~~Notes For~~ on

Introduction to Cardiac Physical Diagnosis

UTMB Division of Cardiology

W. Thornton, M.D.
J. Wallace, M.D.

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Introduction to Cardiac Physical Diagnosis

Cardiac diagnosis is evaluation of the entire circulatory system of which the cardia, the heart, is the central pump. It is the process of judging how well circulation of 5L. of blood is sustaining your patients tissues and functions, and if there is a fault, to determine its location and nature. Since the pumping action is phasic and the human body and its blood vessels are elastic, a series of pulsations, vibrations and sounds are generated by each beat. By location and evaluation of these by-products of the heart's pumping action, an ~~evaluation~~ understanding of a patient's circulation, its faults, their location and nature may be ~~done~~ obtained. This requires trained abilities in seeing, in feeling and in listening.

A basic tool used to introduce you to this training is a simulator ~~which~~ that produces pressures, pulses and sounds which mimic those in normal and a variety of pathological conditions.

~~This introduction~~ Physical diagnosis of the circulatory system may be categorized ~~by areas~~ as follows:

1. peripheral pulses and pressures -

2. ~~central~~ precordial pulsations

3. auscultation

A circulatory problem will usually be manifest in 2 or 3 of these areas and an important part of your evaluation, your diagnosis, will ~~be~~ depend on integration of all findings -

Peripheral pulse and pressure: the heart ~~periodically~~ regularly ejects its stroke volume of blood under pressure into the aorta whose own increased pressure then distributes blood with little pressure loss, to the tissues ~~by~~ through the arterial system.

Pulse rate and arterial blood pressure are traditional and fundamental signs which contain a wealth of information, much of which is often overlooked. ~~Pulse has~~ Evaluation of the pulse has been a part of medicine for recorded history - Pulse rate may be measured by counting the

Fig 1

pulse at any easily accessible point for one minute. If shorter periods are used there is a probability of error which increases inversely c̄ sampling time 1 ~~sample period~~ or with arrythmias.

Heart rate alone can provide considerable insight ~~or~~ but since it is driven by psychological and physiologic stimuli care must be taken to separate their effects. A 'white coat' is frequently a cause of tachycardia — and increases in blood pressure as well. Both should normally be taken in a quiet, cool environment, ~~normally~~ in the seated position. Add * From back.

A physiological tachycardia may indicate an abnormal demand for blood imposed on a normal heart — or a compromised heart attempting to maintain cardiac output and a seldom bradycardia may be an athlete's hearts or a conduction ~~an excitation~~ defect.

Pulse rate is often slightly irregular especially in youth and c̄ respiration. move to start of P.4

2 and these do not always produce contraction.

1 - With a 30 sec. sample period an actual rate of 72 BPM could be 71-3 and c̄ a 10 sec. sample, 66-78. - move to 2 above

2 - Pulse rate is not always heart rate for ventricular contraction is not always effective. Note: Virtually all monitors count EKG complexes.

* Both H.R. and B.P. are affected by posture and any ~~indication~~ suggestion of postural effects in the history demand that ~~pressures~~ HR/BP be taken supine and standing. Good practice also demands that every patient have at least one recorded supine and standing HR/BP.

From P-3

~~A wide variety of~~ Various abnormal rhythms may be present such as regularly reduced or absent 'beats'. Some arrythmeias are pathognomonic, such as the 'irregular irregularities' of atrial fibrillation.

Clinical (arterial) blood pressure Fig 2-A is taken[1] by placing a pneumatic cuff ~~snugly~~ around the arm Fig 3A and inflating it above systolic blood pressure c̄ ~~a known~~ measured pressure. ~~With~~ a cuff of adequate size its transmits pressure ~~is transmitted~~ through tissue and first squeezes and then closes the artery. If the cuff is too small or loose much higher ~~cuff~~ pressures are required to place the same ~~pressure~~ force on the artery which will falsely elevate readings. If the pressure is now lowered at a constant rate (3-4 mm Hg/5sec) at some point ~~upstream~~ proximal arterial pressure will exceed cuff pressure and force a jet of blood into the downstream artery setting up oscillations which may now be heard distal to the cuff ~~downstream~~ by a stethoscope. As ~~pressure~~ cuff pressure is slowly lowered ~~falls~~ blood will flow over more of ~~the~~ each cycle

1. this is the Rivi-Rocci technique almost universally used for manual + many automated B.P. measurements

but will be stopped for a part of it. The opening jet will still induce sounds[1] at each pressure cycle until cuff pressure falls below diastolic and blood flows continuously. This is shown schematically in Fig 3.C.

