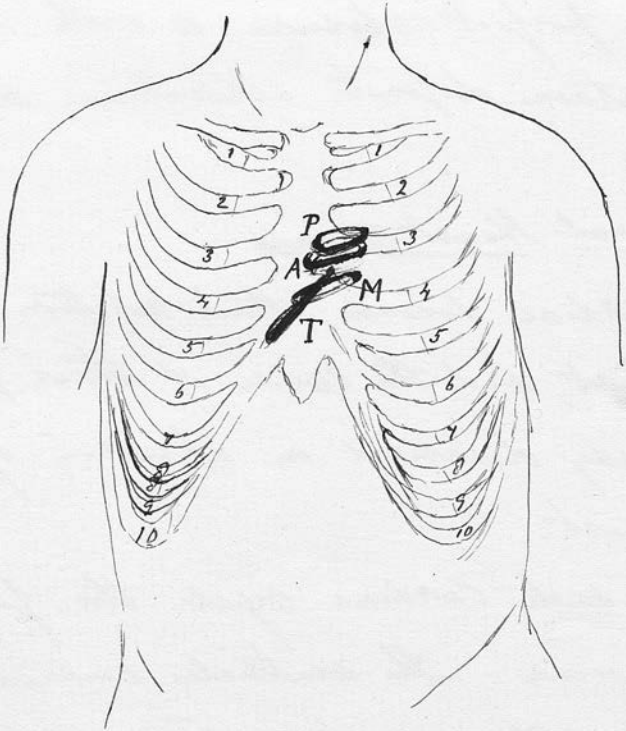
sounds are produced, having a definite relation to the events which occur at the time of their production; these sounds depend for their production and purity chiefly on the condition of the valves, and when these are not competent, or alterations occur, interfering with their perfect closure, or with the lumen of their orifice, certain definite alterations occur in the Cardiac sounds.

The Normal Heart-Sounds

The cardiac sounds, their relation to the contraction of the heart, and the cause of their production have been already described in speaking of the structure of the heart.

During each cardiac cycle the following sequence of events occur - The ventricles contract, causing by the vibration of the muscular fibres and by the tension of the segments of the auriculoventricular valves, the long first-cardiac sound, made up in reality of what may be called the Mitral first-sound and the Tricuspid first-sound. Then follows a short pause, during which the intra-ventricular and arterial blood pressure is balanced, and this is succeeded by the simultaneous closure of the Aortic and Pulmonary valves, causing the Aortic and Pulmonary second sound which are fused into one, namely the second cardiac sound. The long pause now occurs, during which

Fig 39




Position of the valves of the heart

P = Pulmonary Valve
A = Aortic "
M = Mitral "
T = Tricuspid "

The first pair of ribs is flattened superiorly and inferiorly and the ribs are not twisted on themselves like the majority of the other ribs. It is so placed that the superior surface looks upwards and forwards, and together with the first dorsal vertebra and the manubrium sterni forms the upper boundary of the thorax. The other ribs increase in length to the seventh and are laterally flattened and at the same time take a more downward direction, always presenting their flattened surfaces externally & internally, to allow of which they are twisted on themselves. Below the seventh, the ribs become shorter, the 11th & 12th being quite short and termed floating ribs because they are without cartilages. The anterior extremities of the ribs are firmly united to the costal cartilages which are practically the continuations of the ribs and pass forwards, inwards, and in the case of the lower ribs upwards to articulate with the fossae on the margins of the sternum or in the 8th 9th and 10th pairs with the inferior surface of the cartilage above them. The sternum, situated in the middle line anteriorly completes the thoracic framework. It presents flattened surfaces anteriorly and posteriorly and is slightly convex forwards. As a whole the thorax (Fig 2) is somewhat conical in shape, the walls being convex on their outer surface and the vertebral column projects on the interior surface of the posterior wall

the ventricular diastole and auricular systole take place. The time occupied, supposing the whole cycle to be represented by 10 — The first sound occupies $\frac{4}{10}$, the short-pause $\frac{1}{10}$, the second sound $\frac{2}{10}$ and the long pause $\frac{3}{10}$; — this if not absolutely correct- is a good practical division.

The first-sound is thus seen to be twice as long as the second; it is low in pitch and muffled and 'distant' in character. The second sound is sharp and slightly higher in pitch, and appears to be produced nearer the ear than the first-sound. The actual sounds heard are often likened to the pronunciation of the syllables Lubb-Dup which is not an exact comparison.

Position of the Valves with relation to the chest-wall and the points of maximum intensity of the sounds. Fig 39

The valves are placed close together and even overlap one another so that a shilling placed over a certain point of the praecordial area will cover a portion of three of them and probably touch the margin of the tricuspid as well.

The Pulmonary valve lies close to the sternum behind the 3rd costal cartilage, part of the orifice lying behind the sternum

The Aortic valve is a little lower and nearer the middle line than the Pulmonary.

The Mitral valve lies below the aortic, at the level of the upper edge of the fourth costal cartilage. A large portion of the orifice is behind the sternum.

The Tricuspid Valve lies in a plane which slants across

the sternum from the 3rd left- interspace to the costo-sternal articulation of 4th rib (cartilaginous part-).

If the stethoscope be placed over the position of the valvular area, all the sounds can be heard, but- it- is impossible to differentiate one from the other.

The points where each of the valvular sounds can be heard with greatest intensity are the following :-

"Initial sounds are best- heard at the apex.

"Tricuspid sounds at the lower end of the sternum

" or over the lower cartilages to right- or left- of sternum.

"Aortic sounds at the second right- costal cartilage

"Pulmonary sounds at- the third left-costal cartilage"

(B Bramwell l.c P 139)

In auscultation of the heart-sound, it- is important to ascertain at what- point- in the cardiac cycle the sound occurs. This is done by timing the sound, so to speak, by the beats of the heart. If the apex beat- can be felt-, this should be used as if not- the carotid pulse, as by this we know at- once the precise moment of the ventricular contraction.

Alterations in the Cardiac Sounds

"The sounds of the heart- naturally present so much

"diversity of character, and pass from the domain of

"perfect- health to that of disease by stages so insensible,

"that it- is frequently only by calling to our aid such

"other signs as are furnished by an exhaustive examination

"of the organs of circulation, that it can be determined
"whether or not their changes in the sounds, are really
"due to anatomical lesion of the heart-itself. These
"alterations affect the intensity, the purity, and the
"timbre of the sounds; a duplication, a division of the
"sounds, comes under the same category." (Guttmann l.c. P271)

Increased Intensity of the Cardiac Sounds

The strength of sound may be apparently or actually increased, the alteration depending on the conduction of the sound, and the amount of sound produced.

The conduction of the heart-sounds is dependent on the same conditions with regard to the chest-wall and intervening structures, as are the bronchial sounds already described.

Apparent increase in the intensity takes place independently of any change in the mechanism of the heart; it is caused by (1) thin chest-wall, with scant development of muscle and no deposit of fat.

(2) Consolidation of the layer of lung over the heart as in Pneumonia; or withdrawal of the overlying lung as in cirrhosis

3 Amplified and rendered metallic by an air containing cavity such as occurs in excavation of the lung in Pneumo-thorax and Pneumo-pericardium

The intensity is actually increased when the valves (which must be competent and healthy) are more forcibly closed, which occurs when the heart contracts with increased force or when some obstruction exists to the onward flow of blood.

The sounds are increased in strength during health when the heart contracts forcibly as after exertion; in palpitation and in exophthalmic goitre, as well as in some febrile conditions the intensity of the sounds is increased without any organic changes in the heart. In these conditions all the sounds produced in the heart are louder than normal.

Increase in the intensity, the result of changes in the heart or in the circulation, systemic or pulmonary, is generally confined to one sound or the other sounds proceeding from one side of the heart.

The second sounds are more frequently accentuated than the first sound.

The Aortic second sound is intensified, whenever the pressure in the aorta is increased, so long as the valve remains competent and the sound is not replaced by a murmur. This occurs when there is obstruction to the flow of blood through the vessels, as in atheroma, in cirrhotic kidney, or vaso-motor contraction of the vessels even when temporary. Also in hypertrophy

when there is a large amount of blood thrown into the aorta. This most often occurs when the hypertrophy is due to changes in the circulation or to the lesser degrees of contraction of the aortic orifice. In mitral regurgitation especially when of great extent, or in extreme degrees of aortic stenosis, the conditions necessary for accentuation of the sound do not exist. In order to determine whether the Aortic second sound is intensified or not, the sound should be compared with that heard at the Pulmonary valve, remembering of course the possibility that both sounds may be intensified at the same time.

The Pulmonary second sound is intensified under similar circumstances as the Aortic sound, that is whenever the blood pressure in the pulmonary artery is increased. This occurs in those diseases of the lungs, where the passage of blood through the pulmonary arteries is obstructed by changes in the lungs - thus in cirrhosis, in chronic inflammation, a chronic bronchitis, this is seen, but the most important cause is obstruction or regurgitation of the Mitral valve; the blood tends to stagnate in the vessels and the pulmonary valve is closed with increased force. The sound is also intensified by an increase in the amount of blood thrown into the pulmonary artery by an hypertrophied right ventricle.

The upper opening is formed by the 1st dorsal vertebra the 1st pair of ribs and the manubrium sterni. The lower opening slopes from the Xiphisternum downwards outwards & backwards on either side to the extremity of the 12th ribs and then inwards to the spinal column.

Muscles of Respiration — A. Special Thoracic Muscles — These act on the Thorax alone for the most part and correspond pretty closely to the muscles of ordinary respiration. They are:—

The Intercostals external and Internal
Triangularis Sterni
Levatores costarum
Subcostals
The Diaphragm

The External Intercostal muscles, eleven in number on each side occupy the intercostal spaces running from the lower border of one rib to the upper border of that immediately below, in an oblique direction downwards & forwards. The muscles extend along the ribs from the tubercle to the point of junction between the bone & the cartilage, the space between the cartilages being filled with thin fascia.

The Internal Intercostals have a similar origin and insertion & internal to the outer group of muscles but their direction is from above downwards and backwards.

The Triangularis Sterni is a thin stratum of muscle running, from the ensiform cartilage and from the cartilages of one or two ribs below, upwards and outwards to the junctions between the bones & cartilages of the

Intensification of the Mitral and Tricuspid sounds is produced in an excited heart. The ventricle, on either side, contracts sharply, the sound is shortened and is louder and clearer than the normal first sound. It would be expected that the sounds would be louder when the ventricles are hypertrophied, but this is not the case, probably because the contraction takes place more slowly, causing less vibration of the valve segment and chordae tendineae and also because the sound is not well conducted through the thickened ventricular walls.

The tricuspid sound is more often intensified, than the mitral, owing to the less degree of hypertrophy, and greater amount of dilatation, that occur in the right ventricle.

Both sounds may be increased in intensity, when the heart is irritable, and acts excitedly.

## Diminished intensity of the Heart-sounds

The loudness of the heart-sounds is diminished by all those conditions which lessen the conduction of sound. Thus when the chest-wall is thick or covered with a great deposit of fat; when the lungs are voluminous and cover the heart completely, or are emphysematous; or when the pericardium is distended with fluid; or the pleura (left) with exudation the sounds are greatly enfeebled and sometimes inaudible

The heart-sounds are also rendered inaudible by the

presence of râles, when very numerous, in the lungs.

It must be remembered that the heart-sounds may be inaudible over the praecordia owing to any of the causes mentioned, but well heard in other parts, as over a portion of consolidated lung in pneumonia, owing to the conduction of sound through the hepatised lung.

The sounds are also rendered feeble by the following changes in the heart-itself.

(1) Less forcible or sudden closure of the valves - This occurs when the heart's action is weak, in simple debility or more markedly in syncope; when the walls cannot contract owing to degenerative changes such as fatty degeneration, or from great dilatation of a cavity.

(2) Structural changes in the valve segments. When the valve-segments are thickened, they are unable to close with the same force or suddenness as naturally, and the amount of sound produced is lessened and therefore its intensity, as carried to the ear, is diminished.

The Aortic sound is rendered feeble by:-

1 Diminished pressure in the arterial system
2 Thickening of valvular cusps
3 Weakness or degenerative change in the left ventricle
4 Mitral regurgitation

The Pulmonary sound is weakened by:-

1 Weakness, dilatation, or degeneration in the right-ventricle.
2 Tricuspid regurgitation.

The Mitral sound is weakened by:-

1 Weak action of the left-ventricle - It is muffled in hypertrophy.

2 Change in the valve-segments.

The Tricuspid sound is weakened by weak action of the right ventricle

## Impurity of the Heart-Sounds

"The sounds of the heart particularly the systolic "ventricular sounds, are frequently neither so accentuated "nor so markedly flapping in character as those "heard in health; they become impure, and in extreme "instances lose more or less completely the qualities of a "sound proper, so much so that one is sometimes in "doubt whether to regard them as sounds or murmurs.

"Sounds of this doubtful kind often merge into un- "mistakable murmurs when the heart is excited to "more powerful action.

'The slighter degrees of impurity of the sounds may 'have their origin in comparatively unimportant changes 'in the auriculo-ventricular valves, thus a merely 'trifling diminution in the structural delicacy of the 'valves, a slight thickening of their substance, perhaps 'also the want of uniformity of tension and vibration 'in the various valvular segments, and other similar but 'not yet thoroughly known conditions, may be sufficient 'to produce such a result.

'Impurity of the sounds, when not associated with

'other cardiac anomalies, particularly with changes in 'the cardiac impulse or in the volume of the heart, has 'not usually any special diagnostic value". (Guttmann. c275)

Metallic Sounds - The heart-sounds acquire a metallic character, through changes in the surrounding structures, and not through any structural or functional alterations in the heart itself. The production of the metallic sound is similar to that of the metallic voice sounds heard in certain conditions of the lung, and due to consonance of the walls of an air-containing cavity with the cardiac sounds. This variety of sound is heard over a cavity in the lung substance lying close to the heart, in some cases of pneumo-thorax, and especially well developed in pneumo-pericardium.

In some cases the heart-sounds are audible to the patient or to a by-stander. This is the case also in pneumonic consolidation of the lungs — "A striking 'example of auto-audible heart-sounds depending upon consolidation 'of the lung came under my observation during the summer 'of 1881. A patient who for some weeks had been suffering from 'a limited pleuro-pneumonia of the left base, was suddenly seized 'with acute pain in the left-side, which was followed by quick 'pulse, elevation of temperature and rapid consolidation. The day following

the occurrence of the attack, dulness on percussion and tubular breathing were present over the lower two-thirds of the lung, and the heart sounds could be readily heard, when the patient sat up, without applying the ear to the chest. (B. Bramwell l.c. P156)

Reduplication of the Heart-Sounds

Under certain conditions in health and disease, the sounds which normally are heard fused together into the first- or second cardiac sounds, are heard separately and distinctly, the two divisions being separated by an appreciable interval

Doubling or reduplication of the first-sound occurs occasionally in health at the end of inspiration. In disease it is rarely heard, but occurs in functional derangements, in hypertrophy of either ventricle, in mitral and tricuspid lesions, and in degeneration conditions of the heart.

Reduplication of the second sound is more frequently seen than that of the first. In health it occurs at the end of inspiration and at the beginning of expiration.

In disease it is found in mitral stenosis and in obstruction of the pulmonary circulation.

Production of Reduplication.

Cause of Reduplication of the First Sound

Theories 1st. That it is due to non-simultaneous closure of the mitral and tricuspid valve flaps

Dr Bramwell supports this view and believes that three conditions are necessary for the perceptible reduplication of the first sound, viz: —

"(1) Considerable asynchronism in the contraction of the two ventricles.

"(2) Diminished duration of one or other or both of the component parts of the reduplicated sound.

"(3) Slow action of the heart —" (Bramwell Page 158)

and explains the asynchronism by supposing the accelerated or retarded action of the ventricles to be due: —

(1) "Differences in the pressure of blood in the two ventricles by reason of which the muscular fibres of one ventricle are stimulated to contract before the muscular fibres of the other"

"(2) Alterations in the nerve apparatus of one ventricle by reason of which the motor ganglia of one side are rendered more or less irritable than those of the other.

"(3) Structural alterations of the muscular fibres of one ventricle by reason of which its contraction is more or less quickly effected than that of the other ventricle." (Bramwell P 161-2)

2nd That it is due to non-synchronous tension of the individual segments of the auriculo-ventricular valves, owing to the absence of perfect uniformity of the contraction of the papillary muscles (Gattmann).

3rd That the reduplication is due to splitting up of the first sound into its component parts of ventricular impulse and valve tension - (Hayden)

4 That it is due to a double mitral valve click, the true mechanism of which remains to be discovered" (Professor D'Espine)

5 That the contraction of a dilated, and especially of a hypertrophied Left auricle, becomes sonorous, and that the first-division of the double first-sound is the result of the auricular systole (Dr. Johnson)

6 That it is due to a presystolic being closely followed by a normal first-sound, the presystolic sound being produced by the sudden floating upwards of the mitral curtains occasioned by the auricular systole" (Dr Sansom)

(Bramwell loc cit. p 1578-1579)

Reduplication of the second sound - Causes

Theoretically this may occur in asynchronous contraction of the ventricles due to the causes already stated in speaking of the reduplicated first sound; or to asynchronism in the closure of separate cusps of one valve; or to

a rebound of the valve cusps after a first closure, as is sometimes seen in the values of an ordinary pump.
Guttmann suggests that the reduplicated sounds are really the component-parts of a murmur (Clinical diagnosis P279)

The reduplication may be due to longer duration of the systole of one ventricle. The second sound can only occur when the pressure in the ventricle falls below that in the artery, so that if one ventricle begins its diastole sooner, or, in other words, the systole lasts a shorter time than that of the other ventricle, the one valve will close and become tense before the other.

Alteration in the position of maximum intensity of the heart-sounds.

1 As the heart changes its position, it follows that the relative position of the valves to the chest wall will be changed also, and therefore the position where the sounds are best heard will be altered. The position of the sounds relative to the heart remains the same, the mitral at the apex, the aortic over the aortic arch &c.

2 The points of maximum intensity are also changed, by conditions rendering their conduction better - thus in pneumonic condensation, solid tumour, &c, the sounds may be better heard at the base of the lung, for example, than over the praecordia.

3 " Aneurism of the Thoracic Aorta. When the heart sounds are loudly heard over a part of the chest where under

"normal circumstances, they are faint or inaudible, and "when the abnormally placed sound is situated over the "course of the aorta, the presence of an aneurism should be "suspected and the other symptoms and signs of that "condition carefully looked for". (Bramwell l.c P.167)

## Cardiac Murmurs

Murmurs may be defined as new sounds heard along with the ordinary cardiac sounds or entirely replacing them. They may be produced either in the heart or outside it — the former being termed Endocardial, the latter pericardial or exo-cardial murmurs.

### Endocardial murmurs — Production

(1) By changes at the valvular orifices causing either (a) obstruction to the onward passage of the blood, or (b) allowing of its return or regurgitation through the valve.

(a) Obstructive changes are the result of contraction of the orifice of the valve by cicatricial tissue; the union of two or more segments at their bases; roughening or thickening of the valve segments, or even the presence of a tongue of lymph adhering to one of the cusps.

(b) Changes allowing regurgitation are — destruction of one or more valve segments; thickening of their edges which

prevents the cusps falling together; perforation or rupture of one of the valve flaps; degeneration or other changes preventing their synchronous closure; dilatation of the orifice of the valve or of the cavity which the valve protects.

2 Changes in the cavities of the heart causing vibrations at the valvular orifices (contraction or dilatation) the valves remaining healthy.

3 Changes in the roots of the great arteries - Aneurismal dilatation or pressure from without by solid growth or by dilatation of the auricles

4 Changes in the blood - Anaemia.

The cause of the murmurs heard, lies in the vibrations or wave motion set up in the blood passing through a narrow orifice with vibratile margins, or by the passage of altered blood through an orifice, the structure of which remains healthy, but the walls fall together and narrow the opening.

Some observers ascribe the production of regurgitant murmurs to the meeting of two blood currents moving in opposite directions, but it seems more probable that the murmur is caused by the blood being forced through a narrow orifice or through one where the condition of the valvular orifice is such as to be thrown into vibrations by the blood current.

second, third, fourth, fifth & sixth ribs.
The Levatores costarum have a similar direction to the external intercostals. They are twelve in number, and arising from the transverse processes of the seventh cervical and the eleven upper dorsal vertebrae, are inserted into the outer surface of the rib articulating with the vertebra immediately below that from which each muscle springs, but in those belonging to the lower ribs, some of the muscles pass over two ribs and may be distinguished as levatores costarum longiores.

The Subcostal muscles are internal to the internal intercostals and have the same direction as the latter group but their fibres extend over one or more spaces. They are found chiefly about the angles of the lower ribs.

The Diaphragm or midriff (διαφραγμα to divide) divides the abdominal cavity from the thoracic. At rest it has a dome-like shape with the convexity towards the thorax. It consists of muscular fibres which arch upwards from the circumference of origin to the central tendonous structure. The fibres rise from the upper lumbar vertebrae by two crura, between which the aorta passes into the abdomen; from the ligamenta arcuata, two fibrous arches on either side the spinal column; from the ensiform cartilage & the cartilages of the six lower ribs, the fibres springing by a series of slips which become united together and pass upwards & inwards to the central cordiform tendon. This tendinous aponeurosis forms the highest part of the dome. The Diaphragm transmits the

The intensity of the murmur depends partly on the strength of the cardiac contractions, that is the actual intensity, for the sound may be diminished or increased by all those conditions of good and bad conduction, which have been mentioned with reference to the intensity of the cardiac sounds. A murmur may be inaudible when the heart is acting quickly and the patient at rest, but after exertion when the heart is acting strongly a well marked murmur may be heard.

Doubtless the loudness of the murmur depends on the condition of the valve flaps, their degree of thickening or roughness and on the constriction of the orifice in cases of valvular stenosis, but the degree of loudness has nothing to do with the severity of the lesion, and a soft murmur may be more dangerous than one that can be heard without applying the ear to the chest, and when a murmur which has been loud and harsh alters and becomes soft and blowing, it is generally a sign that the heart is failing and may be regarded as a very grave symptom.

Time of the occurrence of a murmur

All endocardial murmurs correspond in time with one of the events in the cardiac cycle. They may be heard during the ventricular contraction and are then

termed systolic, or immediately before the ventricular systole, that is synchronous with the auricular systole and are then called pre-systolic, or they occur after the completion of the ventricular systole that is are diastolic. Murmurs may be 'timed' as the heart-sounds are timed, by feeling the apex beat or by the carotid impulse which of course is exactly synchronous with the ventricular systole.

The character of the Murmur. There is great variety in the character of the sounds. Some are blowing, some whistling, others humming, scraping sawing &c or they may exhibit a combination of these characters. The variety of murmur present will probably depend on the precise condition of the valvular orifice and the strength of the cardiac contraction but it has no diagnostic value and gives no information as to the amount of blood passing backwards or forwards through the affected valves. Systolic ~~Murmurs~~ Murmurs are louder and clearer than diastolic murmurs which are more prolonged but are not accentuated. A murmur due to stenosis depends greatly on the amount of contraction present but no definite rule can be given.

Murmurs are distinguished as organic and inorganic, functional, or haemic. Those "dependent on the existence of actual obstruction of the circulation are termed 'organic', those occurring independently of such 'obstacle, and in a heart in no way altered in 'structure, inorganic murmurs" (Gottmann l.c. 2280)

## Organic Murmurs

Systolic Murmurs. Systolic murmurs are those which occur during the systole of either the right or left ventricle, and may replace or accompany any of the sounds produced during that event. As there are four orifices present, two arterial, (aortic & pulmonary) and two between the auricles and ventricles, (mitral & tricuspid) there are four sites at which a murmur may be produced. Two of these murmurs may be produced by the direct flow of the blood, namely those at the arterial orifices, and two by a backward flow of blood from the ventricles to the auricles, those at the mitral & tricuspid openings. Systolic murmurs are thus divided into direct- and indirect-

or regurgitant murmurs.

Direct-systolic murmurs owe their production to vibrations, sufficient to produce sound, at the aortic or pulmonary orifices, occurring either in the arterial walls or in the valve tissues.

Causes (1) Constriction of the Aortic or Pulmonary orifices, thickening, roughening & puckering of the valve flaps. Aortic stenosis is often seen, while pulmonary stenosis is rare and generally congenital. unless it be due to ulcerative endocarditis.

(2) Deposit of lymph on the valve segments. Even a minute thread of lymph may give rise to a loud murmur, which often possesses a distinctly musical character.

3 Dilatation of the aorta, or pulmonary artery immediately above the valves. The orifice may be of natural size, but more frequently are contracted. When the opening is of its usual size it is relatively narrow as compared with the dilated artery beyond.

4 Anaemic condition. This is a frequent cause of inorganic or haemic murmur, which may be heard at either orifice, but more frequently at the pulmonary opening.

2 Regurgitant murmurs – These are produced by a backward flow of blood through an incompetent Mitral or tricuspid valve.

Causes – (1) Ulceration, thickening, or contraction of the segments of the valves. Rupture of the valves

(2) Imperfect closure, or non-simultaneous closure of the valve segments

(3) Dilatation of the valve orifice, the segments being normal.

Mitral regurgitation is of frequent occurrence and often the result of primary disease. Tricuspid regurgitation is more frequently due to changes in the right ventricle, produced by backward pressure from the lungs, the result of obstruction in the lungs themselves, (cirrhosis &c) or to disease of the mitral valve (stenosis or regurgitation).

## Diastolic Murmurs

These murmurs can only occur at the Aortic or Pulmonary opening. They may replace or accompany the 2nd cardiac sound, and may extend into the long pause. A diastolic murmur is almost always diagnostic of Aortic regurgitation

as the pulmonary lesion necessary for its production is very rarely met with.

Cause The murmur is produced by the backward passage of the blood through a valve rendered incompetent by disease, or rupture of the valve flaps. The blood may escape from the aorta during the whole ventricular diastole, and therefore the murmur is frequently long, and extends into the long pause.

Diastolic murmurs are never functional or haemic.

Presystolic murmurs - These murmurs are heard during the diastolic pause (ventricular diastole) and are sometimes described as diastolic murmurs. As they occur immediately before, and end with the beginning of the ventricular systole, it is better to apply some distinctive name, such as 'pre-systolic', or, as Prof. Gairdner suggests, 'auriculo-systolic'.

Cause - Stenosis of the Mitral or Tricuspid orifice. The latter is exceedingly rare, so that a presystolic murmur for all practical purposes may be regarded as pathognomonic of mitral stenosis.

The valve orifice is altered by contraction of the segments, thickening of the chordae tendineae, deposits of lymph calcareous deposits or on the cusps. Though the blood enters the ventricle, even through a stenosed orifice, during the whole of its diastole, it is only when the force of the stream is increased by the contraction of the auricle, that a murmur is produced - thus the murmur immediately precedes, and ends with the ventricular systole. This is the usual explanation of this murmur, but Prof Austin Flint states: "It may exist in cases of pre aortic regurgitation without any mitral lesion" (Clinical Medicine P, 174)

A murmur following the second sound, and ending before the ventricular systole, is described as occurring in some cases of mitral stenosis, and is termed a post-diastolic murmur.

Besides the systolic murmurs already noticed Prof. Austin Flint describes a "Mitral systolic non-regurgitant murmur, or intra-ventricular murmur. This is heard with its maximum intensity at the situation of the apex beat and over the body of the heart. It is not transmitted far, if at all, to the left of the heart. This murmur occurs in endocarditis. It may be caused by a tendinous cord stretching

across the ventricle as an anatomical anomaly.

It may be produced by the pressure of the apex of the heart against the adjacent pulmonary tissue, the murmur then being caused by the expulsion of air from the air vesicles of the lungs. It may be due to atheroma within the ventricle, the function of the valve being unaffected. It is not therefore in all cases a murmur of importance in its pathological or diagnostic significance. The author has found this murmur twenty to thirty years ago and subsequently, in persons who at the present time are free from any symptom of cardiac disease". (Flint's Clinical Medicine P 173)

Murmurs may entirely take the place of the normal heart-sounds; or the sounds may be audible along with and accompanying the murmur. If, for example, we have a mitral systolic murmur, and the 1st sound of the heart remains audible in the mitral area, distinct from the tricuspid sound, it is fair to infer that the mitral valves are still capable of partially closing the mitral orifice, but if the mitral first-sound be replaced entirely by the murmur, the probability is that the valves no longer act, and that the mitral orifice is without any protection. To determine whether both sound and murmur are present the ear should be only partially covered by the stethoscope, or removed a little distance from it, the sound is rendered more audible the murmur less distinct.

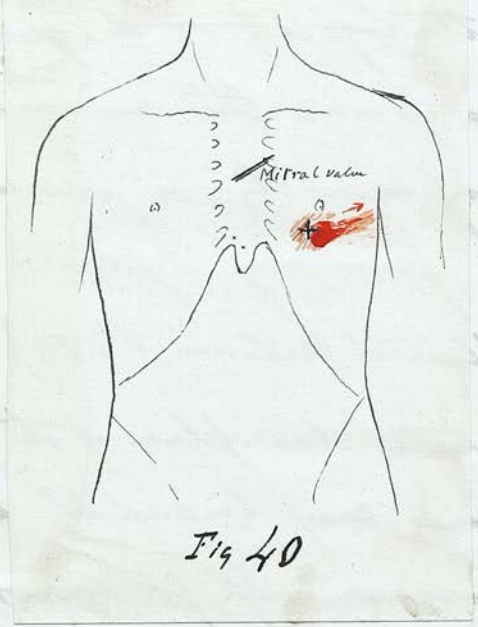



Fig 40

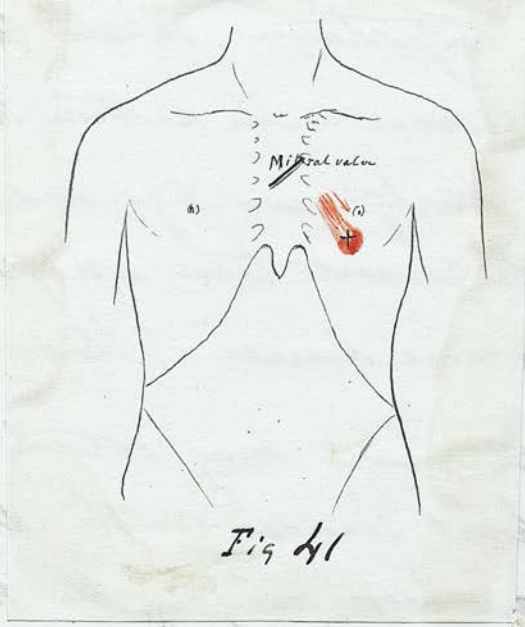



Fig 41

Fig 40 Showing point of maximum intensity and direction of propagation of a mitral systolic murmur
+ = apex beat

Fig 41 Show point of maximum intensity and direction of propagation of a mitral presystolic murmur.
+ = apex beat

Combined murmurs. Several murmurs may be audible over the praecordia, dependent upon disease of one or more of the valvular orifices. It is not uncommon to find a double murmur (systolic and diastolic) at the same valve, the lesion which caused contraction and originated a systolic murmur, rarely allowing the competence of the valve, and regurgitation occurs, causing a diastolic murmur. The most frequent double murmurs are a double aortic, & a double mitral. (presystolic and systolic) Or the murmurs may originate at different orifices, such as are seen in Mitral stenosis followed by tricuspid regurgitation the murmurs being a presystolic mitral, and a systolic tricuspid.

Points of Maximum Intensity, and Propagation of Murmurs.

Mitral Murmurs. Systolic mitral murmurs are best heard at the apex of the heart. Occasionally when the auricular appendix becomes dilated & hypertrophied and lies close to the chest wall, the murmur is loudly heard at the 2nd left intercostal space, close to the sternum. The murmur is propagated outwards to the left axilla and may often be heard at the inferior angle of the left scapula. F. 40

Presystolic Mitral murmurs are heard

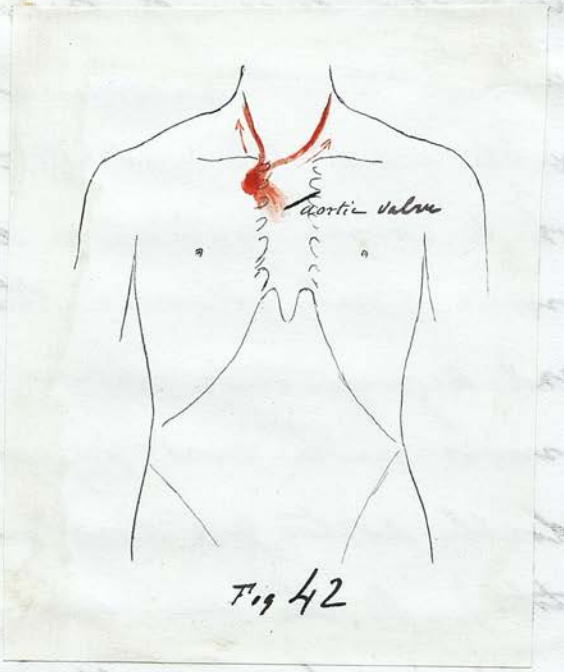



Fig 42

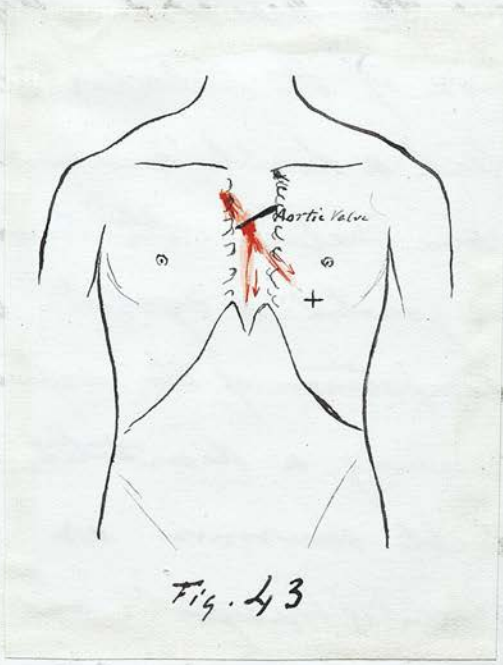



Fig. 43

Fig 42 Shows point of maximum intensity and direction of propagation of an Aortic systolic murmur.

Fig 43 Shows point of maximum intensity and direction of propagation of an Aortic diastolic murmur.
+ = Apex beat

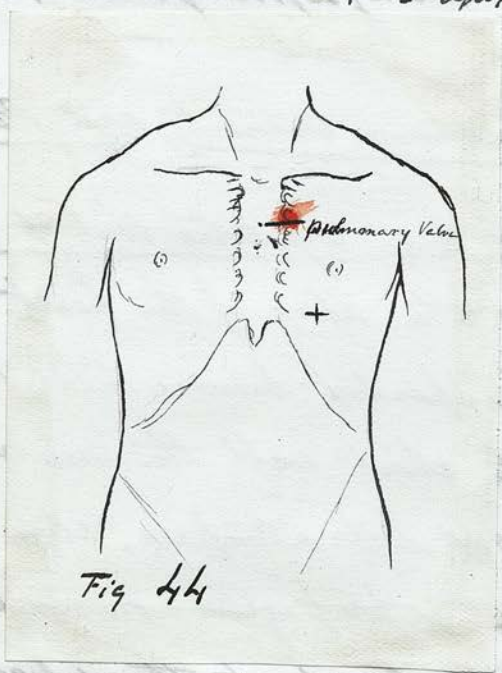



Fig 44

Fig 44 shows point of maximum intensity and direction of propagation of a Pulmonary systolic murmur.

aorta, thoracic duct, and generally, the vena azygos which lies between the crura, the oesophagus passes through a foramen formed by the decussating fibres of the crura, the vena cava perforates the central tendon; there are also small foramina for the sympathetic, & splanchnic nerves on both sides & for the vena azygos minor on the left.

The Intercostal nerves supply all these muscles except the diaphragm which is supplied by the Phrenic nerves from the fourth & fifth cervical nerves, and by the sympathetic by fibres from the plexuses round the phrenic arteries.

The other muscles acting on the Thorax are:—

The Scaleni - S. Anticus & S. posticus
Serratus posticus Superior
Serratus posticus Inferior
Serratus Magnus
Quadratus Lumborum
Erector Spinae especially the Sacro Lumbalis division
Pectorales - Major & Minor
Latissimus Dorsi
Trapezius - Subclavius
Sterno-Mastoid with Muscles of neck arising from Sternum
Triangularis Sterni
Abdominal muscles

These Muscles act on the ribs, cartilages or Sternum and bound down by fascia the greater number of them cover the thorax. External to them there is in most subjects a layer of fat which contributes to the smooth rounded appearance of the thorax, the whole being covered by the integument.

Besides the muscles named in the above list, the

with greatest intensity at the Apex, and the murmur is very soon lost as we leave that area. The murmur varies, being frequently very soft at its commencement in the ventricular diastole, and loud and sometimes rough at its close, that is with the auricular systole. Fig. 41

Aortic Murmurs.

Aortic systolic murmurs have their point of greatest intensity at the second right costal cartilage close to the sternum. They are carried upwards by the blood current and can be heard in the carotid arteries or even at a greater distance. Fig. 42

Aortic diastolic murmurs. These murmurs are frequently heard most loudly at the aortic cartilage, and are propagated downwards along the sternum and also towards the apex. Murmurs sometimes attain their greatest intensity at the xiphoid cartilage. Fig. 43

Pulmonary Murmurs both systolic and diastolic are best heard at the 2nd left costal cartilage, at its sternal articulation. Systolic murmurs are only propagated slightly upwards. Diastolic pulmonary murmurs are too rare to say definitely in what direction they would be propagated. Fig 44

Tricuspid Murmurs. Systolic regurgitant tricuspid

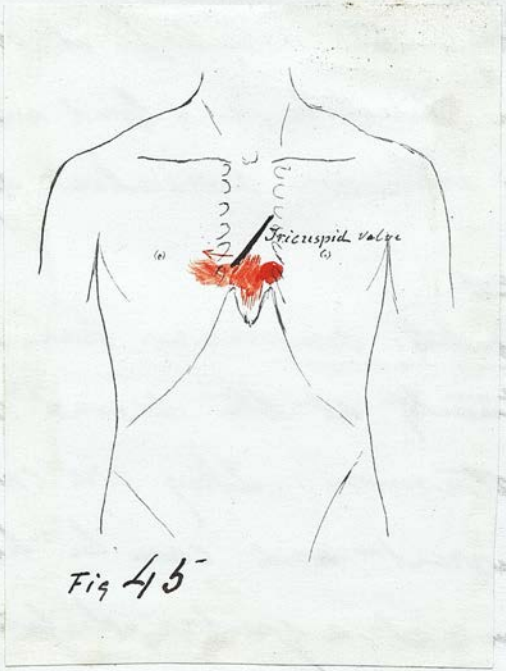



Fig 45

Fig 45 Point of maximum intensity and direction of propagation of Tricuspid systolic murmurs

murmurs are generally best heard at the lower end of the sternum, sometimes slightly extensified towards one side, right or left; probably depending on the position of the right ventricle. They do not propagated extensively but may generally be heard over the greater part of the sternum.

Presystolic tricuspid murmurs are rarely heard but would probably be heard towards the apex.

If several murmurs be present the tone of each murmur must be compared, the points where they are best heard accurately defined, and the direction of their propagation carefully considered. Fig 45

## Inorganic, Haemic, or Functional Murmurs

These murmurs occur independently of any organic cardiac lesion. They are always systolic in time and are never diastolic. They are recognised by the following characters: —

"1 By their softness, fulness, and short duration; they are of a gentle blowing quality or softly aspirated, never harsh, sawing, or rasping, &c.

"2 By their rhythm; they are, as already noted, never diastolic but invariably systolic, and generally attended by a more or less marked systolic heart-sound.

3 They occur most frequently at the pulmonary orifice, next most often at the Mitral orifice, but very seldom

'at the aortic or tricuspid valve. The systolic murmur
'is most usually limited to the pulmonary orifice,
'sometimes it is heard over both it and the
'mitral valve, occasionally over the latter alone,
'and very rarely over both auriculo-ventricular
'valves, and both arterial orifices.
'4 They are very commonly, in chlorotic subjects,
'combined with murmurs in the veins of the neck.
'5 They are not permanent, but become feeble
'as the general health improves, and ultimately
'disappear altogether". (Guttmann loc. cit. P 286)

Haemic or functional murmurs are found in
those cases where from any cause the blood is diminished
in quantity or quality. Thus after severe haemorrhage,
after profuse albuminous discharges, in fevers and
other diseases where great wasting has occured, in
chlorosis, or progressive pernicious anaemia, murmurs
occur which if the condition of the patient improve
will disappear as his health recovers.

The Explanation of their production has given
rise to much dispute and cannot yet be regarded
as settled. The following is a brief statement of the

various theories. In the later stages of anaemia, especially the pernicious form, fatty degeneration and dilatation of the cardiac cavities occur so that regurgitation takes place in some of the valves; about these murmurs there is no difference of opinion. The murmurs which occur in the earlier stages of simple anaemia are explained by the following three theories —

1 "That the murmur is pulmonary". The murmur is said to be caused by "the sudden propulsion of a 'large blood wave of abnormal (Spanaemic) composition 'into the vessel which is probably, in some cases at least, dilated"

"2 That the murmur is due to mitral regurgitation, 'and that it is conducted to the anterior wall of the 'chest through the dilated appendix of the left auricle." (Dr George Balfour's theory)

3 "That the murmur is produced in the pulmonary 'artery as the result of a constriction of that vessel, 'the constriction being caused by the pressure of the dilated 'left auricle. (Dr Russels theory) Dr Russel further believes 'that the murmurs heard in the second, third, and 'fourth left intercostal spaces in the later stages of such 'cases, is due to tricuspid regurgitation." (Bramwell l. c. Page 183)

It is not improbable that all theories are more or less correct, and that different murmurs owe their production to different causes,

some being due to simple blood changes, others to some special relation between the position of the valve flaps, their degree of tension, and the force of the blood current, at present unexplained.

## Pericardial Murmurs - Friction Murmurs.

The fremitus caused by pericardial friction has been noticed and its relation to the heart's beat pointed out. That which to the hand is communicated as fremitus, to the ear is conducted as a friction murmur.

The murmur is caused by the rubbing together of the two surfaces of the pericardial sac, roughened by the deposit of lymph during inflammation. With each contraction and expansion of the heart the two surfaces rub together and a double murmur is heard over the praecordia. The sound as a rule is rough, scraping, or a light rubbing not synchronous with any cardiac event, but occurring throughout the whole, or at any point in the cardiac cycle. The murmur disappears as effusion takes place, but a large quantity of fluid may be present and still allow of some friction sound. Occasionally when the patient lies in one position (on his back for example) no murmur may be audible, but if he change his position

and sit-up or turn on one side, so that the fluid is displaced the friction murmur may become distinctly audible. As a rule the friction is increased by pressure, but this is not always the case. Sometimes it is difficult to distinguish a pericardial murmur from one of endocardial origin, and this is especially the case when the friction sound is very soft and feeble. The history of the case, the other symptoms present, the locality of murmur, and its want of propagation, its to-and-fro character, and want of correspondence with the cardiac sounds will generally serve to distinguish the one from the other.

Pericardial-pleural-friction. Limited pleurisy affecting the layer of pleura reflected over the pericardium will give rise to a friction murmur closely resembling pericardial friction. As the heart moves the pleural surfaces are rubbed together in the same rhythmical manner which is seen in pericarditis.

Pericardial-pleural-friction is distinguished from pericardial friction by the following points.

(1) The former is best heard to one side of the heart, namely the side on which the pleurisy lies, while true pericardial friction is best heard in the middle of the praecordial region.

(2) Pericardial-pleural friction is altered by respiration. It is increased with inspiration and occasionally ordinary pleural friction may be heard.

(3) There should be no symptoms of pericarditis but this is often the case with ordinary pericardial friction, where no other symptom may occur

Significance of the Cardiac Sounds and Murmurs

1 When the sounds are normal both during rest and after exertion, we may infer that the valves are capable of performing their functions — we cannot affirm that the valves are perfectly healthy.

2 Murmurs

(a) A systolic murmur heard with greatest intensity at the apex, and propagated outwards towards the axilla, the heart probably hypertrophied & the left side, and the second pulmonary sound intensified, is significant of Mitral regurgitation

(b) A systolic murmur heard at the Aortic cartilage and in the arteries of the neck; the left auricle hypertrophied, with a small radial pulse, is diagnostic of Aortic Stenosis

(c) A systolic murmur heard at the lower part of the sternum not markedly propagated — pulsation in the jugular veins, and probably a mitral murmur also present

is due to tricuspid regurgitation.

(d) A systolic murmur heard at the 3rd left-cartilage, & the right ventricle dilated or hypertrophied is caused by pulmonary stenosis

(e) A Diastolic murmur heard at the aortic cartilage or in the middle of the sternum and propagated downward towards the xiphoid cartilage and to the apex, with hypertrophy and dilatation of the left-ventricle, and a collapsing pulse is significant of Aortic incompetence.

(f) A diastolic murmur at the pulmonary orifice has been heard but is extremely rare

(g) A presystolic murmur heard with greatest distinctness at the apex of the heart, and heard over a very limited area, with a presystolic thrill, accentuation or reduplication of the second sound (that at the pulmonary orifice is accentuated), hypertrophy and dilatation of the right-ventricle, is diagnostic of Mitral Stenosis.

(h) Tricuspid stenosis is too rare to require any notice.

(i) Systolic murmur - not always heard, ~~most~~ most intense at the base of the heart, and not markedly propagated, with a venous hum, and other signs of anaemia is functional.

following act indirectly on the thorax, or give support to the thoracic muscles viz:- The Rhomboids, the supra- & infra-spinatus, teres minor & subscapularis the muscles of the spine & neck - "In fact every muscle "which by its contraction can either elevate the "ribs or contribute to the fixed support of muscles "which do elevate the ribs, such as the Trapezius, "levator anguli ~~of the~~ scapulae, and Rhomboidei by "fixing the scapulae, may in the inspiratory efforts "which accompany dyspnoea, be brought into play" And again - "As capiration becomes more & more forced "every muscle in the body which can either by "contracting depress the ribs, or press on the abdominal "viscera, or afford fixed support to muscles, having "those actions, is called into play" (Foster's Phys.ᵍʸ P. 305 & 306)

The Thorax as a whole varies in shape in different individuals. In health the surface should be gently rounded with no marked prominences or depressions & should be bilaterally symmetrical both during quiescence and during respiratory movements.

Thoracic contents - The Lungs & air passages

The Lungs are placed one on each side of the thorax. The right lung is larger than the left and is divided into three lobes, while the left lung has only a single cleft dividing it into an upper & lower lobe.

They are closely covered by the pleura which also lines the inner surface of the thoracic cavity & divides it into two chambers by its mesial deflection, the mediastinum.

Each lung is an irregular pyramid with its base resting on the diaphragm and the blunt apex reaching

## Physical Examination of the Aorta and great Vessels

The course of the aorta in the thorax has been described, and it is easily understood that under normal circumstances the presence of that vessel in the thorax is not indicated by any physical signs. Occasionally the pulsation of the aortic arch can be felt in health when the heart is acting excitedly, by pressing deeply into the supra-sternal notch, but this is by no means frequent.

When, however the artery becomes dilated, or when a large aneurismal swelling occurs in the course of the vessel, and especially in that part which lies nearest the anterior surface, namely the ascending portion of the arch, distinct pulsation may be made out both by inspection and palpation.

The pulsation of a large superficial aneurism is easily discovered, but the slight movement occasioned by a small or deep seated swelling requires great care and is apt to be overlooked. On inspection and palpation of the praecordia the

pulsation due to aneurism has been noted, and therefore, the site of the pulsations as found in aneurisms of the different parts of the aorta in the thorax require to be named.

Aneurismal swelling of the ascending aorta causes a systolic ~~[illegible]~~ pulsation in the region of the second right intercostal space, close to the sternum. The pulsation is deep seated and may sometimes only be detected by pressing the anterior and posterior surfaces of the thorax together during expiration. The expansile pulsations, when the tumour is large, are easily recognised, and there is little or no difficulty in determining their significance.

When the transverse portion of the arch is affected the pulsation can be felt in the supra-sternal notch. The patient's head should be bent forwards and the fingers pressed deeply down behind the sternum.

Aneurisms of the descending thoracic aorta, unless they be of large size cannot usually be recognised either by inspection or palpation. Occasionally on the dorsal aspect of the thorax at the left side of

the spine pulsation may be felt if the patient be very spare and the muscles poorly developed.
Pulsation in the epigastrium is occasionally due to thoracic enlargment of the aorta, but this is not common.

Percussion of the thoracic aorta. It is only when the vessel becomes enlarged that any appreciable dulness can be heard on percussion. In aneurism of the ascending aorta well marked dulness may be made out over the site of the tumour.
If the tumour be large, and the lung be pushed aside, absolute dulness may be heard, its extent depending on the size of the aneurism.
Percussion must never be made with any degree of force, in case of causing rupture of the aneurismal sac.

Auscultation of the thoracic aorta.

The auscultatory phenomena heard over the aorta are:

1st Sounds or murmurs conducted from the heart.
2nd Murmurs generated in the vessel due to roughening of the coats
3rd Murmurs due to aneurism
4th Murmurs due to compression of the vessel.

1 The cardiac sounds and murmurs which have been described may be conducted along the aorta for some distance. The intensity of the sounds and murmurs is diminished and distant, though the sound of the murmur due to stenosis may be heard with great distinctness along the course of the vessel.

2 Murmurs due to roughening of the internal coat occur mainly at the roots of the vessel and rarely are heard except in conjunction with the ordinary murmur of aortic stenosis, or in aneurism.

3 Aneurismal murmurs — When the aneurismal swelling is small, and is deeply seated, no abnormal sounds may be heard, except perhaps the accentuation of the aortic second sound. When however the tumour approaches, or is in contact with the chest wall, the sounds of the heart are often heard with great distinctness, a phenomenon which though not of much importance in itself, is, when accompanied by accentuation of the aortic second sound, very suspicious of the presence of an aneurism. When the cardiac sounds are audible posteriorly to the left of the spinal column, in all probability an aneurism is present unless the sounds are conducted through a pneumonic lung, or some other good conductor of sound.

In some cases a distinct murmur is generated in the vessel leading to the aneurism, and is audible as a systolic blowing murmur, which occasionally is accompanied, especially when aortic regurgitation is present, by a distinct diastolic murmur.

In 1882 Dr D Drummond of Newcastle described a "whiff" synchronous with the cardiac systole, heard with a binaural stethoscope, the chest piece being placed in the mouth, during gentle expiration.

He says — "Briefly the oral whiff, which I may call 'the sign I am now referring to, can be detected 'in the following manner in cases of aortic aneurism. 'The patient is directed, while lying on his back, to breathe 'as quietly as possible through the widely opened mouth; 'the oval of the binaural stethoscope is then introduced 'into the mouth to receive the expired air. Should, then, 'the sign be present - the expiration will appear to 'be interrupted at each beat of the heart by a whiff, 'which, in some cases is very loud, whilst, in others, it 'is only detected at the end of expiration, an indication 'that it is but feebly marked. In certain cases, especially if 'the aneurism be large, a diastolic whiff can be heard as well as 'a systolic. In cases in which the sign is well marked, it can 'be plainly heard in the trachea during quiet expirations, or

when the patient is holding his breath with the mouth open and the tongue depressed, so as to allow the gaping glottis to communicate freely with the buccal cavity. In very well marked cases, the whiff is audible in the trachea with the mouth closed, but it at once disappears when the nostrils are compressed by the fingers. In seeking for this sign, it is most important to avoid cardiac excitement; hence it should only be sought for, after the patient has lain in the recumbent position for a short while, and after the reasons for inserting such a formidable looking instrument as the binaural stethoscope into the mouth have been fully explained. It is well, indeed, to school the patient accurately before commencing the examination, for nervous, interrupted respiration on the one hand, and forcible or vocal breathing on the other, will defeat the object of the examination". * * *

"In many cases, aneurismal murmurs are only audible in the trachea. I have occasionally been able to diagnose an aneurism by detecting a systolic vascular murmur in the trachea at the top of the sternum, auscultation at the base of the heart, in the so-called aortic area furnishing, at the same time, absolutely nothing abnormal beyond a somewhat muffled first sound, followed by a loud high-pitched second sound and sometimes not even that. These vascular murmurs confined to the trachea are tolerably frequent in cases of dilated aorta, and small sacculated aneurisms; in one of the cases in which the tracheal whiff was absent, this tracheal murmur was the sign which led me to a diagnosis in absence of ~~all~~ basal bruits.

'It is a fact worth remembering that all systolic
'aortic murmurs are well heard in the trachea; but,
'when they are much louder here than at the base
'of the heart, they generally mean an aneurism, either
'fusiform or sacculated. The two sounds in the
'trachea — the vascular bruit and the air whiff —
'are easily distinguished, for the latter disappears when
'the patient's mouth and nasal passages are closed,
'whilst the former are best heard under these cir-
'cumstances" (Dr Drummond - Brit. Med. Journal 1882 Vol II P 773).

(4) Murmurs due to pressure on the Aorta. Pressure which lessens the lumen of the vessel will cause a murmur at the seat of compression. The aorta may be compressed by a solid tumour, by osseous outgrowth, by a carnified lung &c, and a systolic murmur originated. This murmur will be a little later than the cardiac systole, and will be propagated in the direction of the blood flow. They are rarely heard and are explained only by the absence of other lesions and the discovery of the cause.

Examination of distant arteries.

The radial pulse in diseases of the heart

Examination of the pulse as made
1st By simple inspection
2nd By the fingers (palpation)

The superficial position of the radial artery in the wrist, resting as it does on a hard bony surface which makes its compressibility easy to be ascertained, and the convenience of its situation, render the radial the most suitable for observation of the arterial pulse. As a rule it is indifferent which wrist is examined but certain circumstances, such as malformation of one wrist, injury to the artery, unusual distribution, and various pathological conditions, may make it necessary to examine both radials, or even to choose some of the other arteries for examination.

The points to be noticed in examining the pulse are:-

The frequency; the regularity or rhythm; the volume; the strength, compressibility or tension; Celerity or quickness; Dicrotism and any special features; & the condition of the arterial coats.

(a) Frequency - The quick pulse of most fevers, as well as some of the nervous and other conditions in which an increased frequency is found have been already considered. The normal frequency of the pulse varies in different individuals, and even in the same person, variations occur within very wide limits. In infants the pulse rate is generally about 120 - 130 per minute; in children of 7 years it is from 80 - 90 or even higher;

it decreases still further as time goes on, and at 2 years averages from 65 - 75. Marked idiosyncrasies are seen in some individuals a pulse of 90 or 100 being frequently seen in perfect health, with no nervous or functional ailment to cause any increase in the cardiac rate.

Under normal conditions each systole of the heart is marked by an elevation of the artery at the wrist, so that the frequency of the pulse denotes the number of cardiac contractions. This is not always the case, as it sometimes happens that the heart may beat regularly, but distinct intermissions are observed at the wrist. When this is the case it may be necessary to examine the pulsations of the carotids or when the circulation is very weak to auscultate the heart and count the beats.

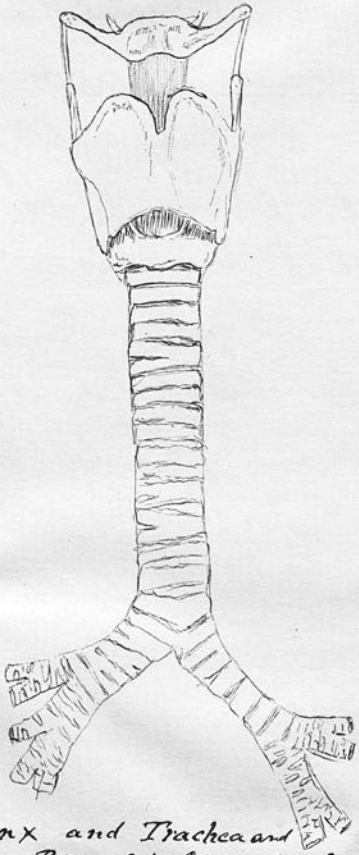
Increased frequency - During health the rate of the pulse is often temporarily increased by slight mental disturbances - the visit of the physician may produce a great elevation above the normal, and even a meal will sometimes be marked by an increased pulse rate.

"The rate of the heart's action, with which the frequency of
"the pulse corresponds, is governed by various influences.
"Resistance to the onward current of blood in the arteries, or,
"in other words, increase of pressure in the arterial system,
"whether produced by compression of large vessels, such as the
"femorals and brachials, or by obstruction in the arterioles
"and capillaries, tends to slow the action of the heart, and
"render the pulse less frequent; and conversely, diminished
"resistance or lowered tension accelerates the heart and
"pulse rate. But more direct and powerful than these
"varieties of the arterial pressure, and entirely overruling
"their tendency, are nervous influences, of which the channels
"are the pneumo-gastric and sympathetic nerves." (Broadbent-
Brit. Med. Journal - March 1887 P. 654)

In diseases of the heart the pulse is increased in frequency
in all acute inflammatory affections, in endocarditis, myo-
carditis and in pericardial inflammation, and in most
of the chronic valvular cases. During rest the frequency
is very little above the normal, but rises greatly on
exertion and the palpitation is often painfully evident
to the patient. In cases of irritable heart, whether
arising from debility or from overstrain, a persistent
increased pulse rate occurs. In the latter case the frequency is
ascribed to stretching of cardiac nerve fibres or irritation
of the ganglia.

Functional palpitation has been already noticed as a

Fig. 3.



Larynx and Trachea and Bronchi from the front

Quain Anat. P. 264 Vol 2.

painful and troublesome symptom, but the most extraordinary increase in the pulse rate occurs in cardiac neuroses, a remarkable case of which has been reported by Dr Bristowe, in which the pulse rate often numbered 200-250 and even 304 or 308 per minute. In these cases no cardiac disease is discoverable and the explanation of the rapid heart's action has not been cleared up. The increased pulse rate in exophthalmic goitre, in some forms of meningitis and in hysteria has already been mentioned.

Decreased frequency. In some individuals a slow pulse appears to be the normal condition, and a persistent slow pulse of 40-or 35 per minute is sometimes seen and must be regarded as an idiosyncrasy. It is important that such a condition should be known to the physician for a pulse rate of 60 per minute in such a case would indicate a serious rise.

In heart-lesions, aortic stenosis is alone characterised by a normal or slow pulse rate and this is due to the difficulty the ventricle has in emptying itself.

In fatty degeneration of the heart, in irritation of the vagus and in some nervous lesions a slow pulse is observed.

In gout, jaundice and some hepatic diseases also a slow pulse rate is frequently seen.

Rhythm. When the heart and system generally are healthy

the beats of the heart and pulse are regular, one beat succeeding another with regularity and each separated from the beat preceding by a uniform interval.
Disturbances of the rhythm are frequent and occur in those who enjoy the best of health.
In disease many forms of irregularity have been described some of them occurring in regular series, others being altogether devoid of regularity
Of the first group the Pulsus bigeminus in which the beats occur regularly in pairs separated by a longer interval; pulsus trigeminus where a series of three beats separated also by a well marked pause are observed; pulsus alternans where a strong beat alternates with a weaker beat; and the abortive pulse in which the weak beat is entirely lost, are the chief forms
The precise causation of these irregularities is not fully explained. The pulsus bigeminus and the abortive pulse are seen in mitral stenosis, and the use of digitalis is not unfrequently followed, in such cases, by a dropped beat. The conditions appear to run into one another and it is seldom that rhythmical irregularities continue for any length of time.
Extreme irregularities occur in some cases of irritable heart, in dilatation of one or more cavities, or in debility.
In old age the pulse is frequently irregular without

* The pulsus paradoxicus also occurs where there is obstruction to the entrance of air into the lungs, especially in conjunction with adhesive pericarditis. The wave is frequently only diminished, not entirely wanting, during inspiration.

apparently causing any inconvenience to the patient.
The influence of the respiration is sometimes very marked in exciting irregular cardiac action. It is due to the difference of pressure within the thorax during expiration and inspiration. Expiration increases the intra-thoracic pressure and thereby increases the pulse-tension and slows the heart's action, during inspiration the conditions are reversed and the pulse rate decreased.
The Pulsus paradoxicus is characterised by the absence of the pulse wave during inspiration. It occurs in cases of mediastinal inflammation, and in fibrous pericarditis, in which bands of adhesions have formed round the aorta binding it to the chest wall.* During inspiration these bands are tightened and the flow of blood through the vessel prevented. When expiration takes place the contraction is relaxed and the circulation goes on as before.
By the excessive use of tobacco, tea &c; by hysterical influences, and various excesses, extreme irregularity of the heart may be originated.

Intermission

" Intermission, occasional or habitual, of the pulse is compatible with health and vigour up to extreme old age, and, in the absence of symptoms, may be practically disregarded." (Broadbent- l. c. Page 709)
In observing an intermittent pulse we find after several

regular beats, one is omitted. This may be due either to the failure of the heart to contract, owing to some nervous failure, or to the ventricle being so poorly filled during diastole, that the muscle was either not stimulated to contraction, or the amount of blood, thrown into the ventricle, was not sufficient to raise the arterial tension so as to reach the wrist. A pulse contraction of the ventricle may give rise to intermission of the pulse at the wrist. The most important Cardiac causes of intermission are atrophy or degeneration of the walls, mitral disease or cardiac failure the result of organic changes in the heart.

Most of the irregularities of the pulse can be recognized by the finger, but in most the sphygmographic tracing is the best method of estimating them.

Volume of the Pulse. The volume of the pulse, smallness or largeness, depends on the size of the vessel, the strength of the hearts action and the amount of blood discharged during each systole, and the state of the blood pressure.

A large full pulse is seen when the hearts action is strong and a large quantity of blood is thrown into the aorta. In fevers the pulse is generally full and often bounding; in aortic regurgitation the pulse is large during the ventricular systole but falls rapidly

as soon as the pressure ceases; in hypertrophy the fulness of the pulse depends on the cause. In the less degrees of stenosis a full large pulse is seen, but when the constriction is great and especially when the mitral valve has given way, a very small pulse may be observed. In the pulsus paradoxus a very small pulse alternates with one of normal size.

A small pulse This occurs in failure of the heart in syncope and extreme debility. In valvular disease a small pulse is seen whenever the physical condition present, prevents a large quantity of blood passing into the aorta. In Mitral disease both in stenosis, when little blood enters the ventricle, and in regurgitation when a greater amount passes back into the auricle, only a small amount enters the arteries. In aortic stenosis the blood does not flow into the aorta with sufficient rapidity to raise the blood pressure, so as to distend the arteries fully, and a small pulse is the result.

Inequality in the two radial pulses is often of the greatest diagnostic importance. A normally large pulse at the one wrist, with one scarcely perceptible at the other, may be caused by pressure on the arteries on the side where the small pulse exists. This may be due to a tumour, inflammatory enlargements, or constriction by adhesions, but the most important cause

is the pressure of an aneurism which absorbs as it were the systolic increase of blood pressure and sends out ~~into~~ an almost continuous stream to the arteries beyond.

Pulse tension. The tension of the arterial pulse can be estimated with the greatest nicety by the fingers. Three fingers should be placed over the artery, with the finger highest up the wrist, that is, nearest the heart, pressure is made directly over the vessel with gradually increasing pressure until the pulsation is extinguished and no beat can be felt by the fingers below. While the flow is stopped the coats of the vessel should be examined by the lower fingers and any thickening noticed.