¶ After cuff inflation and PPL ~~As cuff~~ pressure is lowered, ~~Systolic~~ sounds and a usually palpable radial pulse, appear abruptly at systolic pressure and normally continue until diastolic pressure is approached where they become fainter or muffled and usually fade completely at diastolic level. The level at which fading occurs is generally taken as diastolic, however, frequently there is only a change

1. These are the K (for Korotkoff) sounds

in sounds ~~a~~ which may then continue almost to zero pressure. ~~In this~~ Another variant is for sounds to disappear in mid range and reappear as in 3 C ~~the~~ producing an "auscultatory gap". Systolic pressure is normally recorded as the cuff pressure level where sounds are first heard and diastolic as the level where they disappear. If a gap is present it is ignored and first & last pressures only are recorded. In case of 'muffling' below diastolic pressure, both the pressure at which a change in sound and the pressure at which they disappear are recorded. ~~If a HR/BP is taken in a posture other than seated, it should be recorded.~~

~~Blood~~ + Posture of the patient should also be recorded for this can produce significant changes in pressure. Blood pressure is one of the most valuable and often crucial measurements available and its understanding & application is far beyond this introduction. Range of Current normal values is 130/95 to 90/70 but there are many people often young and female who function ~~well~~ normally at ~~the~~ lower pressures. The 'normal' systolic limit is increased c̄ age.

start here

sounds may continue almost to zero pressure but there is usually a distinct change in the sound's characteristic as cuff pressure falls below diastolic. ~~Blood pressure is~~ ~~usually~~ ~~as~~ In such a case pressures are recorded as: start of systolic sound / diastolic change in sound / end of diastolic sounds at the pressure ~~level~~ in mm Hg the event occurred. eg 140/85/80 mmHg.[1]

{Foot note}[1] [Rarely there will be an auscultatory gap where pressures disappear and reappear as cuff pressure is lowered.]

Pressures are usually recorded in mm Hg but occassionaly ~~in low pressures~~ as $cm\ H_2O$ in veins and other areas of low pressure.

Stet

Arterial Pulses are normally easily palpable at the major points shown in Fig 1. Since the human body is symmetrical, pulses should be ~~are are normally~~ equal at the same point ~~level~~ on opposite sides of the

~~1 mm Hg = 1.34 cm H_2O~~

pulses differ from (R) to
body - ~~Using both hand~~ If ~~they~~ are different in
limbs
the ~~arms~~ then a blood pressure must be
taken in ~~Should a difference to compare~~
~~the~~ major
~~such differences~~ ~~the~~ pulses should be
bilaterally ? ~~###~~
compared ~~simultaneously~~ by by the examiner
using each hand simultaneously. If
differences are perceived they should be
confirmed by comparison of blood pressures
~~from the patients~~ in the limbs, which
should be within 5-10 mm Hg of each[1] other.
~~As one~~ In contrast to the
corresponding
horizontal symmetry of arterial pulses on
both sides of the body
longitudinal in
? there are significant differences ~~between~~
Fig 1
these pulsations. ~~as one moves~~ the
pressure wave ~~is~~ takes time to travel
along ~~the aorta~~ the arteries such
and femoral
that the radial pulses ~~is~~ delayed

1 - or by laboratory procedures are in other areas

c̄ respect to the carotid and the pedal pulses even more. In addition their wave-form is altered. Both of these phenomena are easily appreciated by simultaneous palpation of ~~the~~ a carotid pulse and the pulse in question. In the presence of a significant obstruction a pulse will be both delayed and reduced ~~beyond~~ distal to the obstruction. ~~For~~ In the classic example ~~in~~ of coarctation of the aorta ~~both the~~ the reduction in amplitude and ~~re~~ delay are readily apparent in femoral vessels.

One significant vessel pulsation ~~is~~ ~~is~~ cannot normally be palpated. ~~The~~ jugular pulses must be ~~os~~ observed by use of oblique illumination or by ~~lookings~~ sighting across them. A normal jugular pulse is ~~is~~ biphasic with a larger presystolic A wave followed by the smaller ~~so~~ systolic ~~B~~ V wave.

Atrial contraction forces blood forward into the R ventricle and backward into the superior and inferior vena-cava producing the large A wave. A much smaller recoil of blood from atria into vena cava is produced by bulging of tricuspid ~~A-V~~ valve ~~in~~ ~~under~~ during right ventricular systole ~~pressure~~. Any condition which causes an increase in atrial systolic pressure, or reduced right ventricular compliance such as tricuspid stenosis, will increase the A wave, and any increase in systolic atrial volume (such as tricuspid regurgitation) ~~change in systole~~ will increase the V wave. ~~These are only two examples of many~~.