Dr Broadbent recommends that the vessel be rolled under the fingers, when an artery with high tension will stand out like a tendon, and it will be found possible to trace the vessel a little distance up the arm. The tension of the pulse can also be estimated by the pressure of the sphygmograph spring, but so much depends on the nicety of the adjustment of the pad and the resistance of the tissues & that the results of this estimate are always open to doubt.

The tension of the pulse depends on the state of contraction or relaxation of the arterioles and capillaries. When the blood can flow freely through the capillaries the tension of the blood in the arteries is low; when there is some impediment to the flow, as for example by contraction of the arterioles by cold or some other cause the tension of the pulse at once rises

A pulse of low tension is characterized by "the complete subsidence of all blood pressure between the beats." The pulsations are small and can be effaced with a very slight pressure.

The tension falls rapidly in syncope and in various nervous conditions; also when the arterioles are dilated as by immersion in a hot-bath; and in cases of high temperature after the rigor has subsided the pulse tension is generally low. In diseases of the heart, weak action will be accompanied by a pulse of low tension, and fatty degeneration may sometimes be diagnosed by the condition of the pulse.

The high-tension pulse - "Its distinguishing character is 'that the artery is full between the beats. So full is 'it that it can be rolled under the finger like a tendon

and followed like a solid cord some distance up the forearm, and, when the tension is well marked, no pulsation may be felt - when this is being done, unless decided pressure is made by the fingers. Not unfrequently, especially when the skin is thin, the artery can be seen to form a distinct projection, but no pulsation is visible in it, unless it is thrown into a curve, when this will be seen to be accentuated at each beat. The artery is usually small from contraction of its muscular coats, unless it has been dilated by protracted distension, when it may have much beyond the average diameter . . . it fills the finger powerfully; it persists for an appreciable time, and then gradually subsides with little or no dicrotic echo. It is the long pulse, the "pulsus tardus" (Broadbent Croonian Lectures Brit. Med. J. April 2/87 P. 711)

In cardiac disease a pulse of high tension is not found unless depending on some other affection, such as Bright's disease, where we have seen that is hypertrophy of the left ventricle. A pulse of high tension is found to arise from the following causes - 1 Heredity - a pulse of high tension existing in members of the same family. 2 Kidney disease of all kinds except such as is attended with anasarca 3 Joint and allied conditions - functional liver derangements 4 Lead poisoning with or without renal

disease 4 Gout - 5 Anaemia, 6 Pregnancy, 7 Constipation, 8 Plethora - an overladen state of the entire vascular system, and 9 Chronic bronchitis and Emphysema.

## Celerity or Quickness of the Pulse

When examined by the finger the expansion and retraction of the artery appear in the normal pulse to be nearly equal, the retraction only slightly exceeding the expansion in time. The erectness or otherwise of the sphygmographic tracing give the true relation of the duration of the two events.

By a quick pulse is meant - one which rises sharply with a bound as it were, and subsides at once under the finger. The pulse of aortic regurgitation is typically a quick pulse. It is named from its action the "water hammer pulse", or "Corrigan's pulse" after its first describer. The pulse is generally regular, visible on inspection at the wrist, often jerking and collapses suddenly, especially when the arm is raised. Its characters are well shown by the sphygmograph.

A slow pulse - "pulsus tardus" is we have seen a pulse of high tension. It occurs in the conditions mentioned above and when the arteries lose their expansile character as in atheroma.

Dicrotism - This variety of pulse can only be appreciated in its extreme degree, by the finger, but -

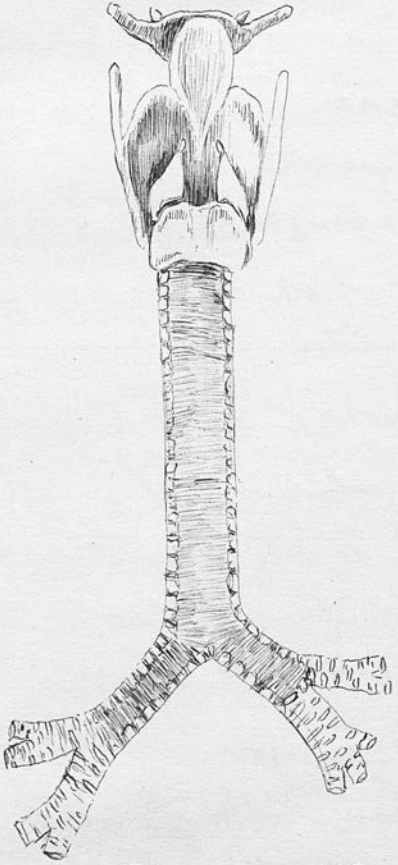
by the sphygmograph the least appearance of dicrotism is shown on the tracing. By dicrotism is meant the appearance of an extra pulse wave in the arteries, due apparently to recoil and synchronous with the closure of the aortic valves. The pulse wave appears as if doubled and this can be detected, when well marked, by the finger. In the normal sphygmographic tracing, the aortic or dicrotic notch is only feebly marked, and in high tension may be absent. It is absent in tracings from aortic regurgitation, or nearly so. When the dicrotic wave is greatly exaggerated the pulse is called dicrotica. The varieties of dicrotic pulse are called (1) Dicrotic (2) fully dicrotic and (3) hyperdicrotic, according to the development of the aortic or dicrotic wave

The conditions favourable to the development of dicrotism are

1 A low condition of arterial tension
2 Freedom of out-flow from the arterial system, i.e. through the capillaries
3 A sudden sharp ventricular systole
4 Elasticity of the arterial walls.

Clinically the pulse is dicrotic in cases in which the nerve tone (vaso-motor system) is feeble, but the

Fig. 4.



Larynx, Trachea and Bronchi from behind

Quain Anat. P265. Vol 2

'the chief condition with which dicrotism is associated
'is pyrexia – a continued temperature of 102°-104°
'being often accompanied by a dicrotic pulse.
'Hyperdicrotism is only seen as a rule in cases
'of great exhaustion" (Bramwell l.c. Pp. 256-257 condensed).

The Sphygmographs –

This is an instrument intended graphically to record the movements of expansion and retraction which occur in the pulse during the cardiac cycle. In general practice it is rarely used owing greatly to the time occupied in obtaining a tracing and to the bulk and heaviness of the apparatus. Should Dr Dudgeon's instrument prove trustworthy (which Dr Broadbent thinks is not the case) or some other portable and easily applied instrument be devised, many of the difficulties would be overcome. The Sphygmographs for diagnostic purposes however may be done without, as most of the pulse characters can be ~~then~~ ~~ascertained~~ recognised by examination with the fingers." It is rarely necessary for diagnosis, and 'scarcely ever to be trusted in prognosis" (Broadbent l.c. P. 657)
In hospital work, for teaching purposes and for research the sphygmograph is invaluable, but it is scarcely likely that it will ever come into general use

The essential parts in the construction of the sphygmograph are a 'pad' to be applied over the vessel, a 'spring' or other contrivance to apply pressure, and a 'lever', or some method, whereby the arterial movements are magnified on a card moved past the writing instrument by means of clockwork. The instrument was first introduced by Vierordt in 1854. This was followed by Marey's instrument which was modified by Mahommed and this form seems to be most reliable. A few years ago a pocket sphygmograph was brought out by Dr Dudgeon who promises great advantages from its use.

The tracing produced by the sphygmograph consists of the following parts - 1st the upstroke representing the expansion of the artery -

2nd the apex representing the state of tension during full expansion

3rd The down stroke representing the contraction of the vessel and any subsidiary waves occurring in the pulse at that period.

In a normal tracing the upstroke is vertical or nearly so, showing that the artery is distended suddenly, the length depending on the force of the ventricular contraction and the elasticity of the arterial coats, as well as the pressure applied by the instrument. The apex in normal tracings and in most cases of

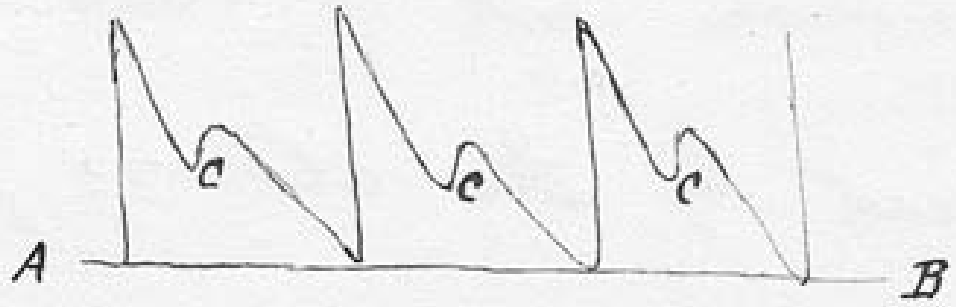
distance is provided, showing that the pressure at once begins to fall in the usual after its distension. The line of descent slopes gradually down until the base line is reached. It is uninterrupted by one, two or even more subsidiary waves. The dicrotic wave is present in most tracings and is especially marked in pulses of low tension. It is said to be due to a recoil current caused by the closing of the aortic valves. Another wave frequently seen, is situated usually above the dicrotic wave. This is named the tidal wave and is said to represent the true passage of the blood through the artery.

It is only necessary for me here to indicate the pathological varieties of tracings that are of diagnostic value.

Irregularities and intermissions are as a rule well brought out, in a sphygmographic tracing; thus the pulsus bigeminus, trigeminus, alternans &c have their characters illustrated and the irregularities of their rhythm shown, by a carefully taken tracing.

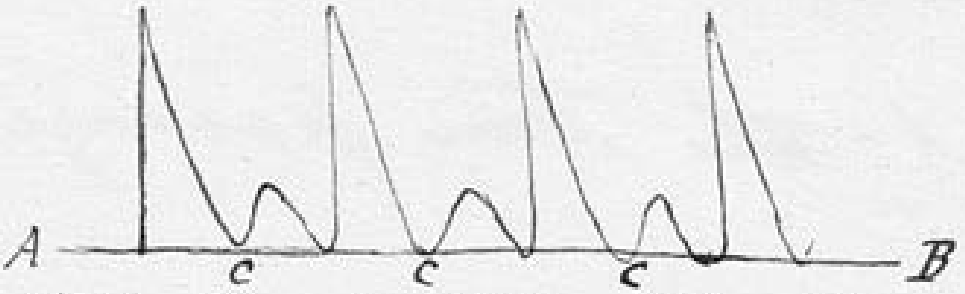
The intermission of the heart or the occurrence of a weak beat, which might be overlooked on examination with the finger, can be detected at a glance &, even, by observing the sphygmographic lever when acting.

Fig. 46

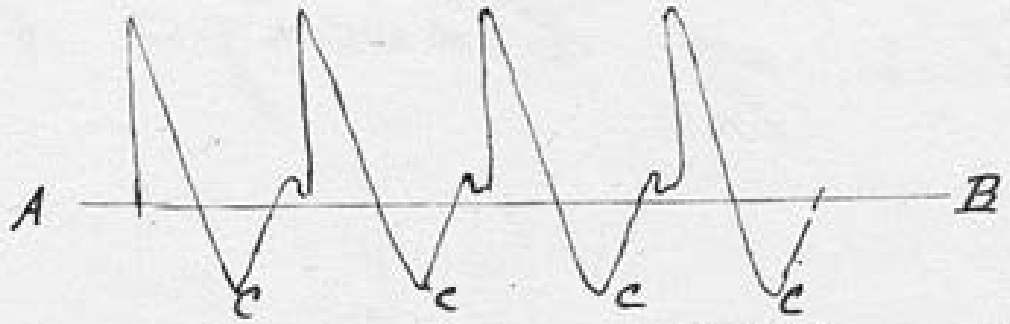



Dicrotic Pulse (after Mahommud)

AB = Baseline . C = aortic notch




Fully Dicrotic Pulse (after Mahommud)




Hyperdicrotic Pulse (After Mahommud)

AB = Base line C = aortic notch

(From Bramwell l. c. p. 255-256)

The irregular pulse of mitral disease; the pulsus paradoxus, and even the inequalities dependent on respiration, are all shown by the sphygmographs, and the tracings, taken at rest, during excitement or after the exhibition of drugs, can be compared.

In heart-disease, the pulse characters of aortic regurgitation, with its quick upstroke and sharp apex, and the very small development of the dicrotic wave, are in many cases diagnostic of the lesion present.

In aortic stenosis, the slow sloping upstroke, an apex generally rounded and the long down stroke are very significant.

In mitral lesions, supposing the aortic valves to be healthy, the pulse tracings are characterised by irregularities and differences in fulness and tension and are rarely of much value in diagnosis.

The high tension of Bright's disease, with an hypertrophied left-auricle, is shown in the high upstroke and square or rounded apex.

The characters of the dicrotic, fully dicrotic, and hyperdicrotic pulse are all well shown and as a rule more fully estimated by the sphygmographs than by the finger. The varieties are shown in fig. 46

The difference in the tracings of the two radials, in cases of aneurism affecting the artery of one side, are well illustrated by the sphygmographs.

The cardio-graph. This instrument which illustrates the cardiac impulse on the thoracic wall is too little known and even in hospital work so little used that it was necessary to give any description of the instrument or of tracings produced by it here.

Recently Dr B. Bramwell and Dr Milne Murray have invented a method by which the exact time of the occurrence of cardiac murmurs can be recorded. This is done by producing a cardiographic tracing on a revolving drum. The observer listens (the eyes being closed) with a binaural stethoscope to the cardiac murmur and signals by pressing a tambour which in turn moves a lever arranged so as to mark on the same drum as the cardiograph. By this means it was found possible exactly to determine the time of the occurrence of a murmur, with reference to the events of the cardiac cycle.

Examination of the Veins -

Distension of the veins of the front of the neck occurs in mitral disease, in obstructive respiratory affections, in disease of the right side of the heart, in pericardial inflammation, and in cases of aneurism

about an inch above the level of the 1st rib. the outer surface is convex & is applied closely to the thoracic pleura, while the inner surface is more or less concave and reaches forward to the middle line above & lower down comes into relation with the serous layer deflected over the pericardium. The anterior border is ~~sharp~~ thin and at its upper part is separated from that on the opposite side by the mediastinum. The posterior border rests in the hollow between the spine & the ribs & reaches as low as the ~~last~~ 11th vertebra; the lower or basal margin is received into the angle between the diaphragm & the costae but does not extend so low as the insertion of the diaphragm

The lungs communicate with the external air by means of the bronchioles, bronchi & trachea, through larynx, mouth & nares.

I The Trachea Fig 344 The trachea is placed in the median plane of the body and extends from the lower border of the cricoid cartilage of the larynx on a level with the 5th cervical vertebra, to opposite the 3rd dorsal vertebra. The trachea is a hollow tube consisting of an elastic framework of cartilages sixteen to twenty in number in the form of incomplete rings presenting anteriorly a curve of rather more than two thirds of a circle. They are held together by a strong fibrous membrane, in which the cartilages are imbedded. This membrane is continued across from one side to the other of the cartilaginous ring and completes the tube behind; in this part of the membrane is a layer of unstriped muscular fibres which

or solid tumour pressing on the veins; these have all been incidentally referred to in what has gone before.

Pulsation in the veins of the neck has also been noticed as occurring in tricuspid regurgitation, and the apparent pulsation arising from changes in the intra-thoracic pressure, adherent pericardium &c and therefore do not require further description.

Auscultation of the veins frequently discovers a humming murmur in the veins, which may be heard over the veins at the root of the neck, over the eyeball or torcular Herophili, and in other situations. The murmur may be heard in health, especially if pressure be made with the stethoscope. It is best heard in cases of anaemia, and in well marked cases is rarely absent. The murmur is a continuous hum resembling that heard in a shell or that produced by some tops. It is known as the bruit de diable or humming top murmur. Its production has been assigned to the altered condition of the blood, or to the falling together of the walls of the badly filled veins. The latter explanation could not hold good in the murmur heard over the torcular

when the veins cannot collapse, the cause probably lies in the condition of the blood.

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In conclusion I append a list of the principal diseases which affect the thoracic organs –

## Diseases of the Trachea and Bronchi

### Bronchitis

(a) acute (b) Chronic (c) Catarrhal (d) Plastic

Diphtheria
Ulcer
Necrosis of Cartilages
Ossification of Cartilages
Softening of Cartilages
Non-Malignant New Growth
Malignant New Growth
Tubercle
Syphilis
Dilatation
Contraction
Parasitic disease
Malformations

Injuries
Foreign bodies in trachea or bronchi
Spasmodic asthma

## Diseases of the Lung

Passive Congestion
Haemorrhage (a) Haemoptysis (b) Pulmonary Apoplexy
Oedema
Pneumonia Varieties
(a) Lobular Synonym Catarrhal
(b) Lobar. Croupous

(Diseases of the Lung continued)

Abscess
Vomica
Pyaemia
Gangrene
Cirrhosis - Syn. Fibroid Phthisis
Chronic Interstitial Inflammation
Brown Induration
Black Induration
Syn. Iron grey induration
Acute pneumonic phthisis
Chronic pneumonic phthisis
Aneurism of branches of the Pulmonary Artery
Non-malignant New growth
Malignant New growth
Tubercle
Syphilis
Emphysema (a) Vesicular
(b) Interlobular
Apneumatosis
Atelectasis
Collapse
Embolism (Infarct-)
Parasitic disease
Malformation
Injuries
Grinstone-maker's phthisis
Grinder's phthisis
Other affections due to inhalation of mechanical, chemical, or otherwise poisonous, irritants.

## Diseases of the Pleura

Hydrothorax
Pleurisy Varieties
(a) Acute (b) Chronic
Empyaema
Adhesions, including thickening and calcification.
Non-malignant New growth
Malignant New growth
Tubercle
Syphilis
Pneumothorax
Injuries

# Circulatory System

## Diseases of the Heart and its Membranes

### Diseases of the Membranes

Haemopericardium

Hydropericardium

Inflammation

1 Peri-and Endo-carditis

2 Pericarditis

Varieties Suppurative

Pyaemic

3 Endocarditis

Adherent pericardium

Pneumo pericardium

Valvular disease

Anatomical distribution

1 Aortic

2 Mitral

3 Pulmonic

4 Tricuspid

Varieties

a. Vegetations

b. Fibroid thickening and contraction

c Ulceration

d Atheroma (chronic inflammation with fatty and calcarious degeneration)

e. Aneurism of valves

f. Laceration

g Simple dilatation of orifice

h Malformation

(Diseases of heart-and membranes continued)

Non-malignant-New growth

Malignant-New growth

Tubercle

Syphilitic disease

Parasitic disease

Injuries

Clots in the Heart- (a) Thrombus (b) Embolus

Diseases of the Muscular Substance of the Heart-

Hypertrophy (a) of left-side
(b) of right-side

Atrophy

Inflammation Syn. Myocarditis

Abscess

Degeneration (a) Fatty (b) Fibroid (c) Pigmentary

Disease of the coronary arteries (a) Aneurism

Excessive growth of fat-

Malignant-New growth - Non-Malignant-New growth

Tubercle - Syphilitic disease

Dilatation (a) of left-side (b) of right side

Parasitic disease - Malformation - Injuries

Exophthalmic Goitre Syn. Graves Disease - Basedow's disease

(Cyanosis - Angina pectoris - Syncope - Palpitation and irregularity of the heart - Symptoms)

Diseases of the Blood-Vessels

Hypertrophy (a) of muscular coat (b) of fibrous coats.

Arteritis - Periarteritis - Endoarteritis

Degeneration a Atheroma (fatty and calcarous) Syn Endarteritis deformans
(b) Primary Calcareous (c) Lardaceous of Arterio-capillary fibrosis

pass transversely across the tube, and a few longitudinal fibres are also seen. A quantity of elastic tissue is found in the submucous layer lining the tube, which allows of a certain amount of stretching. Mucous glands are numerous on the outer surface of the fibrous layer. The mucous membrane lining the trachea is continuous with that lining the bronchi; it is pale pink in health and consists of a quantity of lymphoid tissue, the reticulum of which forms a well marked basement membrane. The epithelium consists of more than one layer of cells, the most superficial being columnar and ciliated; the cilia serving to expel mucous &c from the trachea, their motion being towards the larynx. The trachea is supplied by arteries from the inferior thyroid, and with nerves from the sympathetic, and the recurrent branches of the pneumogastric; it has a rich plexus of lymphatics. Opposite the body of the third dorsal vertebra the trachea bifurcates and forms the two bronchi.

In form the bronchi resemble the trachea, having a similar arrangement of imperfect cartilaginous rings in front, and are membranous behind, and the mucous membrane is in direct continuation with that of the trachea, while the glands, muscular fibres &c are the same. The right bronchus is larger in lumen and appears to be the more direct continuation of the trachea. They enter the lungs and immediately divide into two branches which subdivide again & again until they terminate in the air cells on the surface of the lungs.

Tuberculer disease – Syphilitic disease

Dilatation
Narrowing and obliteration
Occlusion by compression
Aneurism (a) Fusiform (b) Saccular (c) Diffused (cavity bounded by the surrounding tissues)
(d) Dissecting (e) Miliary – the three last rarely if ever occur in the thorax:
Rupture of artery 1 of all coats (a) from disease of artery
(b) from lesion external to artery
2 of inner coats only
Obstruction or occlusion by Clot (1) Thrombosis 2 Embolism
Cirsoid Aneurism – Aneurism by Anastomosis
Malformations – Injuries

Diseases of the Veins

Phlebitis – Varix – Obstruction
Obliteration – Thrombosis (Phlebolith) Parasitic disease
Injuries – Entrance of air
Arterio-venous Aneurism
Varicose Aneurism (a) Traumatic (b) Spontaneous
Aneurismal Varix a Traumatic b Spontaneous

Several of the diseases named are rarely seen in the thorax or its organs – The list is taken from those issued by the Royal College of Physicians London – Nomenclature of diseases 2nd Edition Pp. 67–87

Finis

divides still further and terminates in the air cells or pulmonary vesicles. These vesicles, with the bronchioles vessels, nerves & interstitial tissue make up the substance of the lung.

The Bronchia contain the same elements as the bronchi and trachea, but are cylindrical in form and the cartilages are disposed in irregular plates and imperfect rings over the whole surface of the tube, and as the tubes decrease in size the cartilaginous plates become more & more rare & are absent in the terminal bronchioles. The fibrous coat extends to the smallest divisions of the bronchial tubes, and elastic fibres and muscular bundles are also found. The mucous membrane is similar in character but is thinner than that found in the larger bronchi & trachea, and the epithelium is ciliated. On entering the terminal clusters of air cells or Infundibula the bronchioles lose their cylindrical character and become beset with minute recesses or pulmonary vesicles which become more numerous until the infundibulum is reached. The structural elements of the tube become changed, the muscular layer disappears, the elastic fibres spread out into a sort of network over the infundibulum, and the epithelium loses the cilia and gives place to a layer of cubical epithelium. The air cells consist of fibrillated connective tissue strengthened by elastic fibres, and, according to some authorities by muscular fibres also. The air-cells are lined with tessalated epithelium the cells of which are smaller and more angular at the junction of two ~~air cells~~ vesicles as shown in fig 5.

Blood Vessels. The Pulmonary artery carries the dark impure blood from the heart to the lungs: it is a short vessel arising from the right ventricle and ends at its

The bronchi are accompanied by the divisions of the pulmonary artery, the pulmonary veins, the bronchial arteries and veins, lymphatic vessels & glands, all connected together by areolar tissue and enclosed in a sheath formed by the deflection of the pleura, the whole forming what are known as the "roots of the lungs"

The Lungs - The substance of the lungs is spongy in texture and, after expansion at birth floats in water unless altered by disease, compression, or collapse when owing to the increase in the specific gravity it sinks.

When handled the lung substance causes a peculiar sensation of crepitation, and when pressed the escape of the contained air causes a crackling noise.

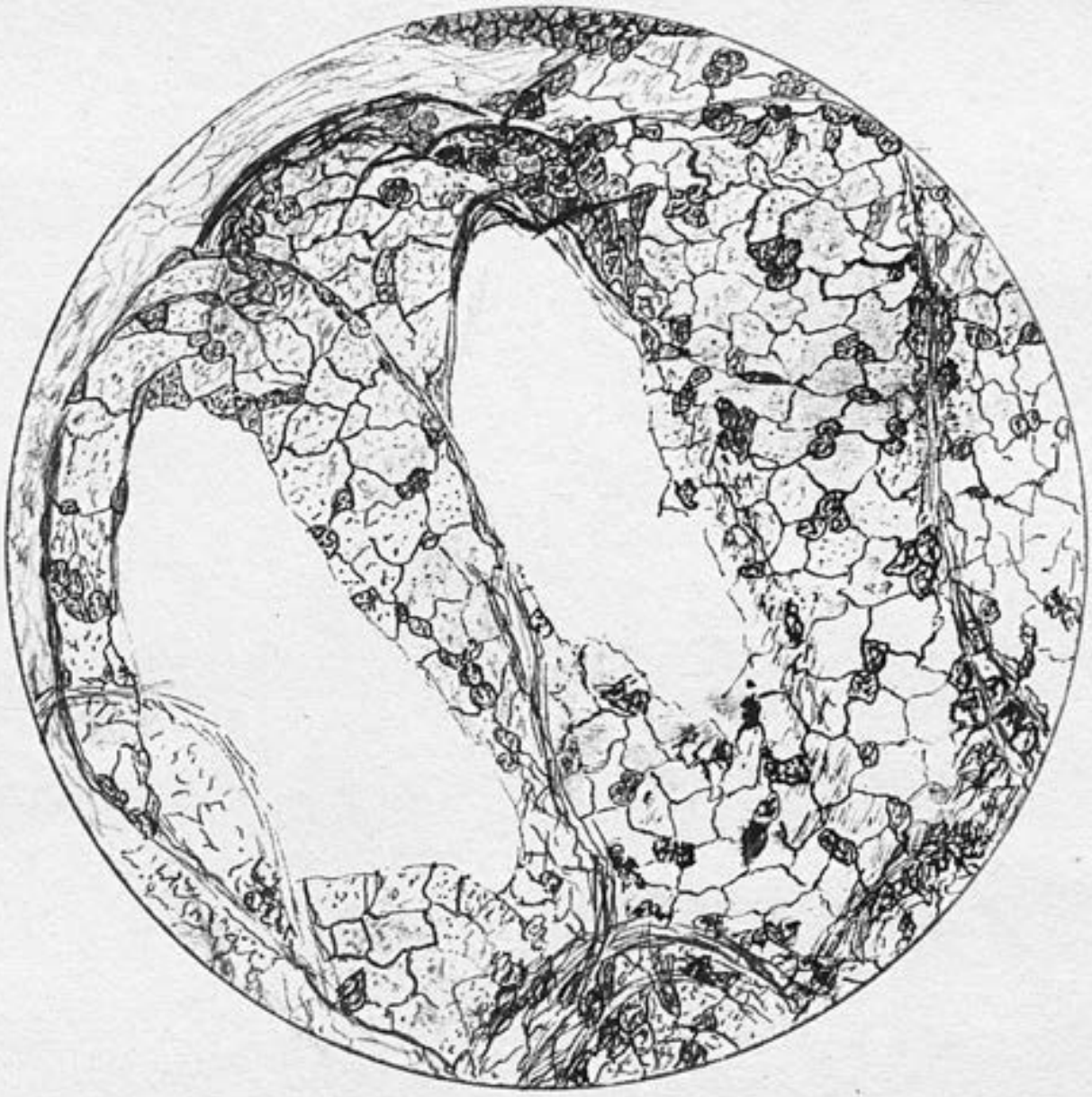
The healthy lung is pink in colour in the newborn child but in the adult is mottled & of a reddish slaty hue. The external surface is smooth & shining owing to the pleural covering. On section the colour is mottled red, the colour varying greatly even in health, and the cut surface exudes a frothy fluid consisting of serum, mucous, & air.

When inflated out of the body the lungs expand easily but contract when the air is released to about a third of the size owing to their highly elastic structure.

The lungs are covered by the pleura which has the structure of the ordinary serous membranes, and immediately below this by a thin layer of subserous areolar tissue in which is found a close network of lymphatics, which are continuous with the lymphatics of the interalveolar septa of the lungs and open by stomata into the pleural sack.

As already stated the bronchi divide & subdivide within the lung substance until they attain very small dimensions, when they enter distinct pulmonary lobules within which each tube

Fig. 5.



Section of Normal Lung

Shewing group of alveoli and character of epithelium

Stained with Argent. Nit. X about 300 diam.

division under the aortic arch into right and left pulmonary arteries. The latter arteries enter the lungs at the roots and immediately divide & subdivide, their branches accompanying the divisions of the bronchi, without anastomosis, until they end in the capillary network round the air vesicles. The network of capillaries is spread over the whole air surface of the lungs and lies immediately below the epithelium and is found wherever the terminal bronchia are beset with alveoli. The meshes of the network are very fine, being scarcely wider than the vessels themselves. Round each alveolus is an arterial circle which communicates freely with the corresponding circles of neighbouring alveoli. The pulmonary veins arise from the capillary network over the alveoli, and for the most part follow the course of the bronchia, but in some places pass alone through the lung substance. The veins coalesce into large vessels and pour their blood, by two openings on either side into the left auricle. The veins are without valves & anastomose freely.

The substance of the lung is supplied with blood by the bronchial arteries. These vessels, one to three in number on each side, are branches of the aorta or of an intercostal artery and ramify in the lymph glands, on the coats of large blood vessels, on the air tubes, and give supply to the fine capillary plexus within the bronchial tubes, which becomes continuous in the smaller tubes with the plexus supplied by the pulmonary vessels; other branches form plexuses in the interlobular tissue; others spread out over the pleura where they form plexuses and a capillary network. Part of the blood is returned from the lung by the pulmonary veins. The bronchial veins unite at the root of the lung, opening on the right side into the

azygos vein & on the left-side into the superior intercostal vein.

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## Mechanism of Respiration

"The lungs are placed in a semi-distended state in the air-tight thorax, the cavity of which they, together with the heart, great blood vessels and other organs completely fill. By the contraction of certain muscles the cavity of the thorax is enlarged; in consequence, the pressure of the air within the lungs becomes less than that of the air outside the body, and this difference of pressure causes a rush of air through the trachea into the lungs until an equilibrium of pressure is established between the air inside and that outside the lungs. This constitutes inspiration. Upon the relaxation of the inspiratory muscles (the muscles whose contraction has brought about the thoracic expansion), the elasticity of the chest-walls and lungs, aided perhaps to some extent by the contraction of certain muscles, causes the chest to return to its original size; in consequence of this the pressure within the lungs now becomes greater than that outside, and thus air rushes out of the trachea until equilibrium is once more established. This constitutes expiration; the inspiratory and expiratory act together forming a respiration". (Foster Physiology Page 296 (3rd Ed.)

The space within the thorax is increased by the elevation of the ribs and consequent forward movement of the sternum & by the contraction of the diaphragm. If a rib with its cartilage be considered as an arc of a circle it will be seen that during rest- or during the pause before inspiration that the greatest convexity is directed downwards & outwards; during the inspiratory movement this convexity changes its direction & at the close of inspiration looks more directly outwards. At the same time the sternal extremities rotate in an upward direction so that the

sternum is pushed forward and upwards & the ribs have a less oblique direction than before. Thus the capacity of the thorax is increased both in the antero-posterior & transverse diameters.

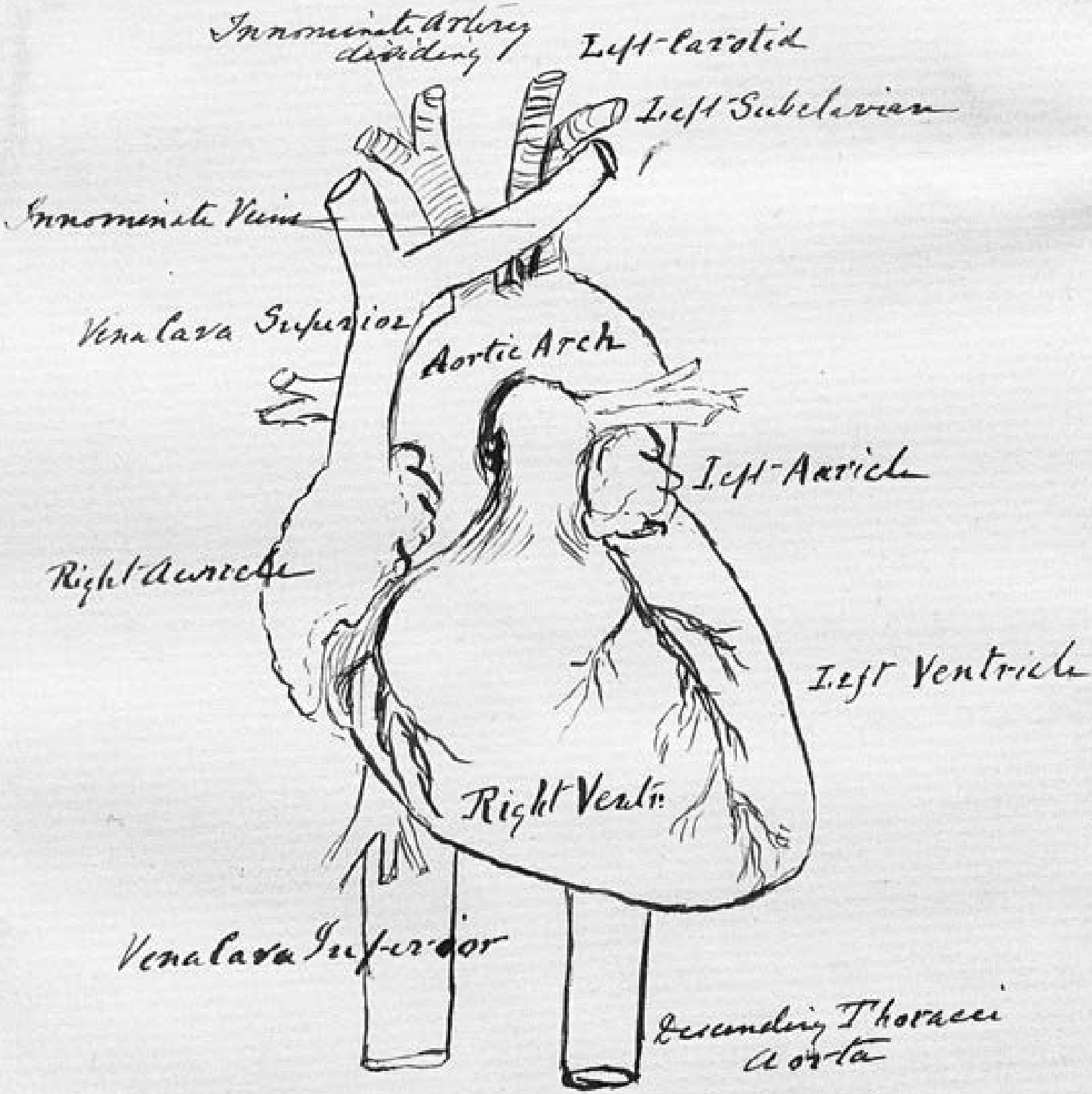
During normal inspiration the ribs are raised by the contraction of the intercostal muscles, both external and internal. These act on all the ribs, but as the first pair is less moveable than those below their action is to draw the lower ribs upwards. The levatores costarum draw the ribs upwards and tend to throw their sternal extremities forwards, while the intercostals with the subcostals contribute largely the rotatory motion of the ribs. The Scaleni muscles probably act during quiet-inspiration by raising the first two ribs, or by rendering them fixed. When the diaphragm contracts the vertical diameter of the thorax is increased by the descent of its floor. The abdominal viscera are displaced and the abdominal wall thrown forwards.

During forced inspiration the scaleni muscles are strongly contracted, the serratus posticus superior by its contraction raises the ribs, the false ribs become fixed giving additional support to the diaphragm. The muscles passing from the chest to the shoulder come into play; the shoulders and arms are fixed and the pectoral muscles, serratus magnus, latissimus dorsi are thrown into strong contractions and as before stated all the muscles which can increase the thoracic capacity or give support to muscles which have such action are brought into play.

Normal Expiration is mainly due to the elastic reaction of the ribs, costal cartilages and of the lungs themselves. The triangularis sterni by pulling down the costal cartilages and the elasticity and contraction of the abdominal muscles will aid in the expiratory act.

In laboured expiration the abdominal muscles are the chief factors aided perhaps by the serratus posticus

Fig. 6.




Out-line of Heart and Great Vessels
Semi Diagrammatic

inferior and by portions of the sacrolumbalis, but, as in inspiration, every muscle which can act directly or indirectly in diminishing the capacity of the thorax may be thrown into action.

Facial and Laryngeal Respiration — In normal respiration the air enters the lungs through the nasal passages where it becomes warmed by passing over the highly vascular membrane lining the nose. During inspiration the nostrils are slightly expanded by the action of the dilatores nasi and the elasticity of the cartilages causes their contraction during expiration. When the breathing becomes laboured these movements are much more evident. On the passage of the air through the larynx there is generally seen a certain amount of expansion and contraction of the glottis; but during forced inspiration the glottis is widely opened by the action of the posticus crico-arytenoid muscles aided probably by all the muscles which by their action can relax the vocal cords or fix the larynx. During forced expiration the cords either fall loosely together or by the action of certain muscles are approximated & rendered tense when phonation occurs. "Whether there exists a rhythmic contraction and expansion of the trachea and bronchial passages effected by means of the plain muscular tissue of those organs and synchronous with the respiratory movements of the chest is uncertain" (Foster loc. cit. P. 306)

The Circulatory Organs — Heart & great vessels Fig. 6

The Heart lies in the front of the thorax, slightly to the left of the middle line. It is enclosed in a membranous covering or sack — the pericardium, which entirely surrounds the heart and extends for a short distance over the aorta and great vessels at the base of the heart. The pericardium consists of two layers an external fibrous coat, which has the structure of ordinary fibrous membrane, and an internal serous layer which lines the internal surface of the pericardial sack and is reflected over the external surface of the heart.

The serous coat invests the vessels entering and leaving the heart for a considerable distance with the exception of the Vena cava inferior on which the reflection is very limited. The pericardial sack is conical in shape, the base resting on the diaphragm, and when distended with fluid presents anteriorly a broad triangular surface.

The Heart is a hollow organ of muscular tissue, and is divided into two distinct parts which may be called right and left hearts, these divisions are again divided into a receiving chamber - the auricle, and a discharging chamber - the ventricle.

In shape the heart is somewhat conical and is often likened to the closed fist; the apex is directed downwards and to the left, while the basal portion looks upwards and backwards. The median division is somewhat oblique so that the right auricle and ventricle occupy the greater part of the anterior surface and only a small portion of the left ventricle can be seen anteriorly when the heart is exposed in situ. The right auricle occupies the right anterior portion of the base of the heart, the auricular appendix being at the upper angle to the front. The cavity of the auricle may be described as irregularly cubical and at its posterior angles are seen the openings of the superior and inferior venae cavae. The posterior wall is the septum between the auricles and near its lower border are the remains of the foramen ovale, which in the foetal state is patent. At the margin of the opening of the inferior cava is the Eustachian valve a thin fold of membrane serving in the foetus to direct the blood in the left auricle. The Auricular Ventricular opening, which occupies the greater part of the anterior-inferior wall is large enough to admit three fingers within the orifice and is protected by valves. The other openings in the right auricle are those for the coronary veins,

of the lesser cardiac veins, and the foramina of Thebesius some of which are closed into, while others are the openings of small veins. The interior surface is smooth, with the exception of the walls of the appendix which are ridged vertically with prominent muscular bands called musculi pectinati owing to their arrangement like the teeth of a comb. The venous openings are unprotected by true valves. The right Ventricle occupies the greater part of the anterior surface of the heart. The posterior wall is formed by the interventricular partition which bulges into the cavity of right ventricle, while the superior wall is occupied by the auricular opening and by the pulmonary orifice. The inner surface of the walls of the ventricle are elevated into ridges by muscular bundles (columnae carneae) which are more prominent in certain parts forming two or three distinct projections from the ventricular wall, one anterior and one posterior, named musculi papillares which give attachment to tendinous fibres the chordae tendineae, through which they act on the segments of the tricuspid valve, serving to keep the segments tense during the ventricular contraction. The auricular-ventricular valve consists of three segments formed mainly by a reflection of the endocardial lining. The valve closes during the contraction of the ventricle and thus prevents any backward flow of blood into the auricle. The Pulmonary orifice is guarded by three semilunar cusps and resembles the aortic valvular arrangement. The left Auricle is similar in structure to the right. It occupies the left posterior part of the base of the heart, the appendix being the only part visible in front. The openings in the auricle are those for the pulmonary veins, two on each side of the posterior wall, unprotected by definite valves; and

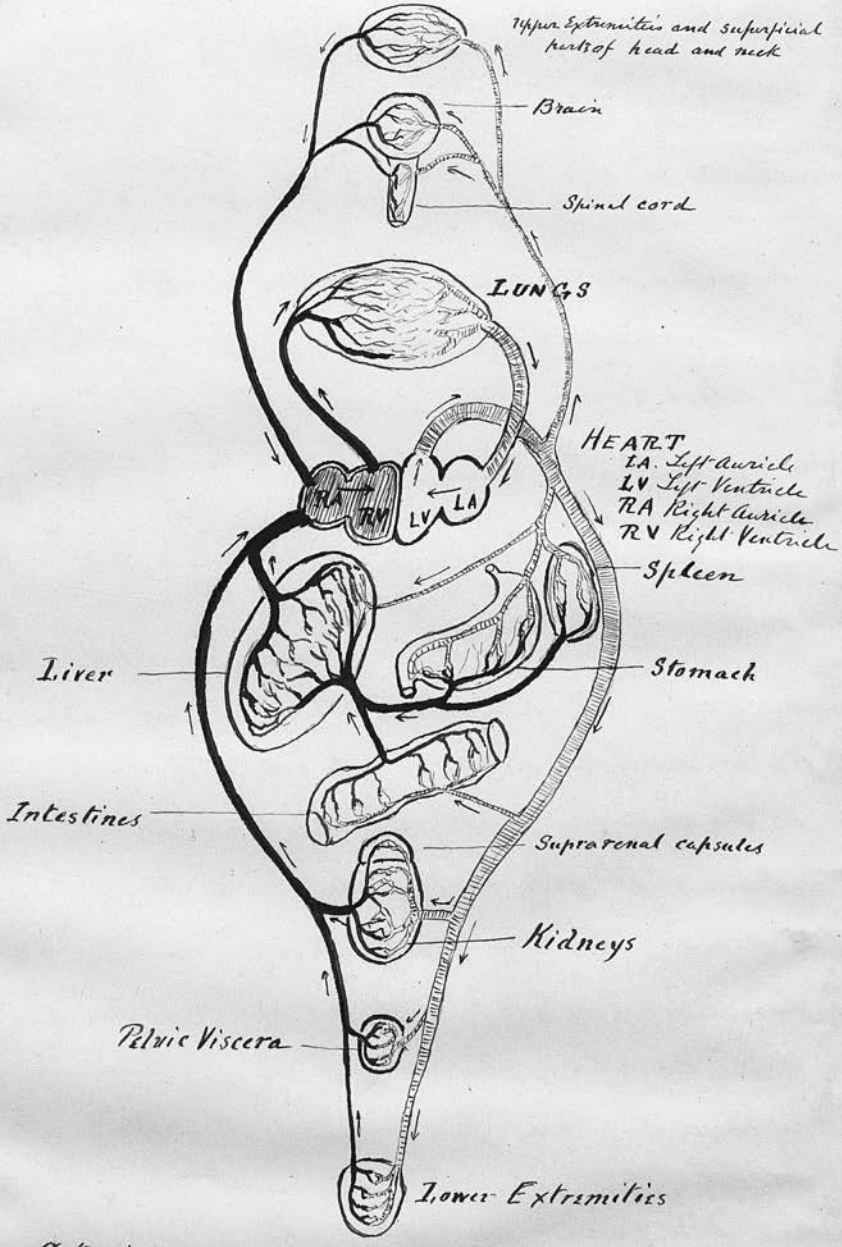
the auricular ventricular opening in the lower and fore part of the floor. A depression corresponding with that in the right auricle represents the obliterated orifice of foramen ovale.

The left Ventricle forms the left posterior and lower or apicle part of the heart. Anteriorly it is visible along the left border of the right ventricle and forms the apex of the heart. The cavity is oval on section and the walls are thicker and stronger than those of the right ventricle. The columnae carneae are smaller and closer, and the muscular papillares are larger than those on the right side, giving attachment through the chordae tendineae to the cusps of the mitral valve. The orifices of the aorta and the auricular-ventricular openings are placed close together in the ventricle, the aortic opening being towards the front, while the auricular opening lies posteriorly and somewhat to the left. The auricular orifice is guarded by a valve similar to the tricuspid in structure but having only two distinct cusps. The segments are thin fibrous flaps covered by a layer of Endocardium and attached at their fore ventricular edges to the chordae tendineae, which unite them to the musculi papillares, the contraction of the latter holding the valvular segments in position during the systole of the ventricle.

The Aortic orifice is circular, and is defended by three semilunar flaps attached by their circular margins to the sides of the arterial opening, having a slightly curved border which projects towards the lumen of the vessel. The three segments are strengthened

# Fig. 6.

Diagrammatic representation of the course of the Circulation (Modified from Dalton)




Arteries marked by cross shading

Veins dark

From Byrom Bramwell's Diseases of Heart P. 4.

by a tendinous band running along their free margin which is slightly thickened in the middle and forms a small nodule called the corpus arantii. The aortic valve differs from the pulmonary in being slightly larger, the cusps stronger and more tendinous, and the capacity of the sinuses of Valsalva greater. In the aorta the cusps are arranged, one anteriorly and two posteriorly, the coronary arteries arising one from the anterior sinus, the other from the left posterior sinus. In the pulmonary valve the segments are placed two anteriorly and one posteriorly, and the orifices of the arteries are absent.

The circulation through the Heart and Lungs: (Fig. 6.)
The venous blood from the systemic circulation is received into the right auricle during its diastole which is synchronous with the "pause" in the cardiac sounds, during part of which time "the blood flows in an unbroken stream from the venae cavae into the [right] ventricle." (Foster loc. cit. P150). The auricle when filled contracts sharply, driving the blood through the tricuspid orifice into ventricle, then it a state of diastole. The contraction of the right ventricle immediately follows, the backward flow into the auricle is prevented by the tricuspid valve and the blood forced through the pulmonary ~~orifice~~ arteries to the lungs. The pulmonary valves immediately close at the conclusion of the ventricular contraction or systole, preventing any regurgitant flow into the ventricles. By repeated cardiac contractions and by the contraction of the arteries, the blood is forced on through the lung capillaries into the veins, whereupon it is poured into

the left auricle, which in turn contracts, driving the blood through the mitral orifice into the left ventricle. The systole of the left ventricle is similar to that of the right but is more powerful and therefore greater strain is thrown on the mitral valve than on the tricuspid. At its conclusion the aortic valve closes & prevents regurgitation. In health the systole of the left auricle is synchronous with the contraction of the right & the two ventricles also contract synchronously.

During the cardiac cycle the movements of the heart are evident on inspection of the praecordia, in the production of the apex beat at a point an inch and a half below the left nipple, generally in the 5th interspace; sometimes in a diffuse heaving in other interspaces or in pulsation in the epigastrium. The apex beat is produced by the contraction of the left ventricle. During the diastole the apex remains in contact with the chest wall (except perhaps in certain positions of the body, as lying on the back, it may fall away) and the sudden hardening which occurs during contraction conveys an impulse to the chest wall which may be seen or felt with the hand.

Production of the Heart sounds — Two sounds are heard during each normal cardiac revolution — one long and dull, the 'first sound' occurring during the greater part of the ventricular systole, the other short and clear following immediately after the conclusion of the systole but separated by a short interval from the 1st sound. The production of the first sound has given rise to much discussion — the muscular contraction

of the ventricles, the sudden tension or stretching of the valvular segments, the vibrations of the cordae tendineae when tense, the impulse of the heart against the chest-wall, having all been as its cause. Probably the sound is due entirely to vibration caused by the sudden stretching of the segments & cordae belonging to the mitral and tricuspid valves.

The second sound is also entirely valvular. When the ventricular contraction ceases, the backward pressure in the arteries closes the valves with a sharp snap and the vibrations caused by the sudden tension is conveyed to the ear as the short second sound.

In reality four sounds are produced by the closure and tension of each valve but the two first sounds and the two seconds occur together so that only one first & one second sound reaches the ear.

Nervous supply of the Heart: The Heart is supplied with nerves from the sympathetic and pneumogastric trunks. The nerves from the sympathetic, three in number, arise in the neck, one from each of the cervical ganglia, and descend into the thorax in more or less close relation with the vessels of the neck, and communicating with the branches of the pneumogastric. In the thorax there is a connection with the recurrent laryngeal branch of the Vagus, and branches are given off to the aorta, the nerves ending in the cardiac plexus.

Cardiac branches from the Pneumogastric arise both in the neck and in the thorax. In the neck they communicate with the sympathetic nerves and lie in immediate relation to the sheaths of the carotid or innominate arteries and terminate in the ~~deep~~ cardiac plexus either separately or blended

with the sympathetic branches. The thoracic branches of the vagus (cardiac branches) lie at the sides of in front of the trachea, those on the left side arise from the recurrent-branch and the nerves on both sides terminate in the cardiac plexus.

The cardiac plexus is divided artificially into a superficial division lying under the arch of the aorta and which receives the superficial cardiac branch of the sympathetic and the lower cervical branch of the Vagus; and a deep division (which may be subdivided into a right & left division) lying behind the arch of the aorta and therefore in close relation with the trachea. All the cardiac nerves except those mentioned as terminating in the superficial plexus, end in this division. From the cardiac plexus nerves proceed to the heart forming over it a dense plexus of nerves which is particularly dense in the arterial grooves, where it receives the names of the right and left coronary plexuses.

Nerves in the Thorax - The sympathetic -

The ganglia of the sympathetic lies over the heads of the ribs, and beneath the pleura, being continuous with the cervical sympathetic in the neck and the lumbar sympathetic in the abdomen. The ganglia usually correspond with the number of ribs but that for the first rib is rarely distinct. From the six upper ganglia, communicating branches are given to the upper intercostal nerves, and from the lower six to the corresponding lower intercostals, and from these ganglia the splanchnic nerves arise. The great splanchnic nerve arises in the thorax from the 7th 8th and 9th ganglia, the lesser nerve from the 10th and 11th ganglia

and pierce the crus of the diaphragm on either side to join the solar and renal plexuses. The least splanchnic arises from the 12th ganglion and goes to the renal plexus.

The Pneumogastric or Vagus enters the Thorax, on the right side, between the subclavian artery and the right innominate vein. It runs along the side of the trachea to the bifurcation, to form the pulmonary plexus on the back of the right bronchus, from which plexus the nerve supply to the lungs is chiefly derived. The right Pneumogastric also supplies the oesophagus forming with branches from the nerve on the left side the plexus gulae; it then passes through the diaphragm to reach the back of the stomach. The Left Pneumogastric as it enters the thorax lies between the left carotid & left subclavian arteries, passing behind the innominate vein. It crosses in front of the arch of the aorta, giving off the recurrent branch, which winds round the arch. Branches are given off to the left lung, to the oesophagus (plexus gulae) and from the recurrent laryngeal, the cardiac branches. The nerve pierces the diaphragm and is distributed over the front of the stomach.

The Phrenic Nerves from the fourth and fifth cervical nerves descend through the thorax to the diaphragm. Both nerves lie on the roots of the lungs, that on the left side crossing the arch of the aorta internal to the Vagus, and then pass between the pericardium and the pleura to the diaphragm. They are accompanied by the comes nervi Phrenici artery, a branch of the internal mammary.

The Intercostal nerves are distributed to each intercostal space, and accompany (except in the 1st space) the intercostal arteries and veins, running along the lower border of each rib. The 1st intercostal nerve joins the brachial plexus and only gives a small branch to the 1st interspace.

The great thoracic vessels.

The aorta springs from the base of the left ventricle and is first directed slightly forwards over the right ventricle, the pulmonary artery lying in front and left, the superior vena cava to the right and behind the root of the right lung. The vessel ascends as high as the level of the second dorsal vertebra and then arches over the left bronchus and right pulmonary artery to reach the left side of the vertebral column. The "left Pneumogastric, left phrenic, and the superficial cardiac nerves lie in front; behind the trachea, oesophagus and thoracic duct, the right pneumogastric & left recurrent laryngeal nerves, oesophagus & thoracic duct. Above the left innominate vein" (Heaths Anatomy Page 385). This part of the vessel gives off the Innominate artery to the right side of the neck, the left common carotid and left subclavian to the left side. It next descends on the left side of the vertebrae, to which it is bound by pleura, till at the level of the 5th dorsal vertebra it passes into the thoracic aorta. This portion lies first to the left and afterwards in front of the ~~spinal~~ vertebral bodies crossing the vena azygos minor. The root of the right lung crosses in front and lower down the oesophagus passes obliquely from left to right. The thoracic duct, and vena azygos major lie to the left side. The branches of the aorta, besides

those mentioned are, the two coronary just above the aortic valve, and from the thoracic portion, the pericardiac, bronchial oesophageal, and mediastinal branches arise, also the intercostals.

The aorta passes between the crura of the diaphragm into the abdomen.

The Pulmonary vessels have already been noticed in the description of the lungs.

The Vena Cava superior formed by the junction of the right and left innominate veins. The latter veins receive the blood from the head & superior extremities and lie in front of their corresponding arteries but the left innominate vein crosses above the arch of the aorta in front of the trachea and left carotid to join the vein of the opposite side. The vena cava receives the vena azygos major and opens into the left auricle. The Vena azygos major passes through the aortic opening in the diaphragm, ascends to the right of the vertebrae receiving the vena azygos minor and sometimes the superior intercostal vein and opens into the superior cava. The Vena azygos minor receives the lower intercostals on the left side and crosses the vertebral column beneath the aorta to join the azygos major vein.

The Inferior Vena cava conveys the ~~blood~~ the whole of the blood from the abdomen and lower extremities and pierces the diaphragm and opens into the right auricle.

Lymphatics. The thoracic duct lies between the Aorta and Vena azygos major. It arises from receptaculum chyli, piercing the diaphragm to the right of the aorta and lies on the vertebral column until the level of the 4th dorsal vertebra when it passes obliquely over to the left beneath the arch of the aorta and ascends in the neck as high as the 6th cervical vertebra and then

curves downwards to enter the left internal jugular vein, close to its junction with the subclavian vein. The Bronchial lymphatic glands lie round the bronchi close to the bifurcation of the trachea and communicate with the lymphatics of the lungs. Other glands are found round the oesophagus, in the intercostal spaces, and in the posterior mediastinal space.

The Oesophagus enters the thorax behind the trachea having the apices of the lungs on either side. It descends in the chest passing behind the arch of the aorta and lower down crosses that vessel obliquely and lies immediately in front of it when the diaphragm is pierced. As has been seen the lungs occupy the greater part of the space on each side of the thorax, the space between them is divided into the anterior, middle, and posterior mediastina — "The Anterior Mediastinum, is the small "space bounded by the sternum in front, the pericardium "behind, and the pleurae at the sides, and is placed a little "left of the median line. It contains (1) the triangularis sterni "muscle, (2) the origins of the sterno-hyoid and thyroid muscles, "the remains of the thymus gland (a ductless gland largely developed "in the foetus); (4) the left internal mammary vessels; some "cellular tissue and a few lymphatics.

"The Middle Mediastinum is the space between the two lungs "and contains therefore (1) the heart and large vessels (2) the "pericardium (3) the roots of the lungs (4) the phrenic nerves. "The Posterior Mediastinum is behind the pericardium" ... bounded by the pleurae on each side, the vertebrae behind and the pericardium in front, and contains "(1) the thoracic aorta, (2) the trachea

Left Side

7 Intern. Mammary Art.
8 Innominate Vein
9 Phrenic Nerve
10 Pneumogastric Nerve
11 Recurrent Laryngeal Nerve
12 Cardiac Nerves
13 Left Carotid
14 Left Subclavian
16 Thoracic Duct
17 Sympathetic
18 Superior Intercostal Art.
19 First Dorsal Nerve
16 Apex of Lung and Pleura

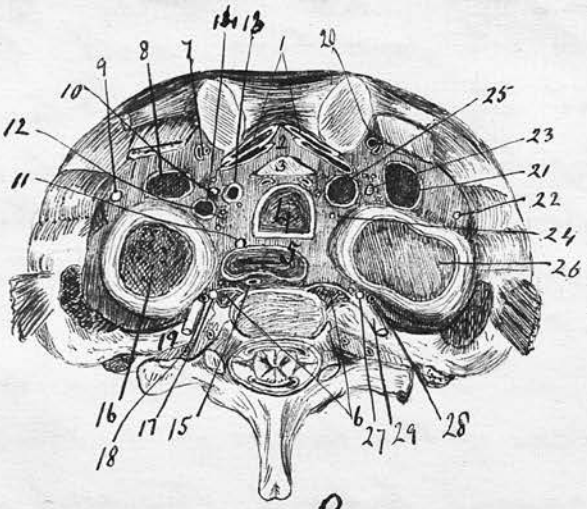



Fig. 8

Heath's Anatomy P. 103.

Right Side

20 Intern. Mamm
21 Innom. V.
22 Phren. Nerve
23 Pneumo. gast.
24 Cardiac Nerves
25 Innominate artery
27 Sympathetic
28 Intercostal Art.
28 First Dorsal Nerve
26 Apex of Lung and pleura

Median Line

1 Sterno-Hyoid muscles
2 Sterno-Thyroid muscles
3 Remains of Thymus Gland
4 Trachea
5 Oesophagus
6 Longi Colli Muscles

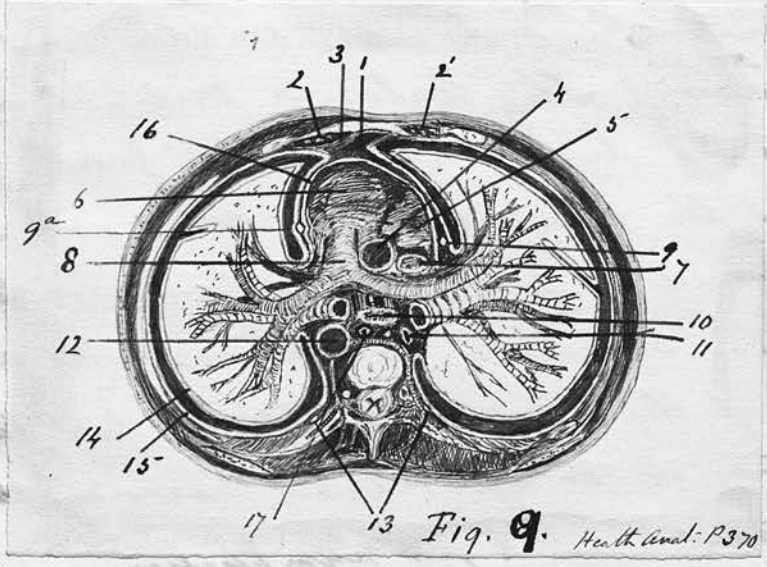



Fig. 9.

Heath Anat. P 370

1

1 Anterio Mediastenum
2 & 2' Internal Mammary Vessels
3 Triangularis Sterni Muscle
4 Aorta
5 Right Auricle
6 Right Ventricle
7 Vena Cava Superior

8 Pulmonary artery
9 Right phrenic Nerve between Pleura and Pericardium
9a Left do. do.
10 Oesophagus with left vagus in front and right vagus behind.
11 Vena Azygos Major

12 Thoracic Aorta giving off intercostal arteries
13 Ganglia Cord of Sympathetic
14 Visceral and
15 Parietal Layer of the Pericardium
16 Pericardium
17 Thoracic Duct in Posterior Mediastenum

(3) the oesophagus with the two pneumogastric nerves, (4) the vena azygos major (5) the thoracic duct; (6) the greater splanchnic nerves at the lower part of the space, with some cellular tissue and lymphatics.

The relations of the thoracic viscera are fairly well shown in the diagrams (figs 8 and 9.)

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## Examination of the Patient

When seeing a patient for the first time, there are certain particulars which require to be noted and which in the form of case-taking are set down as 'preliminary information'. Some of the questions will in many cases be found to have no practical bearing on the case but it is necessary to go into them in order that nothing may be wanting to make the case complete.

Name The name of the patient is generally useful only as a means of reference but may sometimes be interesting as shewing how members of the same family however remotely connected are affected by similar diseases.

Address - The full postal address should be carefully noted in order that the patient may be traced after leaving hospital, or his friends communicated with if necessary.

Residence This is often of importance as bearing on the

causation, or the continuance of the disease and seems to be of especial value in disease of the respiratory system. Bronchitis is common in all countries with the exception of those which have a very dry climate. Upper Egypt for example shews a remarkable immunity from bronchitis and catarrh (Hirsch; Handbook of Geographical Pathology Syd. Soc. Page 5.) In warm countries Hirsch points out that the natives are more subject to catarrh than are foreigners. Pneumonia is subject to the same conditions as bronchitis, districts where water is plentiful, drainage deficient and a low temperature common, are favourable for its development, and when the population is crowded it is apt to become epidemic, especially if the sanitary condition of the dwellings is defective. With regard to the production of Phthisis pure dry air is unfavourable to its development and to its continuance, but at the same time many wet countries show no exceptional amount of phthisis. Thus Devonshire is wet with great rainfall but no excess of ~~phthisis~~ phthisis. Holland has a great amount of moisture in the soil but there is no excess of phthisis. Phthisis is rare amongst those dwelling in high altitudes which Hirsch ascribes to continuous residence in a rarified atmosphere which will enormously increase the development and expansion of the lungs.

Locality has very little influence on diseases of the circulatory organs, aided with exception of those places where rheumatism is common, the cause of disease is traceable rather to the habits and employment of the people than to the conditions of residence. A peculiar form of Pericarditis is described as occurring in certain parts of Russia, rarely elsewhere but the scorbutic Pericarditis is owing to the prevalence of scurvy in those districts - the disease becoming more rare as the scurvy decreases.

**Age** Diseases of the thoracic viscera occur for the most part at all ages but at certain periods of life, they are more frequent than at others.
The life of an individual may be divided into three periods. First - the period of growth (a) Infancy to 3 years of age; (b) childhood; (c) early manhood.
Second Active manhood
Third (a) period of decline (b) old age.
During infancy the mortality from bronchitis especially of the capillary variety is large. Broncho-pneumonia is common and tuberculosis also occurs. Pleurisy is rare and inflammation of the lung substance is less frequent than at other periods. In the circulatory system congenital malformations are almost the only

Fig. 10

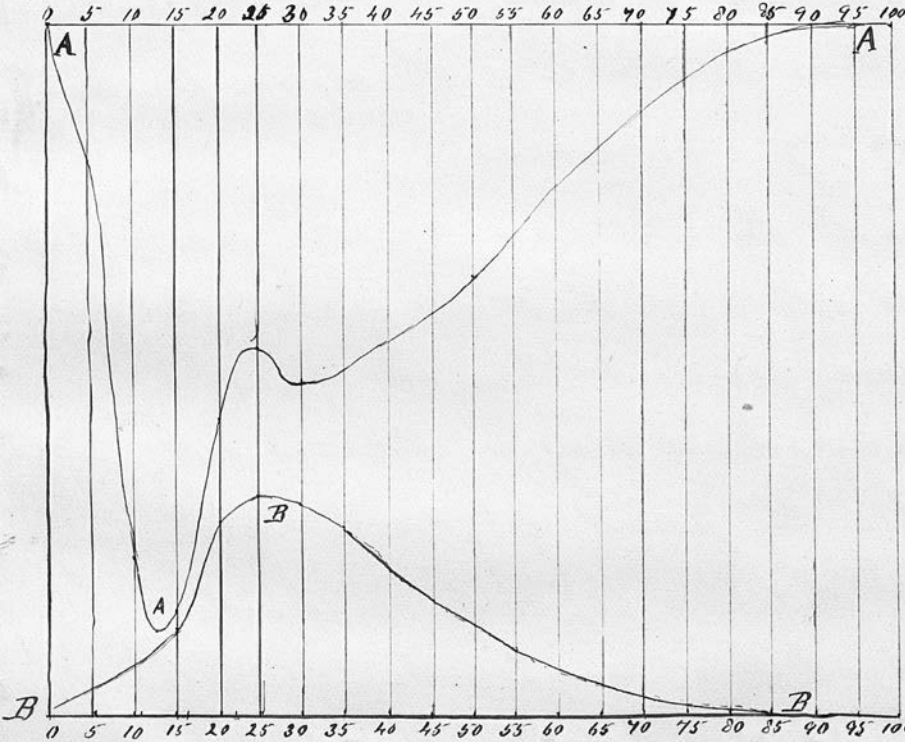



Diagram showing Curves of mortality from all causes and from Phthisis.