P Height of the venous pulse or distension of the external jugular above the atrial ~~heart level~~ level is an ~~sns~~ indication of L atrial filling pressure, which may be increased in a variety of diseases such as congestive heart failure[1]. It may be neccessary to ~~so~~ elevate or lower the patients' truncal angle to observe the appearance / disappearance of jugular pulse or distension.

Footnote 1 - The most common cause of right heart failure is left sided failure c̄ increased left filling pressures.

Normal Cardiac pulsation is also ~~is~~ produced directly by force and contraction of the ~~heart's~~ stet ~~and is a single~~ spiral muscle fibres which thrust ~~its~~ the left ventricle's apex against the chest in a single small ("dime sized") area in the 5th L.I.C.S. at the midclavicular line {the apical area} & Fig 4.

If the ~~heart muscle~~ (L) ventricular ~~Fig e~~ hypertrophies in response to an abnormal pressure load this single ~~sy~~ brief systolic impulse ~~stronger~~ may increase ~~its~~ in size (say to a quarter) may be displaced inferiorly and its ~~waveform~~ ~~p~~ character changed.1 Left ventricular dilatation will increase the area of pulsation, displace it laterally and change its profile. Abnormalities of the heart, such as bulging of an area of the L ventricle during ~~and~~ or after an M-I, may be felt in the "ectopic area" along the L sternal border. Rarely ~~distension~~ the pulmonary artery may become enlarged by severe pulmonary hypertension to the extent that it can be felt in the 2nd L ICS. Occasionally ~~there will be palpable~~ "thrills" (prolonged vibrations) and even third heart "sounds" may be palpable. ~~normal and abnormal~~

Sounds and murmurs are the most complex aspect of ~~any p~~ cardiac diagnosis. Opening and (P-13)

1 In disease the single brief normal apical pulsation becomes more complex and should be studied as part of your cardiology rotation.

closing heart valves ~~m~~ produce brief vibrations,[1] ~~Soun~~ the normal (and abnormal) heart sounds. Since even ~~seven~~ these are complex and require extensive verbal description, a standard diagram is usually a more efficient descriptor - and will be used here.

Referring to Fig 6, As ~~pre~~ ~~muscle~~ myocardial contraction ~~an~~ begins ~~pulmonic~~ and ventricular pressure quickly exceeds atrial pressures closing tricuspid and mitral valves ~~close~~ {and producing ~~and which produces~~ the 'Lub' or first sound. ~~followed by further increase in~~ Intra ventricular pressures ~~which~~ ~~rapidly~~ continue to increase and rapidly exceed pulmonic and aortic pressures ~~and~~ quickly opening normal aortic & pulmonic valves. ~~opening their associated valves open. All of these sounds are of low frequency and amplitude~~ ~~The components which cannot be spe seperated by the ear,~~ and ~~occur in a short period of time. This~~ ~~then~~ They combine to produce ~~is the "Lub" of the first sound, S-1.~~

1. Sound is ~~not~~ simply vibration with a frequency and ~~a~~ amplitude within the detection range of the ear -

When (R) and (L) ventricular pressures fall below ~~a~~ pulmonic & aortic pressures their valves close more forcefully and under larger pressures creating ~~the~~ the louder higher pitched "Dub" the second sound. On expiration, aortic and pulmonic valve closure sounds merge as S-2. On expiration (R) + (L) ventricular volumes are approximately equal ~~but the and~~ so ejection times are equal but inspiration increases ~~in~~ intrathoracic blood flow into ~~initially to the~~ the (R) heart and decreases flow into the (L) heart. These volume changes ~~this~~ requires a longer emptying time for the (R) ventricle and shorter time for the (L) ventricle. This separates ~~and may delay its opening~~ closing ~~of the~~ times of the aortic and pulmonic valves ~~long~~ enough (>.03-4 sec.) for the ear to detect ~~the~~ a 'split' in the second sound. A wide variety of other 'sounds', Fig. 8, virtually all associated c̄ disease are common but must be left to your ~~s~~ clinical experience - two abnormal sounds

1. the difference between sounds and murmurs are arbitrary. ~~m~~ Sounds are usually brief and murmurs prolonged.

~~that~~ occur so frequently that they have been given numbers, the third and fourth ~~heart~~ sounds. If immediately following ~~diastole~~ systole a large volume of blood enters the ventricles[1], or ~~is complear~~ if the ventricles are stiff, a brief low frequency sound is produced, the third heart sound. ~~After this~~ Sometimes this vibration may be felt or even seen in the (L) ventricular area.

P Alternatively if on atrial contraction the ventricle is tense c̄ blood a vibration may occur producing the brief low pitched ~~fo~~ presystolic fourth ~~so~~ sound.