A A. General mortality (after Quetelet)

B B Proportional Mortality from Phthisis.

(Reduced from Oct. 1885 Edin. Med. Journal)

affections that call for notice but when discovered now are almost always fatal.

(b) During childhood we have almost the same class of diseases of the chest as in infancy, tuberculosis of the lungs becomes more frequent, and valvular and other forms of heart-disease, the sequelae of scalatina or measles are not infrequently seen.

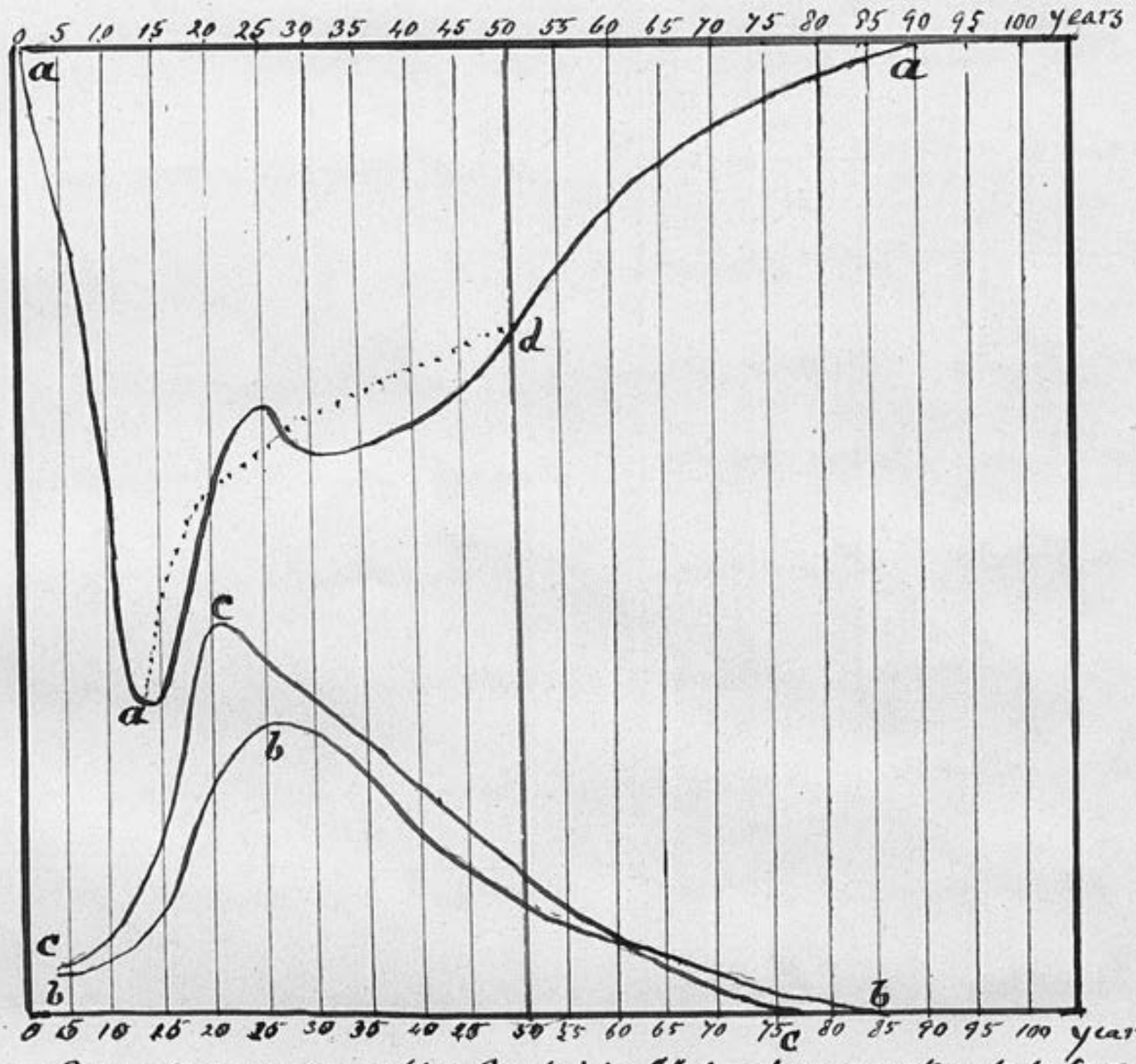
(c) In youth, 12 to 20 yrs of age diseases of the pleura, heart, pericardium are frequently met with, but anaemia, chlorosis, and phthisis are most characteristic of this period.

II Period of action manhood. Disease the result of employment now begin to be common, such as stonemasons lung, rupture of valves, diseases of the vessels, aneurism. Habit and modes of living have considerable influence at this period - alcoholism, excesses &c Phthisis is common.

III (a) Period of decline. The vital powers are failing. Disease tends to become chronic; chronic bronchitis, pneumonia and emphysema are common. Tumours in the lungs; Dilatation of the heart & general debility from interference with the circulation or respiration are often seen.

(b) Old age is marked by general decay - osteomalacia atheromatous vessels - Bronchitis is often fatal.

The age at which Phthisis is especially common is from 21 to 27 years but the disease occurs at all ages from early childhood to old age, as is shown in the diagrams (Figs 10 & 11) taken from Dr James paper in the Edinburgh




aaa General mortality, after Quetelet. It has been constructed for both sexes, but the dotted Line ad shows the modification for women

bbb Male mortality from Phthisis

ccc Female mortality from Phthisis.

Dr A James Edin. Med Journal March 1886

Medical Journal for Oct- 1885 page 297) The Lancet
and March 1886 P. 528)
Mr- Simmeyers statement;- Whilst in infancy
the membranes of the brain, the larynx, the skin,
the intestines, etc., are chiefly liable to disease,
the affections of these organs become less frequent
at the time of puberty, and in their stead attacks
of bronchial haemorrhage, as well as of acute and
chronic inflammations of the lung, increase in
frequency." (Lectures on Phthisis. New Syd. Soc. P 23 & 24)

Sex - Apart from other considerations, sex appears
to exercise little influence in the production of
thoracic disease. Aneurism and cardiac disease are
more common in men, owing to the greater strains
to which they are exposed, and Masons and coal
miners phthisis are due entirely to their employment.
Women during pregnancy are liable to cardiac dilatation
and derangement of the circulation, and phthisis
occasionally is developed as a result of rapidly
occurring pregnancies.

Employment - As a general rule it may be said that
occupation of any sort is better than idleness - that
the economy of the body is better carried on when
the lungs, muscles, nerves etc. have the stimulus of

use and exertion. This is true if the surroundings of the worker are purified and the work proportionate to the physical strength; but if the air is bad or insufficient, or loaded with irritating particles, — if the individuals employed are poorly fed, badly clothed and are exposed to damp or extremes of heat and cold, — or if the work to be done throw a strain on weak or diseased organs then the work becomes injurious and the health suffers. Amongst the working classes these conditions are too often present, — and labourers, porters cab-drivers are frequently sufferers from disease brought on by exposure; mill workers, dress makers, milliners who often are obliged to work in close, badly ventilated rooms are prone to become anaemic, and to suffer from catarrhs of the respiratory passages. On the other hand those whose occupation keeps them in the open air, such as shepherds, farm workers etc generally enjoy robust health. Certain employments again are directly injurious, and of these stone cutters, foundrymen, coal miners, lead or copper workers are familiar examples. These men owing to the quantities of dust and irritating matters they inhale are frequent sufferers from phthisis and catarrhal affections.

strain such as is experienced among navvies, dock-labourers &c is a frequent cause of valvular disease and aneurism, especially if the arteries are weakened by atheroma or the system by intemperate habits.

Married or Single - The condition of married life seems to exercise very little influence on the thoracic Organs - disease being equally prevalent - in both conditions. One point of interest is the probability of the infection of the wife if the husband is consumptive, and vice versa. Double infection does occur and is most frequent between husband and wife, a fact which might influence the diagnosis in a suspicious case.

The date of Admission to hospital or the date when the patient was first seen should be added, and in hospital cases note the No of the Ward & bed.

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II Complaints

The most common complaints made by Patients suffering from either pulmonary or cardiac disease are, pain, cough with or without expectoration shortness of breath especially on exertion and palpitation. To these may be added the more objective phenomena, emaciation, lividity,

oedema general or local, local congestions, enlargement of veins &c. The complaints vary according to the organ affected and only serve as a guide for the physical examination

II History

A – of present attack. After hearing what a patient complains of, we ask as a rule – "How long have you been ill?" The answer to this question determines at once whether the disease is acute or chronic. Acute disease is characterised by a sudden onset, and a rapid course, ending in recovery or death; or it passes into a chronic state. Chronic diseases on the other hand begin slowly (unless they are the result of an acute disease) and continue for months, sometimes years, usually with periods of improvement and of exacerbation and end sometimes in complete recovery, more often in partial recovery or death. It is necessary to exercise great care with regard to acute exacerbations in chronic disease, for example, acute pleurisy the result of ulceration or discharge of pus from a previously diseased lung is a very different thing to deal with, from a simple pleurisy with no such cause.

The mode of commencement, the character of the symptoms with the order of development often give a very good

picture of the disease. Thus a rigor, followed by fever, cough, uneasy feeling in one side, with rusty expectoration will almost certainly indicate acute pneumonia; while fever with or without a preceding rigor, followed by acute pain in the side on breathing, points at once, to Pleurisy.

The course of chronic disease is more difficult to make out owing to the confusion of the patients mind with regard to dates, and to the slow mode of progression. In valvular disease of the heart for instance, it is often impossible to determine the course of the disease, as the affection of the valves may have gone on for months even years without causing any symptoms.

Previous treatment. This should always be ascertained so that the alterations which may have taken place in the phenomena of the case, as the result of treatment may be taken into account. The uneasy tightness in bronchitis will be much allayed by placing the patient in a suitable temperature and giving proper remedies; and the signs of dilated heart may be altogether obliterated by appropriate treatment.

The treatment is occasionally a guide as to the condition of the patient when last under observation and is useful sometimes when the medical attendant cannot

be communicated with

Cause - The causes or conditions predisposing to thoracic disease are various. They may be divided into five groups:-

1st- Direct traumatic injury to the organs - Wounds, such as by stabbing, gun shot wounds, injury by broken ribs may by laceration of the organs or by introduction of septic material into the tissues set up various inflammatory or septic diseases such as pleurisy, pericarditis &c

2nd Irritation (a) Direct - (b) Indirect.

(a) Direct irritation in the case of the lungs is chiefly by inhalation of gasses or particles of matter into the alveoli or smaller tubes and in the case of the heart by the circulation through the viscus, of blood contaminated by septic or other material.

(b) Indirect irritation most commonly occurs by exposure of the body to extremes of heat or cold. The pathological changes which follow are probably brought about by vaso-motor changes. In some cases doubtless disease is due to a lowering in the tone either of the system generally or of one particular organ which renders the development of certain bacilli possible.

3rd The spread of disease from other organs.

Catarrh of the fauces may spread to the bronchi, superficial inflammation extend to deeper structures,

~~to communicate with~~.

pericardial inflammation set up pleurisy, tuberculer disease be conveyed to the lungs from some other organ, — cancer in a distant part developed in the thorax &c &c.

4th Heredity or predisposition.

5th Infection

Health History — The previous condition of the patients health is important, not so much in bringing out the circumstances which have led up to his present illness, but rather in helping us to determine the power of recovery of the patient, the course of previous diseases, and the sequelae which may have been left.

Patient questioning is necessary in order to obtain a correct account of the various ailments from which any patient may have suffered and it is of the greatest advantage to get the particulars from the previous medical attendant.

The question how far previous attacks of illness render the patient vulnerable is one which it is difficult to decide. Bronchitis seems to have a distinct tendency to return and that frequently

at a particular period in the year. Often occurring Bronchitic attacks, weaken the lung substance, which may become emphysematous, inflammation especially of a catarrhal nature is more liable to ensue, and this in turn may culminate in phthisis.

One attack of pneumonia, though it resembles the infectious fevers in some points, does not confer immunity, nor does it appear to render another attack more probable. It is of importance to find out whether the patient has suffered from syphilis, from any of the infectious fevers, from rheumatism &c and to enquire into the severity and course of the attack, and the condition of the health subsequently. It is convenient at this stage to make oneself acquainted with the habits and mode of life of the patient. It is agreed that a well regulated life is a healthy one, and that the contrary proposition is generally true. A man leading an irregular, unsteady life, keeping late hours, frequenting hot ill ventilated drinking saloons &c will find his health suffer both bodily & mentally and disease in him will be more severe & more probably end fatally than in a man whose tissues are kept in good condition by a well regulated mode of living.

The general surroundings and social condition of any individual exercise a considerable influence over the production of disease and to a greater extent influence the course and duration of any malady. The poor and the working classes generally run greater risks as regards their health than those in a superior station partly owing to the amount of exposure they are obliged to endure, and partly to insufficient food and clothing. Disease amongst the poor also is more apt to be fatal owing to the time that generally elapses upon advice is sought and to the lack of nursing and general hygienic remedies which are within the reach of those in better circumstances.

It is of interest to note here any special conditions with regard to the patients employment, such as an insanatory workroom, its situation with regard to C or main sewer, the length of hours, any unusual material used in his work.

In cases where loss of flesh is complained of, the weight of the patient should be ascertained and if possible compared with the weight previously.

Family History - To prove or disprove the heredity of disease is extremely difficult. From many patients it is impossible to obtain any information as to the health even of near relatives, partly owing to carelessness

or ignorance, and partly in some cases because the medical attendant has given to definite name to the disease. All patients should be asked as to the diseases from which their relatives have suffered. The health of brothers, sisters, parents and even grandparents should be investigated, and if the patient has a family the health of the children should be enquired into, not merely whether any of them have suffered from this or that disease, but as to what diseases they may have specially suffered from. It would be of great interest if a note of health were appended to each name in the family tree. Absolute heredity is very rare but the tendency to suffer from certain diseases such as Rheumatism or Phthisis is not uncommonly derived from one or other of the parents or in some instances the liability appears to skip a generation and to descend from the grandparents.

## General Condition at time of examination.

While the preliminary facts and previous history are being elicited, the physician is both consciously and unconsciously forming an opinion as to the nature of the case; excluding this or that condition, narrowing the enquiry limiting the disease to this or that system or organ; and in some cases coming to a positive conclusion as to the exact nature of the morbid process. His conclusions are

based upon the impression which the whole appearance conduct and bearing of the patient — in other words the physiognomy of the case — make upon his mind, and this impression necessarily guides the oral examination and suggests question both as to the previous history and the "present complaint" (Byron Bramwell - Medical Diagnosis P 42.)

I The general aspect of the patient is often very suggestive of the severity of the disease. If for example on seeing a patient he comes forward in an easy manner without any appearance of pain or anxiety, no difficulty in breathing, or flushing or pallor of the face it is fair to conclude there is nothing very serious the matter. To find a patient in bed on the other hand shows generally that the case is considered serious at least by the patient or his friends. In those cases where there is much interference with the respiration the attitude is often striking. The patient is often unable to lie down and requires to be propped up with pillows and assumes such a position in which he can use the accessory muscles of respiration with the greatest effect. In some heart cases he refuses to go to bed and will pass the day and night too in a chair or on the side of his bed the head & body bent forward, his hands grasping his knees or thighs; or sometimes he will find greatest ease

leaning over the back of a chair — the position being chosen in which there is greatest ease or in which there is the greatest power of inflating the lungs. In Pneumonia and other diseases of the lung substance the position is generally dorsal differing from pleurisy when it is generally lateral the patient lying on the affected side.

(6) Countenance Professor Flint describes eleven varieties of "Facies" which may be enumerated only those referring to diseases of the thoracic organs specially being described. These Facies are:-

1 Facies of Anaemia
2 Cyanotic Facies
3 Facies of Renal disease
4 Malarial Facies
5 Facies of Carcinoma
6 " " Typhoid
7 " " Peritonitis
8 " " Pneumonia and Hectic
9 " " Exophthalmic Goitre
10 " " Cholera
11 Hippocratic Facies

1st The Facies of Anaemia.

Blanching or pallor of the surface of the body, of the skin and mucous membranes may be present to a considerable degree without any severe symptoms being manifested, in fact a certain degree of pallor is quite consistent with good general health and appears in some individuals to be the normal condition. In its more marked degrees however it is symptomatic of many more or less grave conditions. It may arise a) from haemorrhage. When a quantity of blood is withdrawn from the circulation either suddenly from the rupture of some large vessel, or gradually from persistent oozing from some injured surface, the blood formation is not sufficiently rapid to replace the loss, the capillaries are insufficiently filled and the surface becomes pale. Allied to this cause is (b) the loss of albumen from the blood as in albuminuria (from renal disease), in effusion into the pleura or pericardium, and in general anasarca or, the quantity of blood is decreased owing to the loss of blood forming material. The quantity of blood may also be diminished indirectly owing to c) deficient supply or malassimilation of food as in obstructive diseases of the alimentary canal. The above causes may produce pallor owing to the quality of the blood being decreased, the quantity remaining ~~the same~~ normal.

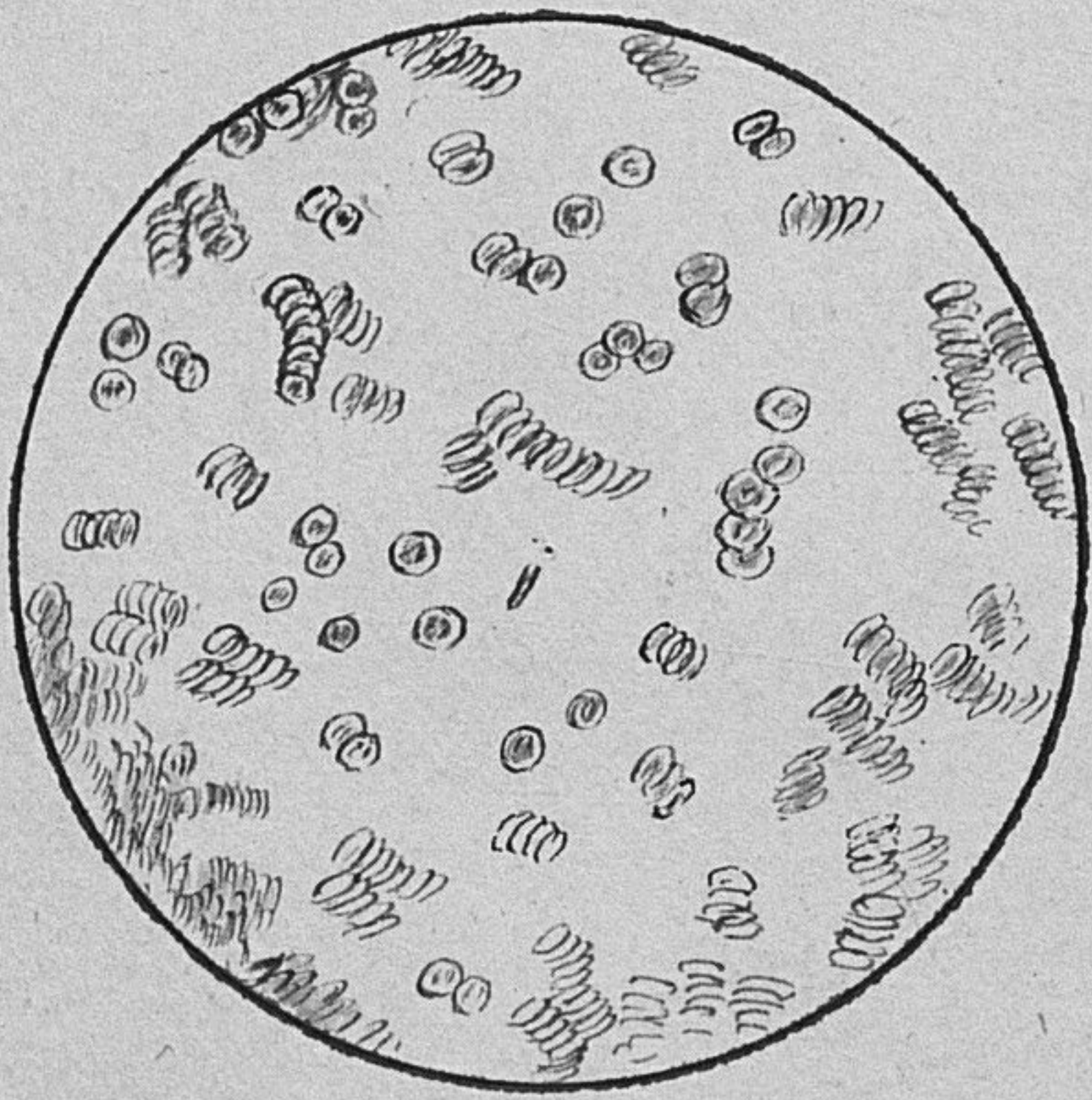


Fig 12. Microscopic Appearance of Normal Blood. (x 250)
(del. ad Nat)

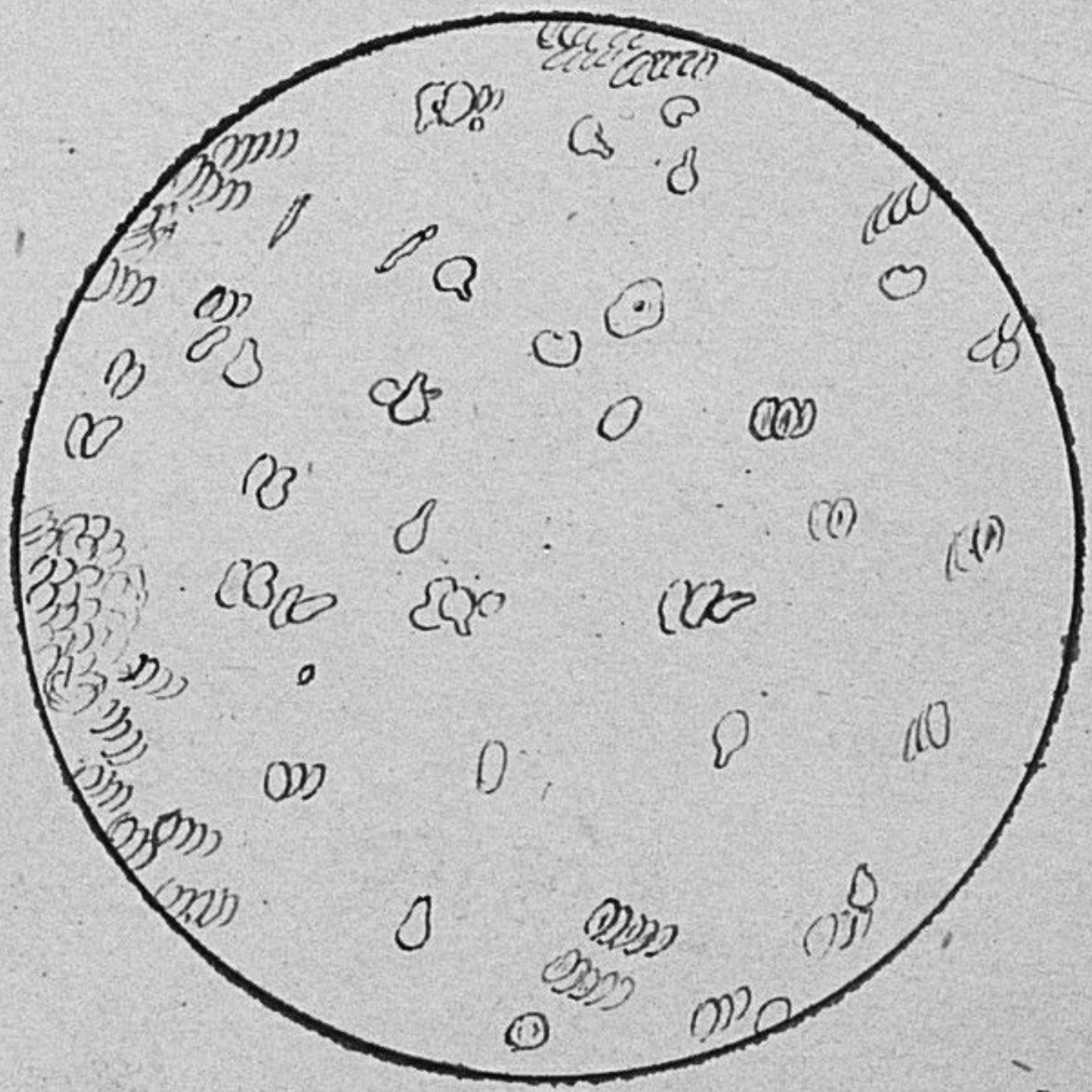


Fig 13. Blood Corpuscles from a case of Progressive Pernicious Anaemia. (X 250)

(del. ad Nat)

(d) In Chlorosis and Progressive pernicious Anaemia the pallor is due to a deficiency in the number of red corpuscles and probably to a less amount than normal of haemoglobin being present in each corpuscle. (See Figs. 12 and 13)

Independently of the amount or quality of the blood pallor is present when the arteries and capillaries are empty or only imperfectly filled with blood. This may arise from failure or weak action of the heart, as in syncope or shock; or from contraction of the arterioles which may be brought about by various emotional changes such as fright, anger &c or more locally by application of cold or other stimulants of the vasomotor nerves. The appearance of the patient varies with the degree of anaemia. In some cases there is little change from the normal but in well marked cases the whole surface is pearly white or slightly yellow in colour, with sometimes a greenish tint. The mucous membranes lose their rosy colour and become pale often almost as pale as the skin. The nutrition is generally maintained, and when affected the loss of flesh is not in any degree proportionate to the degree of anaemia. In severe chlorosis uncomplicated by any other condition there may be no emaciation present or only a very slight degree.

2nd The Cyanotic Facies.

Cyanosis or Blueness of the skin may exist in all degrees, from a slight bluish tinge to an Indigo blue, or

bluish black. In the face it is observed chiefly where the surface is naturally red, as in the lips, cheeks, eyelids and ears and gradually extends over the whole face especially the dependent parts. On the body, the extremities, wherever the skin is thinnest and most transparent, the fingers and toes especially the nails, the elbows and knees are the the earliest parts affected. In extreme degrees the blue ~~####~~ coloration is observed all over the surface but is always most marked in those parts which are most vascular and the skin delicate and transparent.

Causes Cyanosis occurs in all cases when from any cause the blood is imperfectly oxygenated. The cause may lie in the lungs or some part of the respiratory tract or in the circulatory system. The supply of oxygen may be deficient as in vitiated air, or it may be unable to reach the surface of the air cells as in obstruction of the Larynx, trachea, or bronchi by a foreign body or from disease (oedema glottidis, diphtheria, Bronchitis &c) or the breathing surface of the lung may be diminished as in collapse of lung, in pneumonia or phthisis, pleurisy with effusion &c or the capillaries of the lung may be obliterated or diminished as by cirrhosis or Emphysema. The lividity is not always in proportion to the extent of lung involved, the more severe degrees being observed ~~##~~ where the loss of ~~lung~~ oxygenating surface has occurred suddenly as in pneumothorax the result of accident. "Apart from special individual differences

the explanation of the fact that the slowly-advancing diminution of the respiratory surface in chronic disease is associated with but little lividity evidently is that the healthy lung gradually expands, and in that way comes to supply, to a certain extent, the place of the partially disabled lung. That robust full-blooded persons, suffering from embarrassment of the respiration, should present a higher degree of cyanosis than those who are anaemic is to be expected, as the more plethoric an individual is the more completely are his vessels — and among them those of the lungs — filled, and it is well known that oxidation of the blood goes on more slowly when the vessels are distended than when they are partially empty. In Phthisis, on the other hand, as the emaciation and decrease in the quantity of blood in circulation keep pace with the reduction of the respiratory surface, the cyanosis is always slight.

"Cyanosis becomes extreme when as in the emphysema which accompanies chronic bronchitis, both conditions which tend to produce it are present, — obstruction of the air passages and diminution of the functionally active lung substance." (Gottmann — Handbook of Physical Diagnosis Page 13-14 Syd. Soc.)

The capacity of the thorax and as a consequence the breathing space, may be diminished by abdominal tumours or other swellings forcing up the diaphragm and preventing its proper action — Cyanosis in such cases is a prominent symptom.

Valvular disease of the heart is also a common

cause of cyanosis. It occurs in all cases when the lung vessels become ~~distended~~ overloaded as in mitral regurgitation or contraction of that orifice, when there is insufficient heart-power to overcome the obstruction. In fatty degeneration of the heart cyanosis is common as it is in all conditions when the heart from weakness or disease is unable to drive the blood through the lungs. In the disease or condition Rhoumas Morbus Coeruleus the cyanosis is often extreme. When there is imperfect closure of the foramen ovale, the ductus arteriosus may remain open and there is frequently stenosis of the pulmonary artery. The lesion may be so severe that the child dies immediately or soon after birth; or life may be prolonged with the presence of constant cardiac symptoms; or the lesion may be so slight that symptoms are wanting and only appear when from some cause there is a failure of compensation.

Pressure on the veins will also induce cyanosis which may be only partial but will be more general if the vein obstructed be one of the main channels leading to the heart. These local congestions are most important as indicating the seat of tumours or other swellings which are not visible or within reach of palpation.

Facies of Renal disease — "In some cases of acute albuminuria, and of chronic parenchymatous nephritis — the large white Kidney of Bright — the puffiness of the face from oedema with notable pallor, renders the aspect highly diagnostic" (Flint - Clin. Med. P. 24) This only requires notice

in order to point out the importance of distinguishing this form of dropsy from that which occurs in cardiac disease, where the dropsy is generally first observed in the feet and the pallor is not so marked a symptom.

"Malarial Facies – Pallor of the face, sallowness, and "slight puffiness, if renal disease be excluded, point to "malarial disease.

"The Facies of Carcinoma – Notable anaemia, a waxy "or straw coloured complexion, and more or less em- "aciation, in combination, under the aspect marked "in some cases of malignant disease. In a patient over "forty years of age, this aspect has a considerable "diagnostic import although it is by no means always "present when malignant disease exists.

"The Typhoid Facies – In the middle and later periods "of typhoid fever the countenance is often dull, besotted "expressionless. This facies may be present in the typhoid "state which is incident to diseases other than typhoid "fever, E. g., pneumonia. Co-existing with a dusky "hue of the skin and congestive redness of the conjunctiva "it distinguishes typhus, as contrasted with typhoid fever."
(Flint. Clinical Medicine P. 24) The Typhoid state is characterised by the dry, leathery, "typhoid" tongue, the presence of sordes on the teeth, sleeplessness, delirium, tendency to coma, and subsultus tendinum.

The Facies of Acute Peritonitis. – The upper lip raised so as to expose the front teeth, gives an aspect which characterises, in a certain proportion of cases, acute peritonitis. It is often wanting, but when present is strongly diagnostic.

The Facies of Acute Pneumonia and Hectic Fever. –

"Circumscribed redness of one or both cheeks, with abruptly defined borders, is diagnostic of pneumonia. If it be observed in a case of chronic pulmonary disease, it denotes the so-called hectic fever, and is a sign of phthisis." (Flint loc. cit.) Circumscribed redness of the cheeks is seen in myxoedema and in some hysterical anaemic patients but in these there is no fever, and the herpes of the lips, dilated alae of the nose which are so often seen in pneumonia are wanting.

The Facies of Exophthalmic Goitre. – Projection of the eyeballs, giving to the face a remarkably staring and sometimes ferocious expression, conjoined with enlargement of the thyroid bodies and frequency of the pulse, is distinctive of the affection known as exophthalmic goitre, Graves disease, and Basedow's disease.

The Choleraic Facies. – "In the collapsed stage of cholera, 'the face is contracted, sometimes wrinkled; the cheeks 'are hollow, the eyes sunken, the skin livid, and the 'expression denotes indifference. This combination of traits

is quite distinctive. They are however, to a certain extent
"combined in a state of collapse which occurs in some
"cases of pernicious intermittent fever, and in other
"pathological conditions.
"The Hippocratic Facies. — This facies denotes the
"moribund state. The skin is pale, with a leaden or
"livid hue; the eyes are sunken, the eyelids separated
"and the cornea loses its transparency; the nose is
"pinched, and the ears are contracted; the temples are
"hollow, and the lower jaw drops. Hippocrates described
"this facies in graphic terms and the name Hippocratic
"has ever since been used to designate it". Flint l.c page 25

## The Nutrition of the Patient

Healthy nutrition may be said to exist when the waste products of all sorts are equivalent to the food consumed and to the work done. In the child the food is in excess of the waste, and the same condition exists in those who are gaining in weight or putting on flesh, as after recovery from acute diseases or from a state of emaciation. In those whose nutrition is healthy the skin is elastic fitting smoothly to the surface not hanging in wrinkles, nor yet abnormally stretched. The muscles are firm and when in action are hard and tense. The colour is clear and ~~bright~~ the eyes bright. There is always a fair amount of fat present but the healthy amount varies, according to the activity, mode of life

and diet of the individual.

Emaciation — Extreme degrees of emaciation are easily recognised. The causes of emaciation may be divided into two groups 1st Those in which the supply of food, or the amount assimilated is deficient and 2nd where the tissue waste is in excess of the normal.

(1st) The actual supply of food may be deficient, from the inability of the patient to procure food, or from voluntary fasting, but these conditions being easily treated by an increased supply are not of the same importance as the following. The patient may not be able to partake of food owing to painful conditions of the mouth or fauces, from obstruction of the gullet, stricture of the oesophagus, any of which conditions if persistent will cause emaciation, the degree varying with the amount of food which reaches the stomach. Food taken into the stomach may be expelled undigested, either owing to its irritating character or to some irritable condition of the mucous membrane such as catarrh or ulcer. Or the walls of the stomach being healthy the obstruction may exist at the pylorus preventing the food from passing into the intestines and being absorbed.

Disease and obstruction of the intestines in any part of the tract will also similarly cause emaciation if the absorption of food be prevented, though if the character of the food be so regulated that only those varieties of foods be given which can be absorbed and digested in the part of the alimentary tract which remains healthy, the nutrition is maintained and little loss of flesh occurs.

2nd Emaciation occurs in all cases of fever. In all the typical wasting diseases fever is more or less present, and as a general rule it may be said, while the temperature is high wasting and loss of weight continue, and when the temperature falls the patient's weight remains constant or he puts on flesh.

"Diseases of the circulation being almost free from fever, except those in which there is inflammation or suppuration present, are unattended by emaciation.

'In acute miliary tubercle of the lungs there is rapid 'wasting, chiefly owing to the very high fever which accom-'panies it; it is most probable also that the wasting 'which is such a constant and prominent symptom of 'that form of pneumonia, which leads to phthisis — 'pulmonalis, is due not to the nocturnal sweating but 'to the febrile disturbance, as notwithstanding his 'almost insatiable appetite, the phthisical patient 'rapidly loses flesh, but whenever the fever abates, and 'the progress of the disease is thus temporarily arrested, 'he at once gains in weight.

'Emaciation, apart from its prognostic significations is of some 'importance from a diagnostic point of view. Thus of all the chronic 'diseases of the lungs, caseous pneumonia is the only one in which 'it is observed; the other chronic lung affections, however being almost 'free from fever, may run their course without being marked by 'any trace of wasting, though they may give rise to destruction of the 'parenchyma and to the formation of cavities; and after them the 'same physical signs as are found in caseous pneumonia; such

'patients indeed, if only their digestive organs be in good
'condition, may present every indication of being perfectly
'well nourished." (Guttmann. loc. cit. Page 21.)

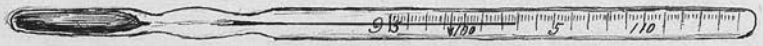
Wasting of muscular tissue from loss of function is seen in all those cases when from any cause the patient is deprived of the partial or entire use of his limbs, - thus in those confined to bed for a broken leg, the muscles waste, but this is a perfectly different thing from what is understood by emaciation and does not require further notice. The same may be said of the atrophy from loss of trophic influence seen in cases of injury or disease of the spinal cord.

**Fever** The two principal indications of fever are 1st the temperature and 2nd the pulse, the skin, tongue nutrition &c being to a certain extent subsidiary.

The Temperature - Method of ascertaining the Temperature. Roughly an appreciation of the temperature of the body may be made by the hand of the observer, but there are so many circumstances that modify the information so obtained that it should never be trusted to, but the evidence of the Thermometer taken. Thermometers are of various forms but the following are those chiefly in use.

1st The Clinical Thermometer. Any thermometer which has a maximum index may be used provided it can be applied easily to the surface, or even if an index be wanting any thermometer with an unprotected bulb may be used if the stem be long enough to read the scale without removing the instrument. The instrument which is

Fig. 14




Clinical Thermometer
nat. size

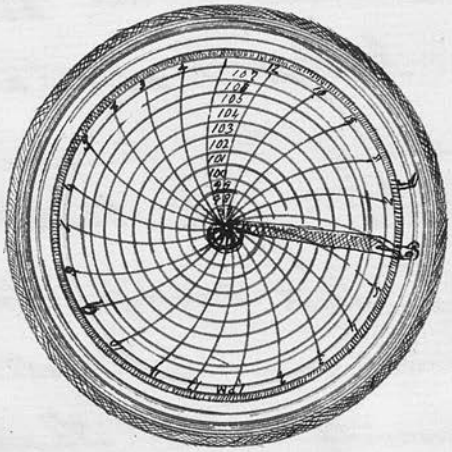



Fig. 15

The Thermograph from wood cut in Brit. Med. Journal.
(the register card should be black with white circles)

most in use at present consists of a very thin glass bulb to which is attached a stem whose bore is of capillary fineness — the effect of this arrangement being, that each division marking degrees is sufficiently large to be divided into tenths, which are large enough to be easily appreciated. The thin bulb renders the heating of the mercury rapid. The index scale is engraved or burnt into the stem. (Fig. 14)

2nd The surface thermometer — In this the bulb is either simply flattened or is a tube of thin glass arranged in a flat coil so as to give an extended surface for application to the skin. One side is covered with wood or some non-conductor of heat, the other being applied to the surface, the stem and index are on the same principle as the ordinary clinical thermometer.

3rd The Continuous registering Thermometer or the Thermograph. Fig. 15

This instrument was introduced in 1881 by Dr. Bowditch. It is thus described:— "The construction of the instrument is as simple as it is ingenious; enclosed in a vulcanite case is a metallic vessel, rigid and unyielding, about 3 inches in diameter and about 1/3 in. in depth. In connection with this is a curved hollow tube or spring, much smaller in size but similar to that used in the Bourdon steam-gauge. One end of this tube is fixed to the vessel, with the chamber of which it communicates; the other extremity is closed, and is in connection with a simple lever movement, increasing a first movement some three or four times. The whole is filled with liquid and hermetically sealed; any

increase of temperature causes the contained liquid to expand; the vessel being unyielding, the expansive force influences the tube only (which is rendered elastic by its form) in such a manner as to cause the end in connection with the lever to recede from its position of rest, and the lever is thus moved upon the recording surface. The recording surface consists of a disk of card board, set in motion by a watch work occupying the centre of the instrument. The dial makes one revolution in 24 hours and is divided by concentric circles into degrees of temperature, and by 24 radiating lines into spaces representing hours." * * "The flat under surface is applied to the body, the other portions being protected by a suitable vulcanite case. It is usually applied to the abdomen, being held in position by a broad band of non-conducting material. (Brit. Med. Journal Vol 2. 1881 Page 903).

Another Thermograph has been invented by Dr A. Wellington-Adams of Colorado Springs but its construction involving the use of an electric battery renders its use more troublesome that that previously described. Neither form of thermograph has come into general use and the question of its utility as a diagnostic method is still in abeyance.

4th The Metallic Thermometer. This is an instrument of the size of a small watch, which has been recently introduced. It appears, so far, to be trustworthy and is less distendible than the glass instruments. It owes its invention to Immisch. Fig. 15-A

The scale in general use in this country and America is the Fahrenheit, — on the continent the centigrade scale

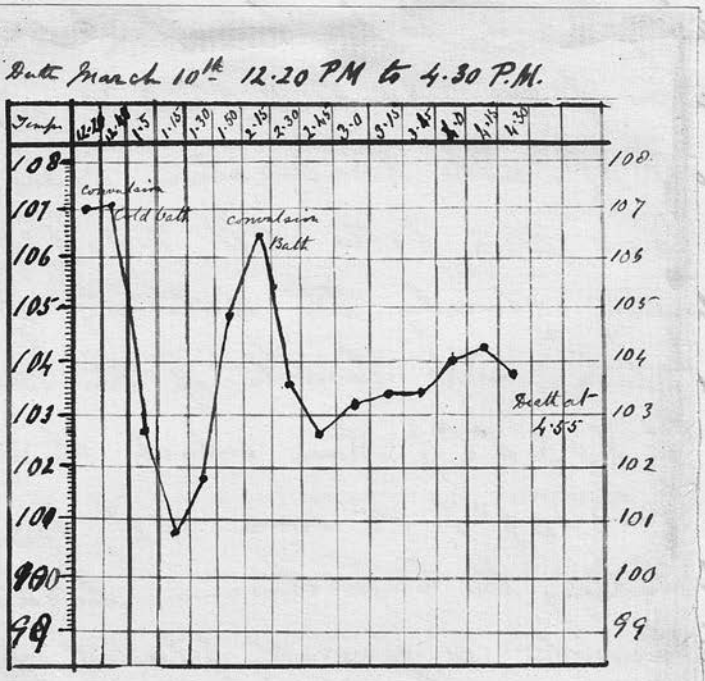
is most often used, but that of Réaumur is in use in some places.

The Normal Temperature - The temperature taken in the axilla varies from 98.4°F (36.9°C) to 99.5°F (37.8°C) in the adult; in the infant it is slightly higher and in old age slightly lower. The diurnal variations are stated by Jurgensen to be from 1.5° to 3.5°. The lowest reading occurs from 1.30 to 7.30 A.M. the maximum from 4.0 to 9.0 P.M. The temperature rises between 7.30 AM and 9. P.M and then falls till 7.30 AM., the variation following pretty closely the activity of the respiration and circulation. The limits of the rise and fall are from 91.4°F (33.0°C) than which there is rarely a lower observation, to 109°F or even 112°, 113° or higher (42°-45°C).

Method of taking the temperature - Situation -

The thermometer is generally placed in the axilla in the adult, but in children it is often found more convenient to place it in the groin, in the rectum or vagina. Sometimes in the adult all these situations have some advantage; or the instrument may be placed in the mouth. The axilla or groin are the only situations in which the metallic thermometer can be conveniently applied.

It is important that the bulb of the instrument should be in close contact with the skin; thus in the axilla it is placed under the fold of the pectoralis and the arm brought close to the side, the forearm lying across the chest. If placed in the groin it is best to cross one leg over the




Hyperpyrexia with convulsions in an infant aged 10 months, March 1885 - A case of Bronchitis and Pneumonia.

Fig 16

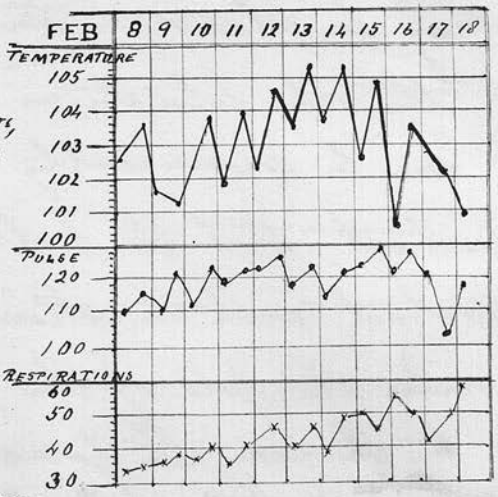



Chart showing the course of the Temperature, pulse and respirations in a case of Acute Tuberculosis.

Fig. 17

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ther so that the skin is close to the bulb of the thermometer. In the mouth keep the bulb away from the teeth, placing it between the tongue and the gums or between the gums and ~~cheek~~ cheek. In the rectum or vagina it is only necessary to see that the bulb is entirely inserted for which purpose a little oil may be applied.

The surface thermometer is applied to the surface to be examined and secured in position by some non-conducting bandage.

The Thermograph is most conveniently applied to the abdomen but may be placed in other situations if found more convenient.

Temperature charts— In taking a series of observations it is advisable that the temperature should be taken as nearly as possible at the same time and under the same circumstances each day. In ordinary cases a morning and evening temperature may be sufficient, but in severe cases it is advisable to observe the temperature at more frequent intervals, for instance every ~~three~~ or two hours or every hour or still more frequently. For ease of comparison the height of the thermometer should be noted on a chart such as that shown in fig 16. which shows at a glance, the temperature, and the time at which each observation was made. A single chart may be constructed to record the temperature, pulse, and respiration and thus show the relation of the one to the other. See fig. 17.

Low Temperature. In disease a subnormal temperature is rare but it is seen under the following conditions.

1st After prolonged exposure to cold. It is not uncommon to see the temperature descend below the normal after the use of the cold bath in the treatment of pyrexia.

2nd After repeated haemorrhages such as occur in typhoid fever and sometimes after long continued haemoptysis. A temporary fall of temperature is seen after slight bleeding but recovery soon takes place and unless the bleeding be carried to a dangerous extent the temperature is not permanently reduced.

3rd In cases of inanition and exhaustion, such as occurs after long continued vomiting, in diarrhoea &c

4th From the use of certain drugs or under the influence of certain poisons. Thus Aconite, Antimony, Chloral and most of the irritant poisons produce a fall in the temperature.

5th When the oxygenation of the blood is incomplete as in emphysema, asthma and some cardiac affections.

6th In the defervescence of fever the fall is in some cases below the normal.

7th In the 'algid stage' of cholera the temperature falls sometimes as low as 92°.7.

Increase of Temperature. This is one of the essential phenomena of fever. If there is a morbid increase in the temperature, either one of the essential fevers exists or the fever is symptomatic of some local affection, and conversely fever is excluded by a normal temperature provided that the influence of drugs, haemorrhages or cold are excluded. The thermometer is the only guide

to the height of the fever, though a quick pulse is the usual accompaniment to a high temperature, yet this is not always the case and a quick pulse may be present without any great rise in the temperature.

The degrees of fever are variously described. A rise of half to one and a half degrees, not exceeding 101°7 is considered a slight fever, and called a sub-pyrik temperature. Moderately high fever has a temperature of from 101° to 103°7. From 103° to 105° is considered a high fever. A temperature above this is generally called hyper-pyrexic. As a rule there is a morning fall and evening rise of temperature, corresponding to the rise and fall which occurs at the same times in health. Generally it may be stated, that, as the temperature of the body depends on the maintenance of a proper balance between the amount of heat generated in the body and the amount given off to the surrounding medium, any interference which causes a decrease in the amount of heat given off, or an increase in the production will cause a rise of temperature.

The Temperature rises, 1st on exposure to heat. If it is 1/2° higher in residents in India (Lauder Brunton. Therapeutics P36)

Prolonged exposure in a medium where the regulating action of the skin cannot come into play, as in hot water or hot moist air, i.e. hotter than the temperature of the body.

2nd When the vital processes are increased as in the various specific fevers, or due to nervous influence as in inflammation.

3rd In some hysterical cases when also the high temperature

due to the influence of the nervous system. The temperature rises to an enormous height. W. J. Teale records a temperature of 122° F in the Lancet in 1875 and Ross records a case where the temperature varied from 98° to above 116° F (Diseases of Nervous Syst. p. 847). Very high temperatures such as these, should always be looked upon with suspicion.

In some nervous lesions, a local rise of temperature has been observed, apparently due to the increased vascularity of the part.

Types of fever. (a) Continued, (b) Intermittent (c) Hectic.

(a). Continued fever. The temperature from the beginning of the attack to its close is above the normal. This is seen in the specific fevers where only a single introduction of the poison takes place, and in simple inflammatory fever when there is no development of the suppurative or hectic variety.

(b) Intermittent fever. In this variety there is a rapid elevation of temperature followed after a certain period by an intermission during which the temperature may reach the normal, to be followed after a longer or shorter interval by another rise of temperature and intermission. The fever poison seems to undergo repeated new multiplication, and does not exhaust the soil as does the poison of continued fever.

(c) Hectic fever. This cannot be described as a distinct type but rather as a variety of a continued fever. The term Hectic, is applied to those varieties of fever which attend malignant

disease, tuberculosis, chronic syphilis, and chronic disease of bones, when there is a continuous proliferation of tissue elements of a low type and the production of purulent discharges. The chief characters of Hectic are its long continuance, insidious development, loss of flesh, and a temperature showing an evening rise with a morning intermission which rarely if ever reaches the normal in the first stages, but which later may become subnormal.

The phenomena of fever —

An attack of fever is usually announced by a feeling of malaise followed by a more or less distinct rigor, in the adult, or in infants by a convulsion. The rigor however may be absent and the malaise only slight. The temperature begins to rise and goes on more or less rapidly, until it reaches its acme which may vary from 101° to 105° F. At this point it remains, it may be for several days with only slight variations and then within twelve, twenty four, or forty eight hours falls to the normal. This is called resolution by crisis. Resolution may however take place by lysis. The return to the normal is gradual and the morning remission and evening exacerbation are more marked, having a difference of one to three degrees.

The symptoms accompanying this course of temperature are the following. The premonitory symptoms are an ill defined feeling of being "out of sorts", sometimes headache

Languor, and depression more or less marked, and a disinclination to be disturbed. The limbs feel heavy and the patient feels unable to raise his head from the pillow - During the rigor he feels cold, the features are pinched, the lips and nails blue, the teeth chatter and the skin is dry and harsh (cutis anserina) This may be so slight as only to amount to a feeling of crepiness or slight malaise. The temperature at this time if taken in the mouth or rectum will be found often considerably above the normal though the surface thermometer may not rise to the natural height. As the axillary temperature rises the face becomes flushed, the skin warm, dry and often burning or pungent. Perspiration is present in rheumatic fever, sometimes in typhoid and relapsing fever.
The tongue becomes furred, dry, and often cracked, the colour varying from the bright red tongue of scalatina to the brown or black tongue of typhoid.
Sordes on the gums and teeth are frequently seen.
The Pulse. The beat is generally proportionate to the rise of the temperature but in cases of the typhoid type it may be below the normal. As the temperature rises the pulse becomes full and bounding and the patient often has the sensation of throbbing in the temples or elsewhere. Towards the end of the attack, the pulse may become fluttering and sometimes dicrotic
The urine in spite of the increased consumption of fluids

and the absence of perspiration is concentrated, and the quantity of urea and uric acid excreted is increased. Albumen is sometimes present - and blood may be observed. The chlorides are scanty or absent.
Delirium and various cerebral disturbances are often present.
Respiration is increased in frequency and is shallow especially when lung disease is present.
The appetite for solid food is impaired and nausea is not unfrequent, but the desire for fluid is increased and thirst is generally a marked symptom.
The bowels are generally constipated but diarrhoea is not uncommon especially if there is any ulcerative or inflammatory affection of the intestines.
Emaciation is always present - but is not marked unless the fever be very high or remain high for a considerable time.
The fall or defervescence - The temperature falls rapidly and steadily in defervescence by crisis, more slowly and irregularly in defervescence by lysis. It is important to distinguish the fall of recovery from the fall of approaching death. In the latter (the preagonistic fall) the pulse remains high, and is irregular and fluttering, while in defervescence the pulse and temperature fall together. The tongue becomes moist, delirium disappears, and there is frequently an outburst of perspiration and a free discharge of urine.
Not unfrequently the defervescence when rapid is followed by a period of great depression and weakness, calling for

the frequent administration of food, and a more or less free exhibition of stimulants. A slight disturbance at this time either of the bodily or mental functions, for example, unsuitable food, too much talking, excitement will cause a rise of temperature and a temporary return of the febrile symptoms.

The Pulse in fever. The normal frequency of the pulse is from 60 to 80 beats per minute; in fever the rate is increased ~~from~~ to 100 or 150 beats per minute. The increased frequency corresponds to some extent with the temperature. A slight fever has a pulse rate of about 100 per minute; 100 to 120 is seen in a moderate fever and with a very high fever the rate may be 140, 160, 180 or even 200 beats per minute.

Character. During the height of the fever the pulse is full, hard and bounding the sphygmographic tracing showing a high upstroke and sudden fall. In the cold stage (rigor) it is hard and small, while in the sweating stage (fall) it is full, large, and soft.

Independently of fever a rapid pulse is seen in cases of Exophthalmic goitre, in irritation of the sympathetic, or in compression of the vagus (destroying the inhibitory action) by a tumour and in some cases of heart-disease — the temperature remaining normal.

A high temperature with a relatively slow pulse is seen in some basal affections of the brain. It is evident therefore that the examination of the pulse alone is not sufficient-

to diagnose a condition of fever.

During defervescence by crisis the pulse falls rapidly corresponding to the fall of the temperature. The fall by lysis takes place gradually, sometimes continually but more often with ups and downs similar to the changes in the temperature.

Fever in thoracic disease. In acute inflammations the fever follows the course of a continuous fever rising with the onset of the inflammation and falling as the inflammation subsides. In chronic affections especially in phthisis, empyaema, carcinoma of the lungs the type is hectic.

In some cases the patient, more especially when the fatal issue is impending, passes into the typhoid state, so called from its resemblance to what occurs in the later stages of typhoid fever. It occurs in cases when the continuance of the fever is prolonged, and is seen in pneumonia, pleurisy, pericarditis with varying frequency.

The Typhoid Condition. "The patient becomes prostrate, he 'lies on his back in bed, with eyes closed, features shrunken and 'ghastly, and a dull stupid aspect, unconscious or nearly unconscious of everything that is going on about him. His skin 'is dusky, moist and sometimes bathed in sweat which 'often yields a fetid odour, and is for the most part, especially 'in the extremities, or exposed situations, cold. His lips are 'dry, black and probably fissured, his teeth loaded with sordes 'his tongue dry, brown or black, and often contracted in all its dimens

'He has no inclination for food, and probably no material thirst,
'but he has a difficulty (partly due to the condition of his mouth)
'in swallowing and utterance. His bowels are sometimes constipated,
'but often relaxed, and the evacuations are apt to be offensive.
'His respirations are shallow, but for the most part not much
'accelerated - ranging probably between twenty and thirty in the
'minute. They may however be much more frequent, and are
'liable to variation. The pulse is rapid and feeble, and, towards
'the end imperceptable at the wrist, and irregular. It may
'vary at first from 100 to 120, but often attains a frequency
'of 140 or more, and at the same time assumes a undulatory
'dicrotous character. The first sound of the heart is liable
'to become inaudible. Shortly before death, the superficial
'capillaries often dilate, the blood accumulates and stagnates
'within them, the surface acquires a rosy aspect, and a profuse
'flow of perspiration takes place. Bed-sores are apt to form
'upon the sacrum and other parts exposed to pressure. The
'condition of the urine presents considerable variety:- sometimes
'it is scanty high coloured and loaded with urates; sometimes it
'is abundant, pale, and limpid, and of low specific gravity. Muscular
'debility is shown in the tendency which the patient has to lie
'upon his back, and to sink towards the bottom of the bed.
'His senses are blunted; often he is deaf; he takes little notice
'(even if his eyes be open) of surrounding objects; he rarely complains
'of pain or uneasiness, or acknowledges its presence, and is
'insensible to conditions which at other times would have caused
'much personal discomfort; his intelligence is impaired, especially
'his memory fails; his mind is full of delusions, and he is more
'or less constantly muttering - he is in a condition of

"low-muttering delirium" or typhomania; he can probably however, be recalled to himself momentarily if addressed loudly, and will then half open his eyes, endeavour to do what he is told, and even give an intelligent response; but he soon lapses into the state from which he was aroused; he picks at the bed-clothes; his limbs are tremulous when he endeavours to use them, and his muscular fibres are in constant vibratile movement, giving rise to the condition known as subsultus tendinum; he passes his evacuations unconsciously, or allows the urine to accumulate in his bladder. With the advance of the typhoid symptoms, the mind becomes more and more obtuse, and the patient gradually passes into stupor, and thence into profound coma. The temperature presents great variety, dependent in a considerable degree on the nature of the disease upon which the typhoid symptoms supervene:— sometimes as in Bright's disease it is a good deal below the normal standard; sometimes, as in the hyperpyrexia of acute rheumatism, it attains the elevation of 110° or more. The typhoid condition is always one of great gravity, and, in a large proportion of cases, terminates in death"
(Theory and Practice of Medicine. Bristowe pp. 99. 100)

Examination of the Subcutaneous Tissue — Dropsy.

"Dropsy is invariably caused by the transudation of the serum of the blood through the veins" — "The causes of the increased transudation of fluid are two, — undue fulness of the veins and consequently increased pressure on their walls, or, an abnormally watery condition of the blood which gives rise to changes in the walls of the vessels and

renders them more easily permeable (Cohnheim + Lichtheim).

Dropsy arising from the first-cause is designated passive dropsy as it always originates in obstruction of the current of venous blood; that from the latter cause is called Hydraemic dropsy" (Guttmann loc. cit.) P22

Passive dropsy is a symptom of certain conditions of the circulation. It occurs whenever the return of venous blood to the heart is impeded as by pressure on the great veins, or when the onward flow of blood is impeded as in tricuspid regurgitation. If the obstruction be on the left side of the heart, as in mitral stenosis or regurgitation the oedema occurs first in the lungs and only after the right-heart has become incompetent does general dropsy ensue. Local passive dropsy may occur owing to pressure or constriction of the vessels as in emphysema of the lungs, or cirrhosis of the liver. Dropsy of a still more local nature is caused by the plugging of a vein by embolism or by its obstruction by pressure from without.

Hydraemic dropsy is symptomatic of a variety of conditions. It may occur in simple debility after exhaustive disease or from simple malnutrition; the most important conditions however are the acute or chronic varieties of nephritis, the hydraemia being due to the diminution of the water excreted by the kidneys and in some cases by the skin also.

The chief features of dropsy are the swelling, the appearance of the skin and the effects of pressure. The swelling is

always most marked where the tissue is loose as in the scrotum, the buttocks, or the face. The swelling is rounded and even, not definitely limited but more widely distributed than swelling from other causes. The skin loses its natural color, is pale, and when the dropsy is well marked becomes tense and shining. When pressure is made the tissue feels doughy and non-elastic, and continuous pressure gives rise to more or less distinct pitting, the depression remaining for a considerable time.

Dropsy in Thoracic disease.

The occurrence of dropsy in cardiac disease has been noticed, as well as that due to emphysema. In its slighter degrees it is noticed in chronic bronchitis, phthisis cirrhosis &c especially when there is much debility. Intra-thoracic tumours, cancer &c will give rise to dropsy.

In connection with cardiac dropsy or any general dropsy it should be noted that there is always more or less exudation into the serous cavities giving rise to hydro-pericardium, hydro-thorax &c.

Subcutaneous Emphysema - The swelling of emphysema resembles dropsy in appearance, but is different in its distribution - Dropsy occurs first in the more dependent parts - Emphysema occurs in the parts nearest the seat of the supply of air. It is caused by the entrance of air into the subcutaneous tissues. This may follow the rupture of any of the air-containing viscera when the rupture

communicates with the subcutaneous tissue. Thus rupture of the trachea or oesophagus or of the pulmonary vesicles may be followed by emphysema, but in the latter case unless adhesions with the thoracic wall are present the rupture is followed by pneumothorax. When rupture of the air cells takes place from simple over distension, as by coughing the air may be forced into the interlobular septa and through the mediastinum into the root of the neck. Emphysema of the subcutaneous tissue is also caused by traumatic injury as by a fractured rib, when the swelling may be local or general as in the remarkable case reported by Prof. Spence (System of Surgery Pp 1113-1127).

The character of the swelling is different from that of dropsy. The skin has not the same shining appearance and the swelling feels less dense and more elastic and on pressure produces a peculiar crackling sensation When the accumulation of air is marked, air either alone or mixed with serum escapes when the skin is punctured.

In Thoracic disease, subcutaneous emphysema occurs after injuries to the parietes, in rupture of the oesophagus by perforating ulcers, in ulceration of the trachea, in abscess of the lungs, and in rupture of the air cells of the lungs.

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The Swelling of Myxoedema — The appearance resembles dropsy in some degree, but the gradual appearance of the swelling, the hardness of the skin, the hardness of the subcutaneous tissues, the expression of the face, the malar flush, the articulation, with the other marked features of the disease serve to distinguish this from other swellings.

## Symptoms

The heart and lungs are so closely connected in their nervous supply, as well as by the mechanical arrangements of the circulation that it is not surprising that many of the symptoms which indicate disturbance of the heart should be the same or closely resemble those which occur in diseases of the respiratory organs, and vice versa.

Pain. Pain the result of traumatic injury, bruising of the thoracic wall, fractured ribs, wounds &c does not call for any special notice, except to point out that a strict examination should be made in order to ascertain as far as possible whether the organs below the seat of the injury have suffered or not and whether pleurisy or pericarditis may not be present, the result of the injury or of some other cause. Pleurodynia (muscular rheumatism) and intercostal neuralgia occasion a great amount of pain which is more or less affected by the movements of respiration and often cause the patient great alarm. The absence of other symptoms and the physical examination will readily make the nature of the case clear. Bronchitis may go through all its stages without pain, but in the early stages especially if the cough be at all severe there is a sense of soreness and rawness often amounting to actual pain in the sternal region. The most important causes of intra-thoracic pain however are pleurisy and pericarditis. The pain in both cases is caused by the rubbing together of the inflamed surfaces of the serous membranes lining the pleura or pericardium, — the pain in both occurs at the beginning of the inflammation, disappears when effusion occurs and may return when absorption takes place.

The pain is often severe, sharp, burning and lancinating. The situation and extent of the pain will usually serve to distinguish the one from the other, but a limited pleurisy in contact with the pericardium will often simulate pericarditis especially in cases of adherent pericardium. The pain in pleurisy and pericarditis is increased by pressure but in pleurisy the pain as a rule ceases when the breathing is stopped while it continues unaffected in pericarditis, and of course the physical examination will clear up the nature of the case.

Pain is sometimes present in pneumonia, phthisis, abscess of lung or but in most cases pleurisy, generally of limited extent, is present, and the disease of the lung may go on through all its stages without pain.

Cardiac affections with exception of pericarditis and angina pectoris are as a rule unattended by any pain, but a feeling of discomfort or heaviness in the praecordial region is present in some cases, especially myocarditis but this is by no means constant. Aneurisms cause a dull boring pain the result of pressure, and for the same reason solid intrathoracic tumours may give rise to pain, while the sharp darting pain of cancer is felt when that disease occurs within the thorax.