~~Now~~ Just as the railway track may carry the sound of an oncoming train long before it can be heard normally, so dense material, especially blood may conduct physiological sounds

1 - this may occur normally in young people.

more effectively. For this and other anatomical reasons sounds from a given ~~area~~ valve or other portion of the heart may be preferentially heard in certain areas of the chest, Fig 7. Also a variety of positions and maneuvers may enhance the sound. Sounds ~~may~~ ~~can~~ ~~be~~ are enhanced by appropriate use of the stethoscope with a lightly applied bell for the lower frequencies and the ~~so~~ diaphraghm for higher frequencies.

Murmurs are usually produced by flow of blood over or through some restriction. They are complex to describe and again ~~sketches~~ ~~the~~ a diagram may be effective and efficient. ~~for or~~ At this point do not try to make murmur diagnoses, ~~Fig 8~~ rather describe what you hear. First and ~~most important~~ fundamental is whether it is systolic or or diastolic. Never try to rely on sounds for a time reference, Use a carotid or precordial pulse, or if a monitor is on, the QRS complex or systolic pressure to determine systole. Location of the sound in the interval; early mid, late, ~~in the interval~~, and its duration. Shape of the murmur rising (crescendo), falling (decrescendo), constant (plateau) ~~diam~~ rise and fall (crescendo-decrescendo or diamond) is important. Next are its ~~freq.~~ amplitude (loudness) and frequency characteristics. Amplitude may be graded I-VI (see Fig 9) and frequency as high or low.

while its quality[1] ~~is~~ may be described by a variety of descriptors such as rumbling, blowing, cooing, harsh, soft, machinery ~~tik~~ noise, etc, etc.

~~B.~~ Physical location of the loudest point of the sound or murmur and any radiation to other areas are essential parts of its description, and understanding of its origin.

Murmurs are not restricted to the precordium but can and often do occur at any point where there is ~~sub~~ significant

1- 'quality' is determined by ~~frequency~~ frequencies, their harmonics phase and relative amplitude

obstruction to a major blood flow.
~~It~~ thus, c̄ any suspicion it is important to listen to the neck for ~~obstruction~~ obstruction in carotid flow which can affect ~~mental~~ brain function, to the abdomen for renal artery "bruits", ~~at~~ often associated c̄ hypertension and other renal sequelae, ~~and~~ in the groin for femoral sounds of an obstruction that can cause a variety of leg symptoms - even loss of a leg ~~and~~ or wherever obstruction suspected. Remember that atherosclerosis is a ~~pan wdes~~ general arterial process

of which coronary atherosclerosis is only a part.

This introduction cannot relate the few abnormal findings ~~presented he~~ briefly described here to their source and significance. Our goal is that you learn to see and recognize them which is the first and most ~~treatm~~ crucial step in treatment.

~~I~~ The use of a simulator has limited the scope of this introduction. You must learn some of the most important aspects of cardiac diagnosis from study of your patients, beginning c̄ appearance and feel. This ~~includes~~ may begin c̄ skin color and temperature. A warm pink skin is seldom associated c̄ ~~a~~ poor perfusion or low cardiac output which may produce ~~pallor, gray skin~~ pallid or gray and cool skin. Bluish tinges of any tissue is associated with decreased oxygenation, either from a poorly oxygenated blood supply or poor ~~loca~~ perfusion. In significant disease, including heart disease ~~may~~ the patient's posture[1] and demeanor contains valuable information. We have not discussed nor demonstrated auscultation of the lungs for the rales of pulmonary edema ~~in~~ associated c̄ (L) heart failure.