**Cough** – A cough is an expulsive respiratory effort, sometimes entirely reflex, being stimulated by irritation of some of the sensory nerves distributed to the epiglottis, trachea, bronchi &c or by extension of some other reflex act – such as sneezing; or it may be purely voluntary and under control of the will, or as is most common it is partly voluntary and partly reflex.

Cough is a common symptom in affections of the throat, larynx, trachea, bronchi, and lung substance; in some cardiac lesions; in aneurism and other intrathoracic tumours it forms an important symptom.

Varieties of cough:—(1) A cough is termed dry, when no expectoration is present and when from the sound of the cough, no evidence of the presence of fluid is observed. In the first stage of catarrh (pharyngeal, laryngeal or bronchial) the cough is dry and becomes moist when exudation takes place. A dry hacking cough is often suspected to indicate incipient phthisis, but most frequently this is found to be simply nervous and quite unconnected with any disease of the respiratory tract and to be due to hysteria. The so called "stomach" cough is generally dry and of nervous origin.

(2) Moist or loose cough. This term is applied when secretion begins to accumulate in the bronchi and to be expelled through the larynx. A cough is typically loose when the secretion is abundant and fluid, and is expelled without any great effort.

(3) Suppressed cough. This can scarcely be called a variety of cough but is rather a symptom of pain, thus in pleurisy or after an injury to the thorax (e.g. broken rib) the patient avoids movement of the thorax as far as possible and thereby suppresses the inclination to cough, and when coughing becomes imperative the action is short and with as little movement as possible and often accompanied by an exclamation of pain.

(4) Spasmodic cough – This is a purely reflex act, and continues for a longer or shorter time before it can be checked or ceases naturally. The best example occurs in whooping cough, but sometimes in bronchitis when the mucus is very sticky and adherent – a cough which began voluntarily will develope into a spasmodic and reflex cough.

(5) Nervous cough, is short and dry and frequently is the result of habit or debility – It is common in Hysteria and is unaccompanied by any evidence of respiratory disease

(6) Sepulchral cough, or churchyard cough – This arises in cases of extreme weakness; it has a hollow sound and is quite unphonetic. It does not actually indicate approaching dissolution, as its name might imply, but merely an extreme degree of weakness.

The sound of the cough (quality and intensity) depends on the condition of the larynx, the strength of the patient and the condition of the pharynx and tonsils. If the larynx is healthy the cough is clear and ringing, but may be muffled or obtain a peculiar nasal sound when the pharynx & tonsils are enlarged. (The cough of pharyngitis and tonsilitis is generally of a hawking nature). Should the larynx and vocal cords be inflamed, even though it is of a slight amount the cough becomes husky and the voice of the patient is affected in a similar manner.

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Examination of the Sputum —

Expectoration is present to a greater or less extent in some of the stages of all diseases of the respiratory organs

and its appearance is often so characteristic as to afford data for an absolute diagnosis. The presence of sputum is not to be looked upon as an indication of intra-thoracic disease, as the secretions from the nose and pharynx which are usually expelled by a short hawking effort, may be drawn through the larynx and expelled by coughing. The absence of expectoration does not exclude respiratory disease, but in the presence of coughing indicates the presence of tenacious mucus in the bronchi and when strength is failing and the disease evidently is extending, it is a symptom of the gravest gravity often indicating approaching dissolution.

The constituents of the sputa are chiefly - mucus, pus, blood, serum, epithelium (chiefly squamous), lung tissue, tubercular nodules and chalky concretions, fibrinous casts of the trachea & bronchi, crystals of fatty acids or of blood pigment, cholesterin and tyrosin, fungi of several varieties, bacilli and micrococci, taenia hooklets, fragments of food, foreign bodies &c.

It is usual to assign special names to the varieties of the sputa, indicating the element which is present in greatest amount - thus mucous expectoration consists almost entirely of mucus and is simply an increase in the normal secretion of the bronchi; purulent of pus, which occasionally is pure from the bursting of an abscess into the trachea or bronchi, but mucus is nearly always present -

and in the muco-purulent variety the two constituents are in nearly equal proportions. Serum is sometimes present in large amount (oedema of the lungs) and the sputum is then termed serous, but it is more usual for certain of the other elements to be present and mixed intimately with the serous discharge and we get the muco-serous or sero-purulent forms of sputum.

Blood may form the greater part or the whole of the expectoration after the rupture of a large vessel in the lungs, or it may merely tinge or streak the expectorated matter, or may be so intimately mixed as to give a rusty or brick red colour to the sputum.

Fibrinous sputa are the result of fibrinous exudation into the bronchi or trachea as in diphtheria or in the fibrinous form of Bronchitis, occasionally they are produced by the decolorisation of blood clot taking place in the lungs.

The other forms of expectoration such as the "prune juice", the "currant jelly" or the gangrenous may be included as varieties of one of the above forms.

Character and naked eye appearance of the sputa.

Mucous sputum is present to some extent in all pulmonary diseases when expectoration occurs, but it is in the first stages of Bronchitis that it is specially significant. The mucus may be clear and glassy but is more usually of a greyish, greenish or almost black

colour from the inhalation of smoke, dust, snuff or other colouring matter. It is adhesive and sticky and when a portion is separated it is drawn out in strings; some air is always present and gives a somewhat frothy appearance and the expectoration will float when placed in water. The consistence varies; at first, especially if the bronchial irritation is very severe, the sputum is so adhesive that it is only expelled with difficulty, but later when the number of white corpuscles increases, the expectoration becomes less viscid and gradually acquires a muco-purulent appearance.

Muco-purulent sputum is generally of a greyish-white or yellow colour. It is more fluid than pure mucus and contains less air and therefore has less tendency to float in water, but has a tendency to separate into layers the purulent part forming a deposit at the bottom, on which rests a layer of mucus often in nummular masses, with frothy mucus at the top. The expectoration may run together in a vessel, into a mass; at other times each distinct mass expectorated remains separate hence the name "nummular" is applied to this variety of sputum, from the rounded and flattened character of the little masses. This appearance is often seen in Phthisis, as is also the separation into layers of the

sputum but neither can be considered to be pathognomonic of that disease, as they occur in ordinary subacute cases of Bronchitis.

Purulent expectoration — Sometimes in Bronchitis especially in the more chronic forms the sputum contains so much pus that it is termed purulent. A large amount of mucous however is always present as can be seen by the stringy nature of the sputum, but pure pus is sometimes expectorated after the bursting of an abscess into the trachea or bronchia Such an abscess may be in the lung substance, in the mediastina, in the liver, splen or elsewhere. In Empyaema, the matter may be discharged through the bronchi, a sinus being formed in communication.

Pus when expectorated has the same character and appearance as pus from other sources - It is generally of a creamy consistence, sinks in water and when free from mucus cannot be drawn out into strings.

When the pus is discharged from a suppurating cavity in the lungs, it is frequently fetid and the smell of the expectoration, as well as the patients breath is very offensive.

Expectoration of blood, or Haemoptysis —

It is always necessary to examine the throat and

nose, to ascertain whether the 'expectorated' blood does not come from those regions. Usually there is no great difficulty in determining this point, but it is more difficult sometimes to be certain whether the patient has not vomited the blood especially if the blood be not seen. Vomited blood is dark in colour not mixed with air and has a slightly sour smell, but it must be remembered that vomited blood may come originally from the lungs and has just passed into the stomach. As a rule after the expectoration of a quantity of blood, the sputum remains coloured for a little time after, and blood pigment may be demonstrated in the sputum some time after the haemoptysis has ceased

A small amount of blood is sometimes seen in the beginning of Bronchitis, but merely as streaks in the sputum and rarely lasts long. Before any of the physical signs of Phthisis show themselves, haemoptysis is often seen, and is a most important symptom, but by Niemeyer is regarded as the cause of the lung disease.

Doubtless a great number of cases of Phthisis are met with where haemoptysis has occurred followed by the lung symptoms but it is difficult to determine the extent to which the lung symptoms owe their causation to the presence of blood in the alveoli.

When cavities are being formed in the lungs, the vessels as they are exposed are very apt to be the seat of haemorrhage which may be only of small amount, but is frequently extensive and sufficient to cause the immediate death of the patient. The blood in such cases is generally bright and florid and is only slightly mixed with mucus, pus or lung detritus. In other cases, the haemorrhage takes place more slowly, and the blood is expectorated mixed with the secretion and detritus from the cavity; or the blood may remain in the cavity and become dark from deoxygenation, or undergo various changes the result of decomposition or other chemical processes.

When the lungs become engorged with blood the result of Mitral disease small haemorrhages are not uncommon, cough is present owing to the oedematous condition of the lungs, and the expectoration before the haemoptysis, is watery and of considerable quantity. It is in mitral disease, or as a complication of Bright's disease, that pulmonary apoplexy is most prone to occur. The haemorrhage takes place partly into air cells partly into interlobular tissues. Some of the blood is expectorated and may be bright in colour but more often dark and venous, the rest of the extravasated blood remains in the tissues, where it may be absorbed leaving only a patch of pigment; or breakdown and suppurate, or death may ensue before any change can take place and a post-mortem examination shows a more or less rounded

batch having the appearance of dark solidified blood clot.

Haemoptysis not unfrequently occurs in purpura and scurvy and in the course of typhus, smallpox and some other fevers, also in anaemic subjects it is sometimes seen and occasionally it occurs vicariously in cases of amenorrhoea - Hysterical patients occasionally try to simulate haemoptysis so that caution is necessary in such cases.

An intimate mixture of blood with the sputum is the cause of the rusty red expectoration which when it occurs is pathognomonic of pneumonia. The sputum in pneumonia is however not always rusty but clear and of a yellowish or greenish tint, due to changes in the haematin derived from the blood. Sometimes also it is darker in colour resembling "prune-juice" due to the presence of a larger amount of blood in the sputum, which may, throughout the whole course of the case, preserve this appearance.

A jelly like sputum tinged with blood, and called, from its colour, "currant-jelly sputum" occurs in some cases of sarcoma and if not diagnostic, is highly suggestive of that disease.

Injury to the thorax - Haemoptysis is an important symptom in cases of injury, fractured ribs, bullet wounds stabbing &c in which the occurrence of blood in the sputum will point to injury of the lung substance.

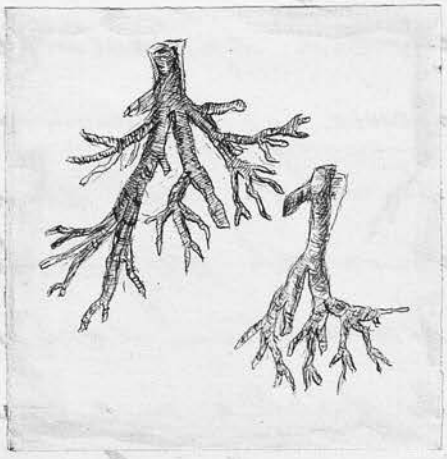


Fig. 18. Fibrinous casts from Bronchi
(Bristowe Medicine P 340)

Serous expectoration occurs in edema of the lungs due to obstruction of the mitral valve, and in congestion of the lungs, and occasionally is secreted in the bronchial tubes. The sputum is thin and watery with generally some viscidity dependent on the amount of mucus present, or it may be turbid and semi purulent from the presence of pus-corpuscles. In the former case the expectoration is termed muco-serous, in the latter seropurulent.

Fibrinous expectoration. This consists of fragments of false membrane from the trachea, or bronchi, more rarely of casts of the bronchi extending to their finer divisions (Fig 18). The sputum should be placed in water when the casts unroll and their treelike character becomes evident. "They are always the result of fibrinous bronchitis "and occur very frequently in the croupous pneumonia of "adults, which is generally accompanied by a fibrinous "inflammation of the finest tubes. They appear in the "sputum from the beginning to the acme of the stage of "hepatisation, that is usually from the third to "about the seventh day of the disease, but are absent "in the first stage, as exudation has not yet taken "place, and in the third stage, the plastic exudation having "then become fluid and in great part absorbed. * * "in about 10-20 per cent of cases they are absent, when the "patient is weak sputum is scanty and the patient weak "and exhausted and unable to cough with any degree of pow

* * Fibrinous casts of the bronchi are most numerous and most perfectly formed in cases of Croupous bronchitis, acute as well as chronic." (Guttmann Pp. 180-181)

Gangrenous expectoration - In gangrene of the lungs and in ~~bronchiectasis~~ putrid bronchitis ~~when putrefaction has occurred~~ the sputum is of a very offensive character. The sputum is of a dirty yellowish colour, but is sometimes stained dark claret-colour the result of haemorrhage. Pus lung detritus, millet-seed bodies, and (if the secretion has remained long enough in the lungs), fatty crystals are the chief constituents. Few or no elastic fibres are discovered in which point this sputum differs from the phthisical sputum where there is also great destruction of tissue.

The odour is very offensive and the patients breath has a putrid odour even before expectoration has occurred.

Microscopic Examination — The sputum may be examined without special preparation with a magnifying power of from 200 to 300 diameters but for the demonstration of lung tissue it requires to undergo special treatment in order to bring out the elastic fibres clearly, and special processes, staining reagents and high powers of the microscope are necessary to discover the bacilli, or micrococci which have been identified in the expectoration.

The Microscopic characters of mucus and pus do not require any notice here.

Phthisical sputa should be collected for about 24 hours

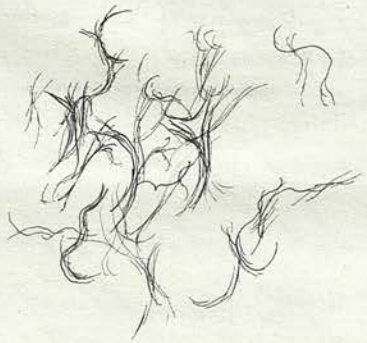


Fig. 19 Elastic fibres from Phthisical Sputum

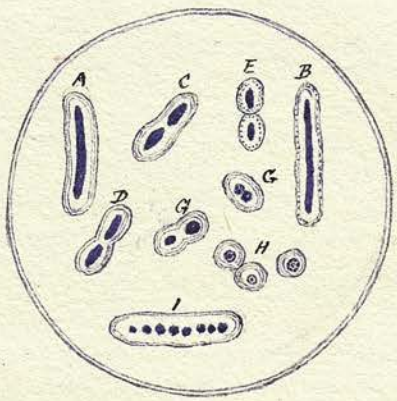



Fig 20 Bacterium Pneumoniae Crupposae from Pleural cavity of a mouse A.B. Thread Forms C.D.E. Short Rod Forms. G Diplococci. H Cocci. I Strepto Cocci

From Cruikshanks Bacteriology P226

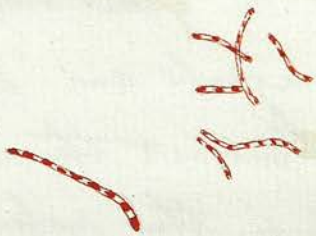


Fig 21 Bacillus Tuberculosis (Cruikshanks Page 272)

Stained by Ehrlich's Method

X 2500

mixed with a solution of caustic soda or liquor potassae and boiled till the mucus which is present has lost its tenacious character, then if allowed to settle in a conical glass and a specimen taken from the bottom of the vessel and examined with a multiplying power of about 300 diameters there is no difficulty in demonstrating the curled fibres of elastic tissue, as shown in fig. 19

To demonstrate the bacteria of pneumonia:— "Cover-glass preparations may be treated as follows—

"(a) Stain by method of Gram, and after stain with eosin (Gram's method is to stain for 3 minutes with aniline-gentian-violet solution, and decolorize with absolute alcohol, when the eosin may be added.)

"(b) Treat with acetic acid, then stain with gentian-violet or bismarck-brown. Examine in distilled water, or dry and preserve in Canada balsam.

"(c) Float them on weak solutions of the aniline dyes twenty four hours; differentiation of coccus and capsule is thus obtained.

"(d) Stain with osmic acid; the contours of the capsules is brought out." (Cruikshank's Bacteriology P. 227)

The Bacterium Pneumoniae Crupposae is shown at Fig 20

The Bacillus of Phthisis - Tubercle Bacillus - "Rods, 2-4μ and occasionally 8μ long, very thin, and rounded at the ends. They are straight or curved, and frequently beaded (Fig 21) and occur singly, in pairs or in bundles"...

- - - - - "The bacilli appear to be the direct cause of tuberculosis, and the presence of the bacillus in the sputum

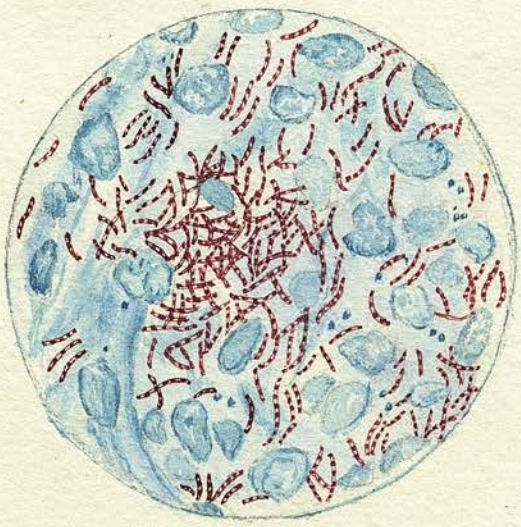


Fig 22. Bacillus Tuberculosis.
From a coverglass preparation of Pus from a tubercular cavity of the human lung. Ehrlich's Method (Fuchsin and Methylene Blue)
Zeiss 1/12 O.I. Oc.4.
Cruikshank Bact.y Pl.20.Fi.

"of patients is regarded as a distinctive sign of the existence
"of this disease. The detection of the bacillus has, consequ-
"ently, become a test which is daily applied by physicians
"in forming clinical diagnoses." (Cruikshanks loc. cit. P 273 & 4)

To demonstrate the bacillus in the sputum, cover-glass-preparations should be made, taking care to take some of the matter expectorated from the air cells or a cavity and not merely from the bronchi; this should be spread in as thin a layer as possible and dried, after which they should be thrice passed rapidly through the flame of a spirit-lamp or bunsen burner. To stain the preparation, various methods may be followed but Ehrlich's or Gibbes' methods are the most useful.

"Ehrlich's Method - Cover-glass-preparations are allowed to
"float in a watch glass, containing a solution of gentian violet
of fuchsine, added to aniline water. (A saturated alcoholic
solution of the dye is added till precipitation commences
(10 ccm. aniline water, and 10-20 drops of the colour solution)
The cover glasses are left in the solution for about half an
hour; then washed for a few seconds in strong nitric acid
(one part - commercial acid to two of distilled water), and
rinsed in distilled water. After stain with vesuvin or
methylene-blue, rinse in water, dry and preserve in Canada
balsam. ..... (Fig 22)

"Gibbes' New Method - Cover-glass-preparations are placed
in the double staining solution, which has been warmed in
test tube, and, as soon as the steam rises, poured into a watch glass

"They are allowed to remain for five minutes, and then
"are washed in methylated spirit till no colour comes
"away, dried in the air or over a spirit-lamp, and
"mounted in Canada balsam. (Cruickshanks P276-277)

Dr. Gibbes "double stain" is prepared thus:—

Rosanilem hydrochlorate 2
Methylene blue 1

Triturate in a mortar

Anilen oil 3 parts dissolved in 15 parts of rectified spirit and added to the above, to which finally 15 parts distilled water are added. This is very convenient from the short time preparation takes to stain.

To examine Bacilli a 1/12 O.I with a No 3 or No 4 eye piece gives excellent results.

The other matters found in the sputum are fatty-acid crystals, crystals of tyrosin & cholesterin, hydated hooklets coal dust, fragments of stone & particles of food &c. &c.

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Dyspnoea - orthopnoea - shortness of breath.

The feeling of want of air, occurs both in health and disease, and may be so slight that the breathing is scarcely altered and a moments rest or a slight change in position is sufficient to relieve it; or it may be so extreme as to cause the most violent efforts, into which nearly all the muscles of the body may be pressed, in order to obtain relief.

In health dyspnoea occurs under the same conditions which it does in disease, that is, when the supply of oxygen is insufficient for the expenditure; thus on violent exertion the circulation is quickened, the oxygen in the tissues is exhausted more rapidly than usual and the respiration must be increased in rapidity or depth to supply the want. In rarified air at high altitudes, dyspnoea is a common symptom with those who have ascended rapidly from the denser atmosphere of the plains, while the residents at such elevations are unaffected, probably owing to the great expansion of the lungs which takes place in those who habitually breathe rarified air. (Hirsch. Geographical Pathology Vol P 9. Syd. Soc.).

In disease, dyspnoea occurs whenever the process of blood aëration is interfered with and is thus a symptom of cardiac and pulmonary mischief.

In affections of the lungs large areas may be shut off, from participation in aërifying process without any dyspnoea, unless on exertion, provided that the diminution has taken place gradually. Thus dyspnoea occurs only on exertion in many cases of pneumonia, phthisis, or pleurisy when the consolidation of the lung has taken place slowly. When however the aërating surface is rapidly diminished dyspnoea is marked and often most painful. This is best seen in collapse of one lung in pneumothorax, the

result of the sudden entrance of air into the pleural cavity through an opening in the lung substance or in the wall of the thorax. In pleurisy also when the expudation takes place very rapidly and in pulmonary apoplexy where a large portion of lung is rendered useless suddenly, dyspnoea is often extreme. The sudden plugging of one of the larger bronchi as sometimes occurs from a foreign body slipping into the trachea through the glottis and becoming impacted in a bronchus will give rise to a great amount of dyspnoea with a sense of suffocation.

In cardiac cases, everything which tends to hamper the action of the heart will tend to produce dyspnoea. Thus it occurs in pericarditis especially when adhesions form, in compression or dislocation of the heart by a tumour, and to a minor extent by a distended stomach. When the heart's action is weak also, the walls degenerated, or loaded with a deposit of fat, dyspnoea is present. The most marked cases however are in those forms of valvular disease in which the pulmonary circulation suffers; thus in mitral stenosis and incompetence, in pulmonary, and tricuspid disease dyspnoea is often very marked, and orthopnoea (that is when the patient is unable to lie down on account of the difficulty of breathing) is frequently present. In aortic disease so long as the mitral valve remains healthy respiration is only slightly interfered with, and any dyspnoea present is probably due to the rapidity of the heart's action

Pain in the thorax or in its neighbourhood will

often cause dyspnoea owing to the shallow respiration which the patient adopts to ease the pain

Certain nervous lesions interfering with the ~~medulla~~ respiratory centre, paralysis of the muscles of respiration obstruction of the larynx or trachea and the inhalation of irritant gases, such as sulphurous acid, by causing spasm of the bronchial muscles are amongst the other causes of dyspnoea. Anaemia is also a very frequent cause of dyspnoea.

The Amount of dyspnoea present depends to a great extent on the wants of the patient, thus in phthisis though the greater parts of both lungs are rendered almost useless, the patient experiences comparatively little difficulty in breathing owing, no doubt, to the little exertion he is capable of, and the very low state of the vital process which is seen in the emaciated phthisical patient. A healthy full blooded man on the other hand if deprived of the use of even a small part of his lungs would suffer to a greater extent from dyspnoea -

The depth and rapidity of respiration vary greatly during dyspnoea - As a rule, the rapidity is in inverse proportion, to the depth, very rapid respiration being more shallow, while deep respiration is slow. In dyspnoea from disease of the lung substance or caused by pain, the respiration is very shallow and rapid, while in that caused by obstruction of the larynx or tracheae the depth is increased, and the duration of inspiration prolonged

while expiration, unless the expulsion of air is likewise impeded, as it may be in Bronchitis with copious sticky secretion, may be normal or shortened.

Dr. Bramwell gives the following as the chief forms of dyspnoea in cardiac diseases: —

1 Breathlessness on exertion, the breathing being natural when the patient is at rest. Chiefly met with in mitral lesions; in dilatation of the right cavities of the heart; and in cases of anaemia, in which it is ~~[illegible]~~ in great part owing to the altered condition of the blood.

2 Dyspnoea the result of ~~[illegible]~~ alterations in position independent of lung complications. Patient says when sitting up, becomes breathless on lying down, after a time the heart accommodates itself to the altered position, breathing quiets down and patient falls asleep. Probably due to the altered position of the diaphragm or to reflex impression passing from the stomach through the Vagus to the heart.

3 Paroxysmal attacks of dyspnoea. Due in some cases to sudden over distension of the cardiac cavities; in others to spasm of the glottis, produced by pressure of an aneurism on the recurrent laryngeal nerve; in others to the pressure of an aneurism on the trachea; in others to sudden oedema of lungs produced by over distension of the left ventricle (rare); to sudden distension of right ventricle and imperfect supply of blood to the lungs; in others to plugging of the pulmonary artery (very exceptional).

4 Typical orthopnoea. Difficulty of breathing comes on

gradually until permanent orthopnoea is established, common in late stages of cardiac disease, mitral disease and dilated right ventricle. Patient more or less cyanotic; dropsy, hydrothorax, bronchitis, oedema of lungs & prominent symptoms.

5 Cheyne-Stokes Respiration: Angina sine dolore.

"In some cases of cardiac disease more particularly where "right heart is dilated and fatty, a peculiar rhythmical "dyspnoea is observed" There is difficulty of breathing for a few respirations, the dyspnoea gradually subsides then breathing becoming shallower & slower until for a time - half to three quarters of a minute - it is suspended. Breathing gradually reappears becoming deeper and quicker until the height of the paroxysm is reached. The same sequence of events then occurs, the cycle lasting about one or two minutes, less than half being occupied by the period of rest.

It is not pathognomonic of any one condition and occurs in (a) advanced cardiac cases - dilated and fatty right heart, atheroma of coronary arteries, dilatation of aorta; (b) certain cerebral conditions affecting neighbourhood of Medulla; - (c) uraemia; (d) very exceptionally in other conditions

It is a grave symptom, as a rule speedily followed by death." (Condensed from B. Bramwell - Dis. of Heart - P 66 - 69)



Diagrammatic representation of Cheyne-Stokes respiration

Dyspnoea then as a symptom points to: —

1st- In the respiratory system — obstruction of larynx trachea or bronch; partial or complete compression of the parts of the lungs; infiltration of the air cells of the lungs distruction (rapid) of lung tissue, pain in the thorax.

2nd In the circulatory system — Valvular disease especially of the Mitral and valves on right side of the heart; dilatation of the cardiac cavities especially the left auricle and right ventricle; rapid action of the heart; weak heart-(fatty); adherent-pericardium; Aneurism.

3rd In the abdomen. Pain, — distension by tumour, gas fluid & preventing diaphragmatic action, or hampering action of the heart

4th Nervous System. Certain cerebral affections, — paralysis of respiratory muscles

5th Condition of the blood — Anaemia &c

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Palpitation — Hyperkinesia —

Over action and rapid action of the heart occurs in paroxysms of varying length, which last for a few minutes or may extend for some hours. The sensation is often painful and sometimes is accompanied by the dread of approaching death. Palpitation is occasionally observed in valvular disease but is most frequently due to functional disturbance. The rate of pulsation

may be as high as 200 per minute. Simple over-action is felt in these lesions when hypertrophy has occurred to a great extent - the heart's pulsation is slowed rather than quickened and the sensation is altogether different from the rapid excited beating of palpitation.

Intermittent action of the Heart - Sometimes the patient is conscious of the stoppage of the heart and this alone may bring him under observation. Intermittency is sometimes purely functional but may indicate serious valvular lesions or cardiac dilatation or that in all cases a thorough physical examination is required.

Syncope. This is frequent in anaemia, and in simple debility and may be entirely independent of the condition of the heart, but due to vaso-motor influences causing a sudden emptying of the vessels of the brain. In dilatation of the right ventricle and some other cardiac conditions, syncope is not unfrequent, especially after exertion.

Headache and Malaise often precede acute diseases such as pneumonia, pleurisy &c and a distinct rigor may occur. A continued throbbing headache is sometimes suggestive of valvular disease but is by no means a constant symptom. The purely objective symptoms, Dropsy, Cyanosis &c have been already noticed under the "general condition"

# Physical examination of the Thorax.

## Diseases of the Respiratory System

**Inspection** – The patient should be stripped to the waist, and placed in a good light in front of the observer; he may be seated, standing, or lying the position varying according to his condition and the convenience of the physician – to inspect the dorsal aspect of the thorax of course it is necessary to have the patient raised even though he be confined to bed. The light should be so arranged as to fall evenly on the surface, and it is as well to avoid a strong light from one side, which is apt to throw shadows and exaggerate any irregularities in the conformation.

**Shape of the Thorax** – The Thorax presents many varieties in its form and configuration, and it is impossible to describe exactly what constitutes a perfectly formed thorax. The symmetry of the two sides is essential the sternum perfectly in the middle line, slightly convex forwards but free from any decided bends or irregularities, the spinal column straight, that is with no curvature to either side, but with a slight convexity backwards, the two segments of each pair of ribs should correspond in their direction and curvature; and the thorax as a whole should have a general roundness and fulness that is more

Unilateral enlargement - Sometimes this can be seen at all stages of the respiratory movements, at others when the expansion is less it is only at the end of expiration that it is evident that the one side is less than the other. The enlargement is brought about by the distension of the pleural sac with fluid, gas or a combination of both. The movement of the affected side is restricted and the intercostal spaces are flattened (levelled up) or bulge forwards. Unilateral enlargement is seen in pleurisy or empyaema in which the amount of fluid is large and in pneumo-thorax or hyo-pneumo-thorax.

"Extensive pneumonic infiltration of one lung is "occasionally accompanied by considerable enlargement "of the corresponding side of the chest. Vesicular emphysema "of one lung can scarcely ever occur to such a marked "degree as to alter the form of the Thorax or chest side; "the author at least has never seen such a case" (Guttman loc. cit. P. 30.).

Local enlargement = External swellings such as abscess or solid growth, enlargement of the bones will cause a local bulging which must be distinguished from those occuring within the thorax. The sternum may bend in spinal curvature or in rickets, or in cases where the accessory muscles are constantly brought into use, as in [illegible] emphysema, a local enlargement takes place. In solid growths within the thorax, such as mediastinal

tumours or aneurism a local enlargement is sometimes produced, which in the latter case will often be seen to pulsate. Enlargement of one side of the chest may be caused by upward pressure from the abdomen, an enlarged spleen, a dilated stomach, a hypertrophied liver, or a solid tumour, ascites or will, sometimes occasion local swelling of the thorax generally confined to the lower part.

The causes of paracordial bulgeing will be referred to later.

Diminution in size.

Contraction of one side occurs chiefly in connection with chronic or old standing exudation into the pleura. The lung becomes consolidated and in many cases bound down by adhesions, so that when absorption does take place or the effusion is artificially withdrawn expansion cannot take place, ~~so that~~ and the wall of the thorax must sink to meet the lung. The side becomes flattened, and the whole side becomes less, the nipple being nearer the middle line and the scapula nearer the spine, which itself is sometimes bent with the convexity towards the affected side. The diaphragm rises higher on the contracted side, and the abdominal viscera are displaced. Thus if the disease be on the right side the liver will be displaced upwards, and the heart either drawn by contracting adhesions to the right or thrust out of its place by the expanding left lung. If on the left side the spleen, or stomach will rise higher and the

heart can be pushed or dragged more to the left.

These changes occur when the whole of one lung fails to expand and are always most marked in young subjects when the bones yield easily; in the adult the natural yielding requires sometimes to be brought about by surgical means and part of 2 or 3 ribs cut away to allow the chest-wall to fall to the level of the unexpanded lung.

Local depressions - These are frequently seen in the supra or infra clavicular regions more rarely lower down, the result of condensation and contraction of the lung in phthisis or catarrhal pneumonia; when the depression exists only on one side, it is easily detected even though slight, but should there be a slight depression on both sides, it might easily escape notice being assigned to emaciation. Local depressions are also produced by the non-expansion of parts of the lungs after compression by pleurisy, empyaema or pneumo-thorax. The greater part may expand while a small portion remains bound down and collapsed and to meet this part of the chest-wall sinks and a local depression results.