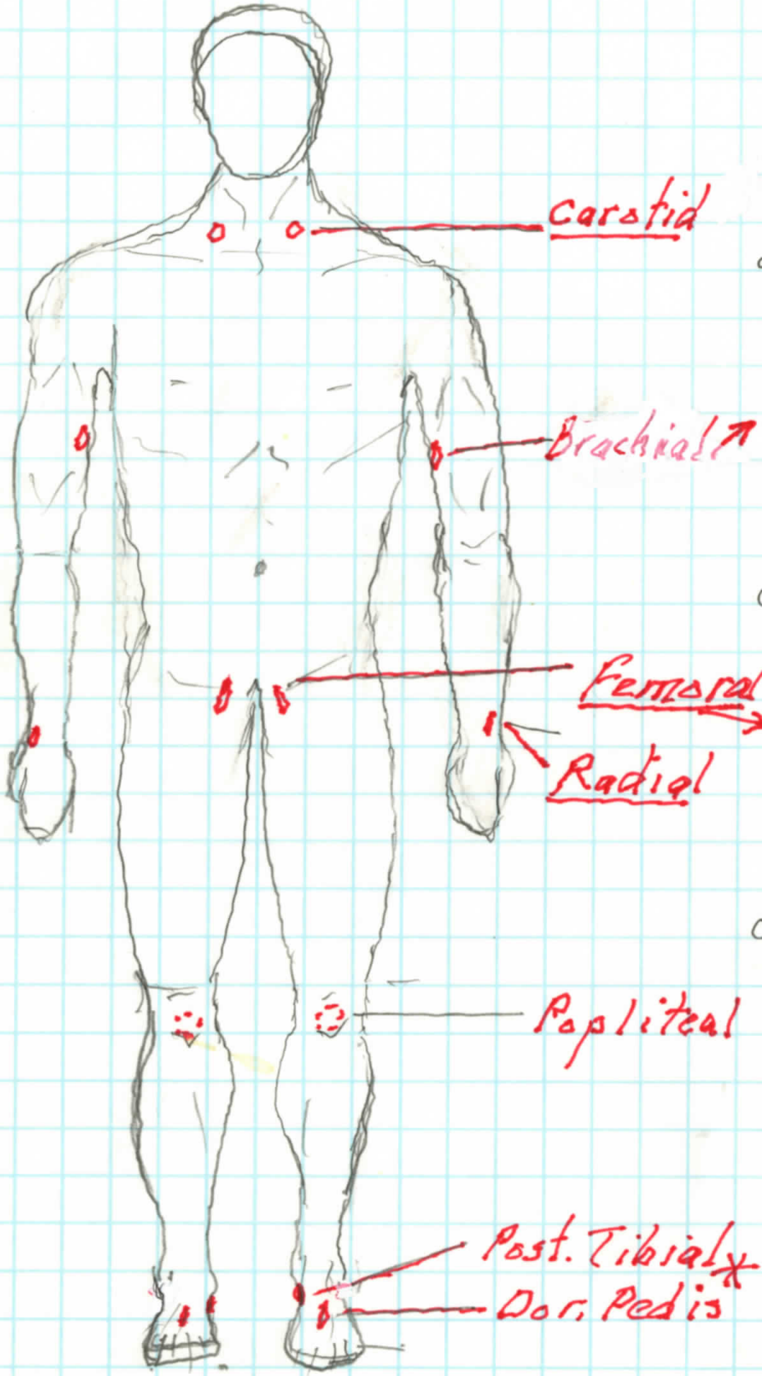
1 Patients c̄ congestive heart failure and pulmonary edema prefer, even demand upright posture.

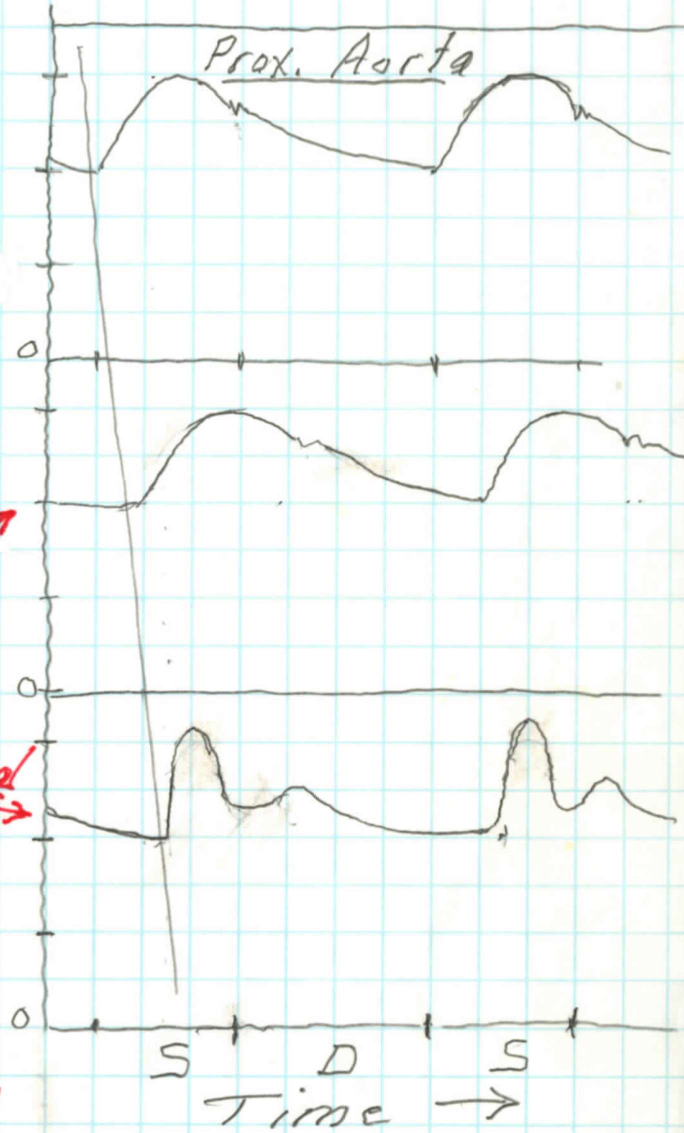
The range of heart rates and arrythmias ~~car~~ could not be simulated. Hopefully the basics which were simulated here ~~were~~ will ~~eases~~ expedite your ~~educations~~ education in ~~from~~ the real world of patients.