Other depressions may be the result of mechanical pressure, thus in shoe-makers and in some other trades where some of the implements are held against the chest,

the wall after a time gives way. In rickets and diseases of the spine, also in some cardiac cases the thorax becomes entirely deformed; the sternum bends, one side may be thrown forwards and the other backwards and the walls bent, flattened or bulged so that the natural configuration is lost. Local, or sometimes general contraction occurs in those suffering from diseases in which there is difficulty in inspiration as in whooping cough, stenosis of the larynx &c especially when they occur in young children. In cirrhosis of the lungs & in atelectasis contraction is also seen.

Specially shaped thoraces as the 'pigeon-breast' are often the result of rickets and do not indicate any special change in the lungs. Guttmann describes the thorax in individuals of a phthisical habit which he states may itself "give rise to caseous degeneration and tuberculosis of the lungs". This variety is due to imperfect development. "It is characterised "by a long, narrow, and shallow chest, by sloping of the "supra- and infra-clavicular regions, wide intercostal "spaces (on account of the diminished power of the intercostal muscles), wing-like projection of the shoulder blades (from the feeble action of the serrati), undue prominence of the acromial ends of the clavicles, and diminution of the antero-posterior diameter. The manubrium sterni takes

are mentioned. They are :—

(1) Want of oxygen in the air - rarification of the air

(2) Obstruction to the entrance of air into the lungs, provided that the obstruction is not sufficient to cause inspiration to be prolonged, when respiration is rather decreased in rapidity.

(3) Capillary bronchitis - more rarely bronchitis affecting the larger tubes; though this, when occurring in a patient whose lungs are already weakened or infiltrated, will cause rapid respiration.

(4) Collapse of lung (rapid) the result of pleurisy &c

(5) Infiltration of the alveoli, as in pneumonia.

(6) Changes in the heart - especially those valvular lesions which interfere with the pulmonary circulation.

(7) Condition of the blood - Anaemia

(8) Nervous lesions or functional disturbance.

(9) Abdominal distension interfering with the action of the diaphragm.

Diminished frequency of respiration.

The respiration may be slowed by the influence of the will and may be stopped altogether for 30 to 60 seconds or more. It is slow when oxygen is inhaled pure or in greater proportion than it exists in the atmosphere. It is slower if the respiration is habitually deep.

In disease the respiratory rate is slower, when obstruction to the entrance of air exists. Thus in stenosis of the larynx, oedema of the glottis, diphtheritic croup

inspiration is prolonged and as a rule the breathing is deep and the rate of respiration diminished.

In bronchial asthma, when the bronchi are lessened by the contraction of the bronchial muscles, the respiration is slow and laboured, differing markedly from the obstruction of the smaller bronchi caused by swelling of the mucous membrane and exudation

The breathing is slowed by certain drugs such as opium especially when taken in large doses; also by certain cerebral conditions, paralysis of the vagus, apoplectic coma and does not necessarily indicate any respiratory affection. Slow action of the heart may be accompanied by slow respiration or ~~many~~ the respiration may be normal or increased in rapidity.

The character of the respiratory movements

There are two types of respiration, the thoracic or costal, and the abdominal or diaphragmatic. Under ordinary circumstances, the breathing is carried on by a combination of the two, and is thoracico-abdominal. In the male the abdominal type of respiration is more marked than the thoracic, and in the female the reverse obtains.

The diaphragmatic action may be lessened or entirely abolished under the following conditions:— Paralysis of the diaphragm, which may be the result of spinal disease or injury, injury the nerve of supply (phrenic), or by the action

of drugs (chloroform); by distension of the abdomen by fluid, or gas, or the presence of a solid tumour; by pain in the abdomen. The type of the respiration becomes then entirely or almost entirely costal. The breathing is hurried and dyspnoea, or exertion at all events, is present. Costal respiration may be lessened or entirely prevented by paralysis of the respiratory muscles, but a paralysis or extension so to involve both the ordinary and extraordinary muscles of thoracic respiration is scarcely consistent with the prolongation of life. The costal respiration is restrained when the movement causes pain or by the application of a tight-bandage or tight-clothing. In emphysema there is very little movement in the thorax or abdomen and owing to the non-contraction of the lungs during expiration, the thorax remains in an expanded condition.

Diminution in the movement on one side only is often seen; it occurs when from any cause the lung does not follow the movement of the thorax. Thus in pleurisy, empyoema, or pneumothorax, the lung is incapable of complete expansion and the movement on the affected side is distinctly lessened. The same is seen in pneumonia and other conditions when the alveoli are infiltrated with plastic material. The presence of pain is also a powerful agents to restrict the movements of the thorax on the side affected.

The restriction may be still more local and affect only a part of one side, as when the apex is consolidated or excavated, the thorax is generally flattened, and the movement lessened over the affected area. Restriction of the movements is seen in cases in which contraction has occurred, the result of an old pleurisy, or where from any cause complete expansion of the lung is prevented.

The appearance of the interspaces is important during both inspiration and expiration. In a well nourished individual with healthy lungs, there is no bulging or indrawing of the interspaces, but should fluid be present and the thoracic walls thin, distinct bulging will be seen especially during expiration. When the lung does not expand easily, as is the case when bound down by adhesions after pleurisy or the interspaces are drawn inwards during inspiration generally recovering during expiration, though, in some cases they remain drawn inwards then also. When the entrance of air into the thorax is obstructed the interspaces are also drawn inwards, thus in croup stenosis of the larynx there is a marked symptom; and if one bronchus were entirely stopped, as by a foreign body, it is seen on one side, that is, the affected side, more than on the other.

* In inspiratory difficulties the action of the extraordinary muscles, in the neck and elsewhere, will be evident on inspection, while in difficulty of expiration the extra muscles of expiration, which are chiefly the abdominal muscles will be seen in strong contraction.

Relation of Inspiration to Expiration.

Normally the inspiratory and expiratory acts are equal or nearly so, separated by a short interval or pause. (This does not apply to the respiratory murmurs)

Inspiration may be prolonged while expiration remains of the usual length, when there is obstruction to the air entering the lungs, but where there is no impediment to the air leaving the chest. This occurs in paralysis of the laryngeal muscles, when the glacial vocal cords form an impediment to inspiration, but none to expiration. In stenosis of the larynx, croup & other obstructive diseases both inspiration and expiration are prolonged, but occasionally inspiration only is affected. An increase in the length of expiration is seen in some cases of chronic bronchitis when the tubes are filled with sticky expectoration, the inspiration remaining of normal length. *

Disturbances in the rhythm of respiration are common both in health and disease. In health they are due to emotional influences, fear, grief, &c while in disease, they may point to respiratory or cardiac mischief; the significance of the former cases ~~xxx~~ has been sufficiently indicated in what has gone before - "Cheyne-Stokes respiration" which is the most marked case of disturbance of rhythm has also been described.

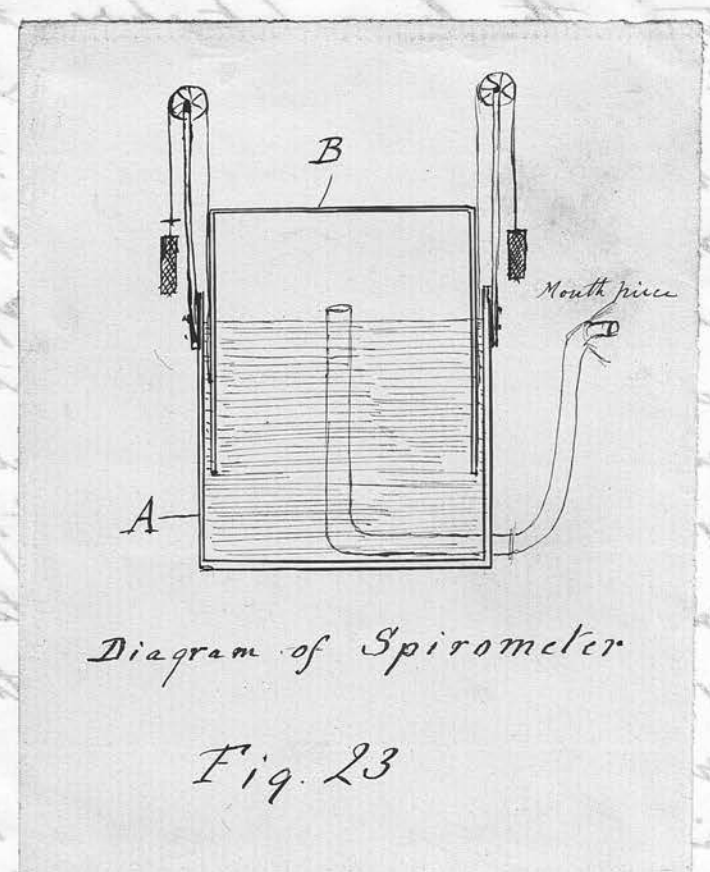



Diagram of Spirometer

Fig. 23

The movements of respiration may be graphically represented by the stethograph. This instrument is of different forms, but its principle is a lever one arm of which will move with the thorax while the other will record the movement on a revolving cylinder or a slip of paper drawn in front of it. A double stethograph which will enable a comparison to be made at different points of the chest at the same time has been invented but owing to the trouble of application and the scant information to be obtained, none of the instruments have come into use in general practice, though for teaching purposes and for hospital work they are of service.

The capacity of the lungs and the depth of respiration can be measured by the Spirometer, Fig. 23 an instrument resembling the ordinary gas-reservoir. It consists of two cylinders the under and outer one (A), contains water and into this the second is inverted (B); the patient breathes ~~into~~ through a tube which opens under (B) but above the level of the water. The cylinder is balanced and its rise will indicate in cubic feet and inches the amount of air expired. The process may be reversed the cylinder being filled with air, the patient will inspire through the tube, when the fall of the cylinder

will indicate the amount of air drawn into the chest at an inspiration. The apparatus is cumbersome and could hardly be used in those cases where acute disease is present, as in acute pneumonia when it might be of service to know how much of the lungs could contain air.

Palpatometry (Waldenburg) — The ordinary manometer may be used to indicate the force of inspiration and expiration. The respiratory force varies in health within the limits shown below:

| | Inspiration | Expiration |
|---|---|---|
| | mm. | mm. |
| "In moderately strong men .. | 70 – 160 .. | 80 – 130 |
| "In very powerfull, built men .. | 120 – 160 .. | 150 – 220 |
| "In women .. .. .. .. .. | 50 – 80 .. | 60 – 110 |

"These points are reached only when the movements of "respiration are executed rapidly .... when they are "performed slowly the manometer indicates a much lower "pressure, and the mercury remains longer at its highest point "oscillating slightly upwards and downwards. .....

"The diseases of the respiratory organs may be divided into two "principal pneumatometric types; in the first the conditions "of health are reversed, [the expiratory force is normally greater than "the inspiratory] "the positive expiratory pressure being less "than the negative inspiratory force, while the latter may be "increased, normal, or subnormal; in the second, the negative "inspiratory pressure is lower than the physiological minimum

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while the positive expiratory force may be normal or subnormal, in the latter case being still slightly greater than the inspiratory force. In the first class, that in which the expiratory pressure is diminished, belong pulmonary emphysema (the lowering of pressure here being due to diminution in the elasticity of the lung tissue), bronchitis and nervous asthma. In the second class in which it is particularly the inspiratory power that is lessened, are found phthisis pulmonum (the manometric difference being observable here even when the disease is of but slight extent), stenosis of the larynx and trachea and generally those diseases of the respiratory organs which offer increased resistance to the expansion of the lungs (pneumonia, pleurisy); in the more advanced stages of such cases the expiratory pressure may also be decreased. Among diseases of the heart mitral lesions most usually produce diminution of expiratory power, the result of the consecutive hyperaemia of the lungs (Waldenburg). Tumours of the abdominal organs (pregnancy, effusions &c), inasmuch as they impede expiration rather than inspiration, tend chiefly to lessen the expiratory force (Eichorst).

"It is worthy of notice that in comparing the pneumatometric with the spiro-metric signs, in health and disease, we find no evidence of any fixed relation between respiratory pressure and vital capacity; the former may be high while the latter is low, and vice versa". (Guttmann loc. cit. P. 61)

## Palpation of the thorax

The patient remains in the same position as for inspection, and as a rule, inspection and palpation go on up to a certain point together, for palpation is to a great extent used to confirm the information gained by inspection. The hands of the observer must be thoroughly warmed, or cough may be excited, respiration disturbed, and even pain set up.

All irregularities of the surface are carefully examined by palpation and their locality carefully noted. Differences also in the size of the two sides of the thorax can be definitely determined and if necessary measurements made. That there is a difference present, may be easily recognized but when variation in the size of the enlarged or diminished area occurs, as in acute pleurisy, measurements become necessary. The diameters of the thorax can be made with an ordinary pair of calipers, while the circumference is measured with a tape-measure. It must be remembered always to take the circumference at the same point in the respiratory movement, either at the end of expiration (the most usual time) or at the

effect of pressure noted. In neuralgia the pain is localised to the course of the nerve or nerves affected and generally, specially tender spots can be discovered by pressing along the intercostal spaces, while in nearly every case a sensitive spot is found at the root of the nerve close to the spine or over the corresponding spinous process. The pain of pleurodynia is also increased by pressure and the muscles appear tender when pinched, and here the pain is not so distinctly localised as in neuralgia. The pain of pleurisy appears to be more deeply seated than either the pain of neuralgia or muscular rheumatism. It may only be elicited by pressure, and if present is always increased.

Vocal or pectoral fremitus — This is a name given to the vibration of the thoracic walls caused by phonation. When the patient speaks if the hand be placed on any point of the chest wall a distinct vibration is felt ~~[illegible] the patient [illegible] or coughs~~. The vibration is conducted chiefly through the air tubes and then through the pulmonary tissues to the external walls

The intensity of the vibration depends on (1) the strength of the voice, being greater when the patient

A Increase

The vocal fremitus is increased by

1st Increase in the strength of phonation, which may indicate increase in the strength of the patient

2nd By alteration in lungs which increase the conducting power. Consolidation of the lung tissue by the presence of pneumonic or other exudation in the lungs, causes a marked increase in the intensity of the vocal fremitus over the affected area. The vibrations are conveyed more readily through tubes embedded in solid tissue and through the solidified tissue itself than through the free air cells. Cavities when superficial and in direct communication with a bronchus will increase or amplify the vocal fremitus and therefore it is more marked over a spot corresponding to the situation of such a cavity.

3rd By removal of bad conductors. The fremitus is increased when the chest walls are thin, free from fat or from any great mass of muscular tissue, provided that the strength of the patient is maintained. In those diseases however where the chest walls are the thinnest, that is where emaciation is most

* This only applies to small tumours near the surface of the lungs. A large growth in connection with, & surrounding a large bronchus with conduct vocal fremitus and cause its increase, if the growth be not separated from the surface by healthy lung tissue, just as condensation, from other causes, does.

marked, as in tubercular phthisis, the strength of the patient frequently is so much diminished, and consequently his power of phonation lessened, that the vocal fremitus is often diminished instead of increased. The same is frequently seen in cases where the fremitus would naturally be increased, as in pneumonia the patients voice becomes too weak to produce any vibration of the chest walls, here too the presence of a plug of mucus in a bronchus communicating with a consolidated area, may diminish or altogether stop the fremitus in that area. If the plug be removed by coughing the fremitus will at once return.

B. Decrease

The vocal fremitus is diminished or may be wanting altogether when the reverse of the conditions just described is present. Thus:—

(1) When the patients strength is diminished his voice is weakened and the vibration produced by phonation is lessened or may be wanting.

(2) A solid growth in the lung substance does not conduct the vibrations in the same way that exudation into the air cells does and therefore the fremitus over such a tumour, (i.e. if situated superficially) will be diminished * The tumour will act as a damper and thus prevent the fremitus from reaching the surface.

(3) When the walls of the thorax are thick, and loaded with fat, fremitus which otherwise should be increased will appear normal or diminished or may be absent altogether. Inflammatory thickening of the pleura, independently of the presence of fluid, will diminish or entirely prevent the fremitus from being perceived.

(4) Effusion into the pleural sac, whether serous or purulent, or the presence of air as in pneumothorax will diminish if the amount be slight, or completely abolish the fremitus if the amount be large. As the fluid tends to gravitate to the lowest parts it is usual to find that the fremitus is wanting at the base of the lung affected and as the fluid increases this area gradually rises until the fremitus may be absent from the whole side. The level of the fluid will change within certain limits on change in position of the patient and the fremitus may be felt in one position and absent in another if the lung ~~is~~ touch the surface in the first instance and in the second is separated by a layer of fluid.

(5) As already stated the presence of a plug of mucus large enough to occlude the bronchus supplying a large area of the lung will be sufficient to diminish or abolish the fremitus. Such an area is limited according

to the extent of lung supplied by the bronchus. The fremitus is restored as soon as the obstruction is removed by coughing.

In testing the vocal fremitus, it is best always to use one hand and test the different areas on either side in order. The diseases which occasion variations in the fremitus are as a rule unilateral in their distribution so that the difference from the normal is easily perceived by comparing the sound side with the affected, and by using one hand only, there is no chance of a difference in the sensibility causing confusion.

Friction fremitus, or Pleural fremitus —

When pleurisy occurs the two surfaces of the pleura become roughened by changes in the epithelium and by the deposit of lymph on the surfaces, so that with every expansion and contraction of the lungs they rub together and communicate to the chest walls a vibration of a rough scraping, creaking nature that is distinct from any other sensation. It is absent when the breath is held and the movement ceases; it gradually ceases as effusion occurs which separates the two roughened surfaces and prevents them rubbing together. It is often present in the upper parts of the chest after it has ceased in the lower, and may sometimes be felt by changing the position of the patient so as to alter the level of the

fluid. It is increased by pressure into the inter-costal spaces, and by deep respiration

Friction fremitus is felt over the praecordia in pericarditis. In this if the friction corresponds to the action of the heart in its rhythm, and is not affected by holding the breath. It is occasionally difficult however in aboral thurisy in the neighborhood of the heart to exclude pericarditis, especially when the respiration is very rapid or in cases where the heart has become adherent to the pericardium.

Bronchial Fremitus - This is sometimes produced when the bronchial walls are thickened and inflamed and their calibre reduced by the presence of exudation The vibration occurs with both inspiration and expiration and somewhat resembles vocal fremitus in its character but is independent of phonation. It is altered or disappears after coughing, and the vibration which is communicated to the hand as fremitus, is evident to the ear as a rhonchus sometimes loud enough to be heard at some distance from the chest and can generally be heard by the patient. It can as a rule be felt over the whole of the thorax but is most evident over the area of the larger bronchi and occasionally is more distinctly felt at one side than the other, indicating the presence of a quantity of

viscid secretion in the tubes of the affected side. When present it points to diffuse bronchial catarrh.

Cavernous Sibilus - A peculiar bubbling sensation may sometimes felt over cavities containing fluid which have a free communication with a bronchus. The sensation is attend by coughing and may disappear when the fluid is expelled. It can be best felt when the cavities are near the surface and the walls of the patients thorax thin. Occasionally it is felt in empyaema when there is a fistula into the pleural cavity especially if the amount of fluid is small and the lungs near the surface.

Fluctuation - When the quantity of fluid present in pleurisy or empyaema, is so great that the interspaces are bulged outwards, it is possible to detect fluctuation by placing the fingers of one hand along the interspaces, especially the lower, and tapping at a little distance with the other fingers taking care not to tap above the level of the fluid. This sign of the presence of fluid is by no means reliable and mistakes may easily be made.

"Palpatomelody as a means of diagnosis

"A Russian physician, Dr. V. V. Filipopovitch has "recently published a pamphlet containing some observations

'on the advantage of ascertaining the degree of
'tenderness over particular areas by means of an
'instrument corresponding to Eulenberg's Caraesthesiometer,
'it may be compared to a vertical spring letter-weight,
'the plate of which is replaced by an extremity having
'the desired form. The term used is "palpatometry";
'the highest pressure by variously shaped extremities
'which could be born without pain was tested. This
'was found, by trial on a number of healthy subjects,
'to vary from 1,500 to 2,000 grammes, when the
'instrument with the Rand was used. The work
'of M. Peter is referred to, as also Dr Burney Yeo's lectures on
'Pain in the Region of the Heart and Palpitation (which have
'been translated into Russian), and several diagrams and
'charts are given of heart and other diseases, when the
'mapping out of the surface, according to the iso-aesthesic,
'or, rather, iso-analgesic, areas, indicates with great
'exactness the course of the disease whether favourable
'or otherwise. The author has observed, that in typhoid
'fever, the spleen undergoes a marked and sudden increase
'of sensitiveness within the forty eight hours immediately pre-
'-ceding defervescence. This was quite appreciable to ordinary
manual palpation, and, during an epidemic of typhoid, he
was able to predict pretty accurately the occurrence of
defervescence. He points out the value of more

"exact means of estimating the tenderness in "affections when peritonitis is feared" (Brit. Med. J.s 1886 Vol II P 1049). So far as I am aware this method has not been much used in this country, but it appears from the account given ~~of the method~~ that it might be applied in pulmonary diseases with advantage in those cases when pain is a significant feature, such as pleurisy, especially when of limited extent, pneumonia, incipient phthisis &c.

## Percussion of the Thorax

### Definition of Percussion

"By percussion is meant the investigation "of the condition of internal organs by the sounds "which are yielded by sharply striking the surfaces "over them" (Bristowe Medicine P 346)

Methods - There are two methods of percussion the Mediate and Immediate - The position of the patient varies according to the area to be percussed - Thus for the anterior surface of the thorax it is most convenient to have the patient lying flat on his back or a bed or couch so that stooping is not necessary the physician being seated or standing by the bed side. For the back and sides the patient should be either sitting or standing, but if found necessary he may

lie on his face or side, and this is best in cases of extreme weakness
The surface should be exposed and the thorax
free from any external pressure -

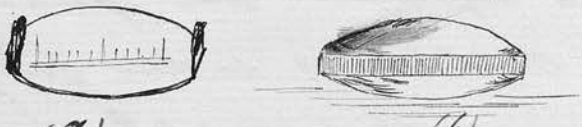
Immediate or Direct Percussion - This was the
method used on the introduction of this mode of
investigation by Auenbrugger in the middle of the
18th Century. The chest is struck directly by the
fingers, two or more being bent together so as to
form a hammer, or the forefinger is flipped from
the thumb against the surface, or the knuckles
may be used. This method of percussion has fallen
greatly into disuse, partly because it caused
a considerable amount of pain to the patient, but
rather because the results were not so good as
with other methods. It is still sometimes used in
percussing over the clavicles, or over the ribs when
they are prominent and the chest walls thin and
when no tenderness is present; also over the
general surface when very light percussion is
required, for example over a very thin layer of lung
such as the extreme apex, or the inferior margin.
Mediate or Indirect Percussion. Hammer & Pleximeter
Of this there are three varieties 1st using
the finger of one hand as a pleximeter and one or
more fingers of the other as a hammer.

2nd The fingers still used as a hammer but a plexometer of ivory, wood or other material being used.

3rd Percussion with Weinrich's Hammer.

The first is the most common and convenient method, dispensing with any form of instrument and capable of bringing out all the varieties of percussion sound as well as the sense of resistance.

The finger to represent the plexometer, which is usually the middle or index finger of the left hand is placed with its palmar surface downwards flat & firmly on the chest wall so that the long axis of the finger is parallel to any dull area whose limits it is proposed to map out, while the finger or fingers of the striking hand are so bent that a firm sharp stroke may be made with the tips. One finger may be used and for this the middle finger answers best and gives a clearer note and has the advantage of localising the stroke better than when more are employed, though some find that they can more easily produce a clear note by using two or even three fingers. In striking the hand should move principally from the wrist with only a slight or no motion at all from the elbow.



(a) (b)

PLEXIMETERS

Fig 24

and thumb does not deaden the sound as a finger might be supposed to do. Its disadvantage is that there is apt to be some noise made by striking the instrument itself which might conceal or alter the ordinary percussion sound.

(9) The third variety is that with Wintrich's Percussion hammer. The ordinary form of hammer is shown in fig 25. The head is generally weighted and the striking end is protected by a pad of india-rubber so that the noise of the hammer striking the pleximeter is as far as possible avoided.

Advantages (1) Its use is soon learnt and more easily performed than the other methods.

(2) The sounds are clearer and can be heard at a greater distance which is of great advantage in clinical teaching

(3) Sounds are brought out which are only elicited with difficulty by using the fingers.

(4) The fingers are not hurt.

Disadvantages (1) An instrument is not always at hand

(2) The finer degrees of percussion are lost, unless the greatest care be taken, and may be overpowered by the noise produced by striking the pleximeter itself

(3) Too large an area is apt to be thrown into vibration.

The Percussion sounds and their production.

The sounds produced on percussion of the thorax are dull or resonant, the dulness and resonance varying within certain limits and under certain definite circumstances.

The dull sound which is naturally produced by percussing over certain areas is caused by the presence of solid bodies, either within or in close contact with the chest-walls. These (the heart, liver, spleen &c) from their nature are incapable of being thrown into vibrations, and percussion over them causes a noise only with complete absence of resonance — this is known as "absolute dulness" or "flatness".

The normal resonance of the thorax is variously explained, some assigning the note to the vibrations of the air in the vesicles, others to the vibrations of the chest-walls. Both factors enter into its production. In order to produce a resonant-note like that of a drum, it is necessary to have an air containing chamber with walls capable of vibrating in waves of definite and regular lengths. In a drum so long as the tension of the parchment and of the contained air remain unaltered, the note

remains the same, but the note can be raised or lowered by raising or lowering the tension, and if this be carried to excess in either direction the tympanitic resonance is lost. In the thorax the walls are capable of vibration, not certainly so perfectly as the drum parchment, but sufficiently to produce a definite note provided that it be filled with air at a certain tension; but the air in the thorax is contained in the minute vesicles of the lungs and the pressure varies with every respiratory act - so that instead of having a note possessing the musical qualities of "pitch, intensity and timbre" we have a note in which pitch & intensity are present - but - timbre is wanting. The sounds then produced by percussion are varieties of resonance and dulness, the former occurring over the whole area ~~of~~ occupied by the lungs, and which under certain circumstances may acquire a tympanitic character or may be muffled and lose its resonance and pass into absolute dulness; the latter being normally present over solid bodies, and under certain circumstances taking the place of the normal resonance.

Rules to be observed -

(1) Percuss systematically the various regions and mark exactly the limits of resonance or dulness present.

(2) Always make a comparison of the note at the same point on both sides, percussing with equal force in both cases. This is necessary in order to detect slight inequalities in the sound, for, though well marked dulness is easily detected the slighter degrees are not detected unless when compared with a normal area - Should the note on both sides be impaired the comparison fails between the two sides and it is necessary to compare the note with some other area which is not affected.

(3) Percuss gently where pain or tenderness is present; where destructive processes are going on; when the patient's condition is much lowered; over pulsating areas (not the heart) especially when the walls are thin. Also where the layer of lung tissue is very thin, as at the apices, or at the lung margins unless it is desired to bring out the dulness of some solid body lying beneath as in percussing the deep cardiac dulness.

(4) Percuss firmly or forcibly, when the chest walls are very thick, covered with deep layers of fat or muscle. More force is needed for the posterior surface owing to the thickness of the walls and the difficulty of throwing them into

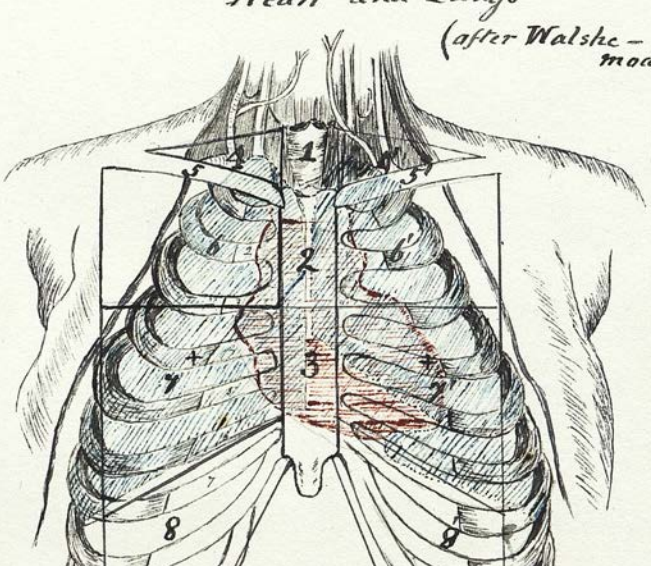
vibrations. The difficulty is got rid of to a certain extent if the scapulae are drawn forwards and it is usual in percussing the back of the thorax to cause the patient to lean forwards and fold his arms across the chest.

Percussion of the Normal Thorax -

Taking first the anterior surface, the percussion note is clear and resonant on both sides from the apices to the level of the third interspace. The apices rise above the clavicle for about one and a half inches the right apex being sometimes a little higher than the left, the note here is not so loud as lower down but distinct resonance can be made out, by percussing lightly, even at the extreme apex. The apices are separated widely in the neck, and the line of resonance marking their anterior and inner borders curves downwards and inwards till they meet behind the manubrium sterni, at which point the lungs are only separated by the mediastinum.

At about the level of the third interspace a slight difference is noticed in the notes on the two sides, the note on the left side being distinctly less resonant than the other, which is especially marked on deep percussion. As we percuss lower the note on the left side becomes more and more impaired till at about the level of the fourth rib it becomes absolutely dull, while the note on the right side retains

Fig 26 The regions of the Chest
and
Diagramatic representation of the relations between Heart and Lungs
(after Walshe – Bramwell modified)




1 Supra sternal region
2 Upper " "
3 Lower " "
4,4' Right & Left supra-clavicular regions.
5,5' " " " clavicular "
6,6' " " " infra-clavicular "
7,7' " " " mammary "
8,8' " " " infra-mammary "

Lungs represented by blue shading - Heart by Red -

its normal resonance. The impaired note indicates the thin border of the lung which overlaps the heart, which is again heard if we percuss outwards from the area of absolute dulness, which is the area of heart uncovered by the lungs, (7 & 26) the note becoming resonant after we pass beyond the area occupied by the heart. On the right side the note is clear till the lower margin of the fifth rib when it becomes impaired owing to the presence of the liver below the inferior border of the lung, while absolute dulness marks the extreme limit of the lung about the upper border of the sixth rib, the dulness extending downwards to the lower border of the thorax below which the tympanitic note of the colon can be heard. If we percuss in a curved line outside the nipple the pulmonary resonance can be heard from the apices on both sides to the level of the 5th rib when it becomes impaired or muffled on the right side and a little lower absolutely dull (at the 6th rib) while on the left side at the 5th rib an almost tympanitic note is heard on deep percussion and at the 6th rib provided that the stomach contain air the note is truly tympanitic, and remains so over the lower part of the thoracic surface in this line. In the axillary line the note is resonant on the right side as far as the 8th rib, below which the liver dulness begins and on the left to the 9th rib where the splenic dulness is generally heard while at the 11th rib the tympanitic note over the colon is made out.

Posteriorly the resonance at the apices is heard as high as the Seventh cervical vertebra and pervades downwards as far as the tenth pair of ribs on each side. The note on the posterior surface is not so clear as on the anterior, excepting perhaps at the bases, owing to the greater thickness of the walls, the presence of the scapulae and the great amount of muscle; also because the ribs being bound to the spinal column are less easily thrown into vibrations than are the more free anterior extremities.

The note over the sternum is peculiar, - here a more or less resonant note can always be heard even though the tissues below be non-resonant. The bone itself vibrates easily and it is probable that the vibrations are communicated from it to more distant tissue and so a resonant note is produced.

The normally resonant-areas are altered during respiration, they are increased as the lung expands with inspiration, the apices rise higher, the area of heart-uncovered by the lungs is lessened and the lower limits of the lungs descend; the liver dulness also descends with each contraction of the diaphragm, and rises with expiration when also the lungs contract and the resonant-areae diminish. The distribution of resonance may be altered also by displacement of the heart or of the abdominal viscera without the presence of any respiratory disease or any pulmonary symptoms, so that any divergence from the limits described is not necessarily indicative of pulmonary disease.