Fig. 1 - Peripheral Pulses

Pulse Rate = pulses/60 sec = 72 $\begin{matrix} +10 > \text{Tachycardia} \\ -20 > \text{Bradycardia} \end{matrix}$

~ pulses/n seonds ± 60/n





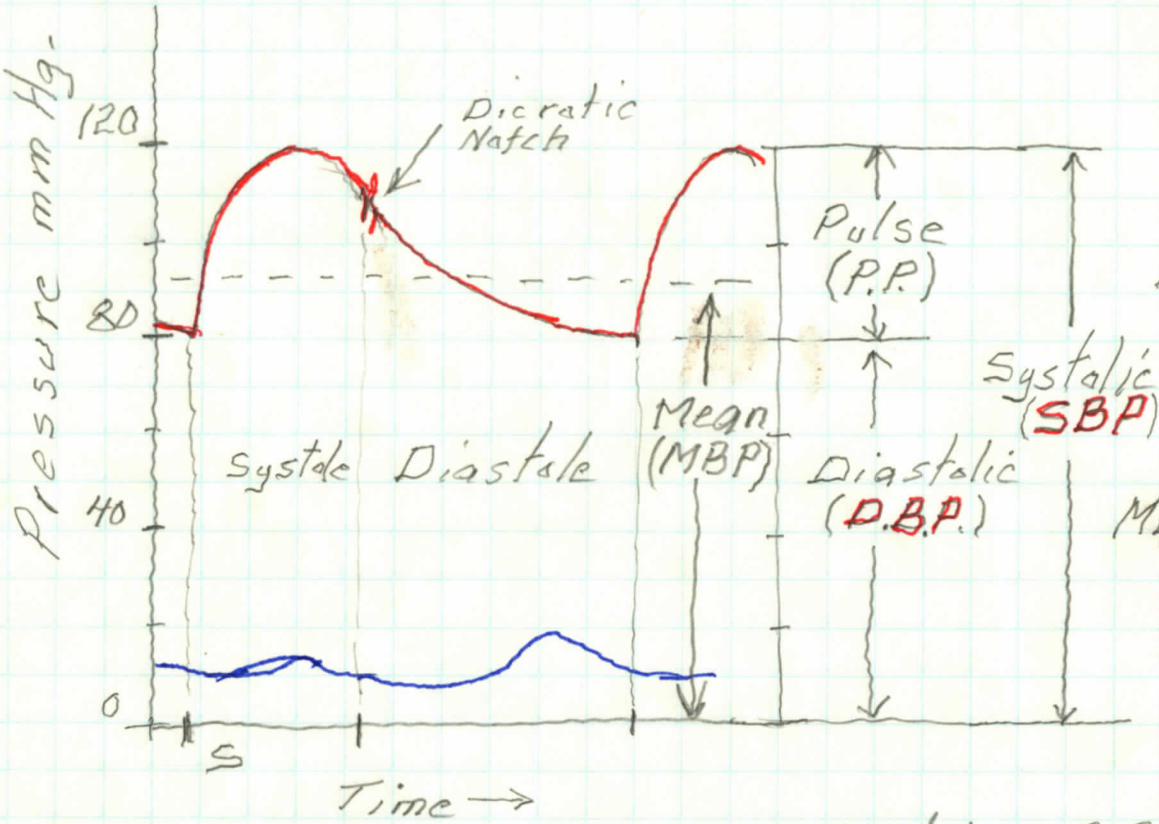
Prominent pulse locations - Underlined should be routinely palp.
* Pedal pulses should be palpated for any suspicion - Routinely in Diabetes, etc.

Note delay in pulse and altered shape along vertical axis

Right = Left

Pressure-waveforms in Supine Position

Fig. 2 Arterial (Prox. Aorta) Pulse / BP



$BP = \frac{SBP}{DBP}$

$= \frac{120}{80}$ mmHg

$P.P. = SBP - DBP$

$= 40$ mmHg

$MBP = \frac{PP}{3} + DBP$

$= 93.3$ mm Hg.

Median BP $= \frac{120}{80}$

Range

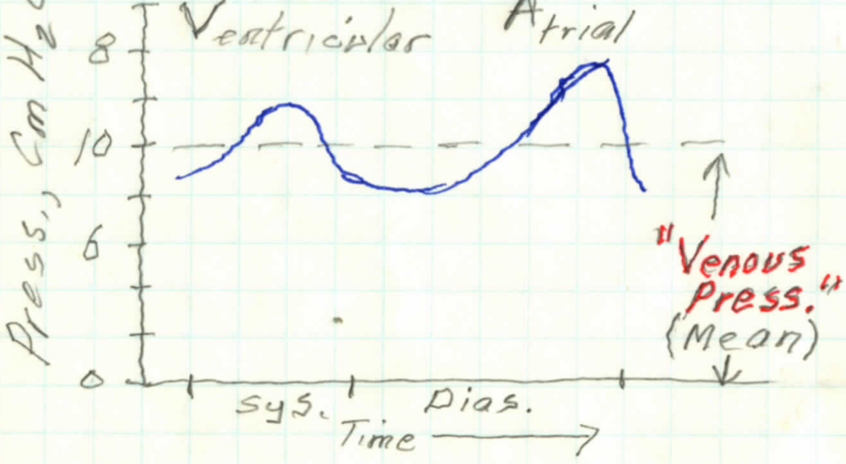
Normal

Hypoten $\leq$ 90 – 135 $>$ Hyper-

tension $\leq$ 70 – 98 $\geq$ tension.

A.

Venous (Int. Jugular) Pulse/Press



Venous Press.

Median –

Low $\leq$

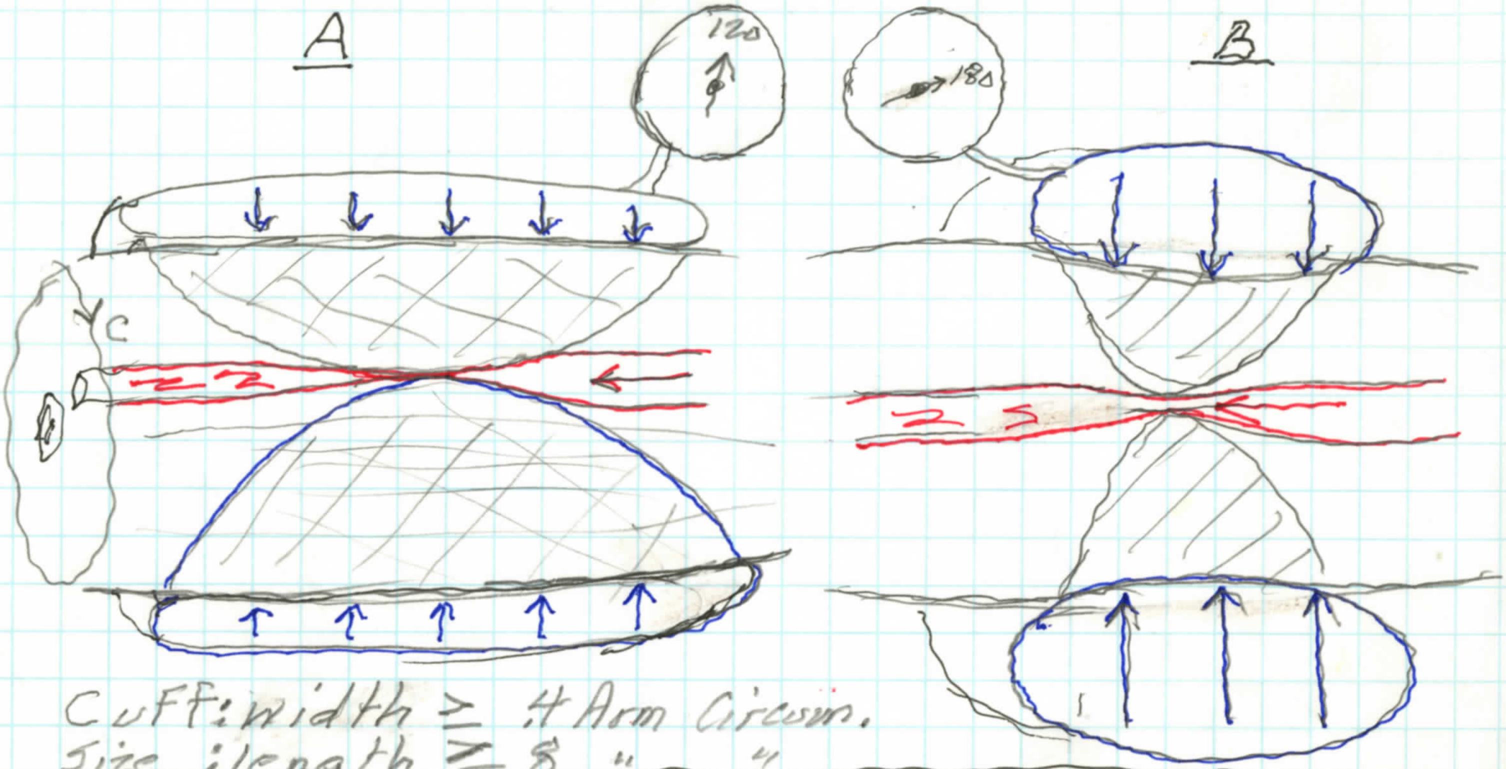
High $\geq$

B.

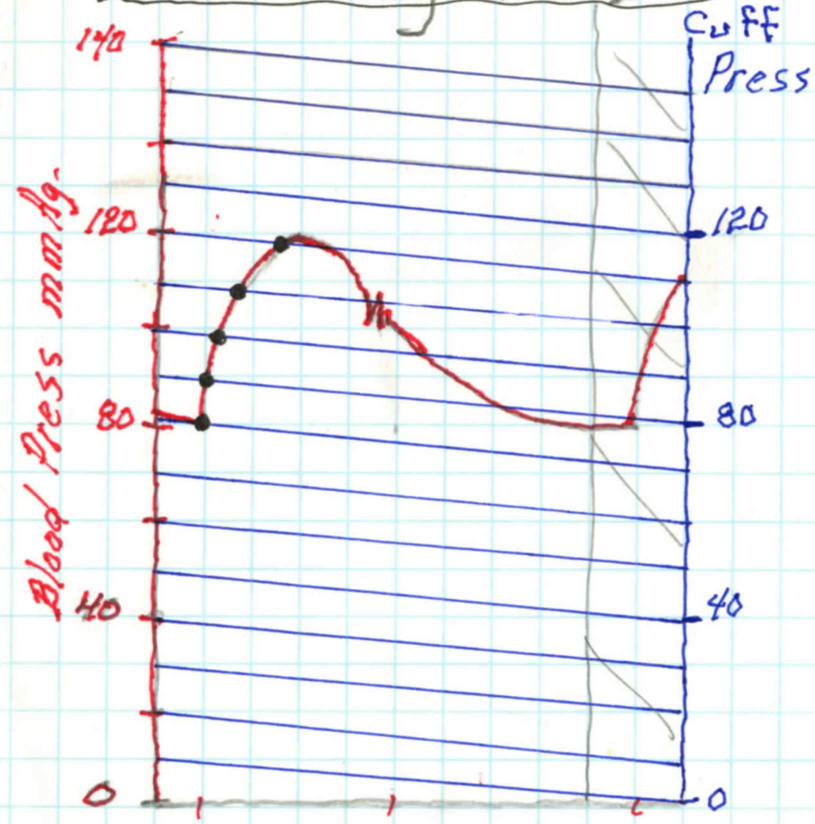
1 mm Hg = 1.36 cm H_2O

Fig. 3

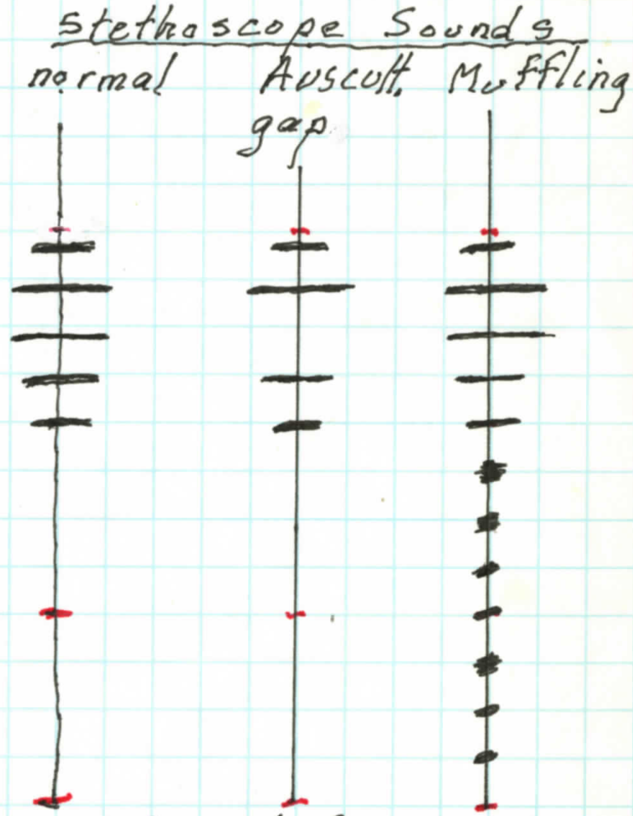
Manual Blood Pressure



Cuff: width ≥ .4 Arm Circum.
Size: length ≥ .8 " "



C



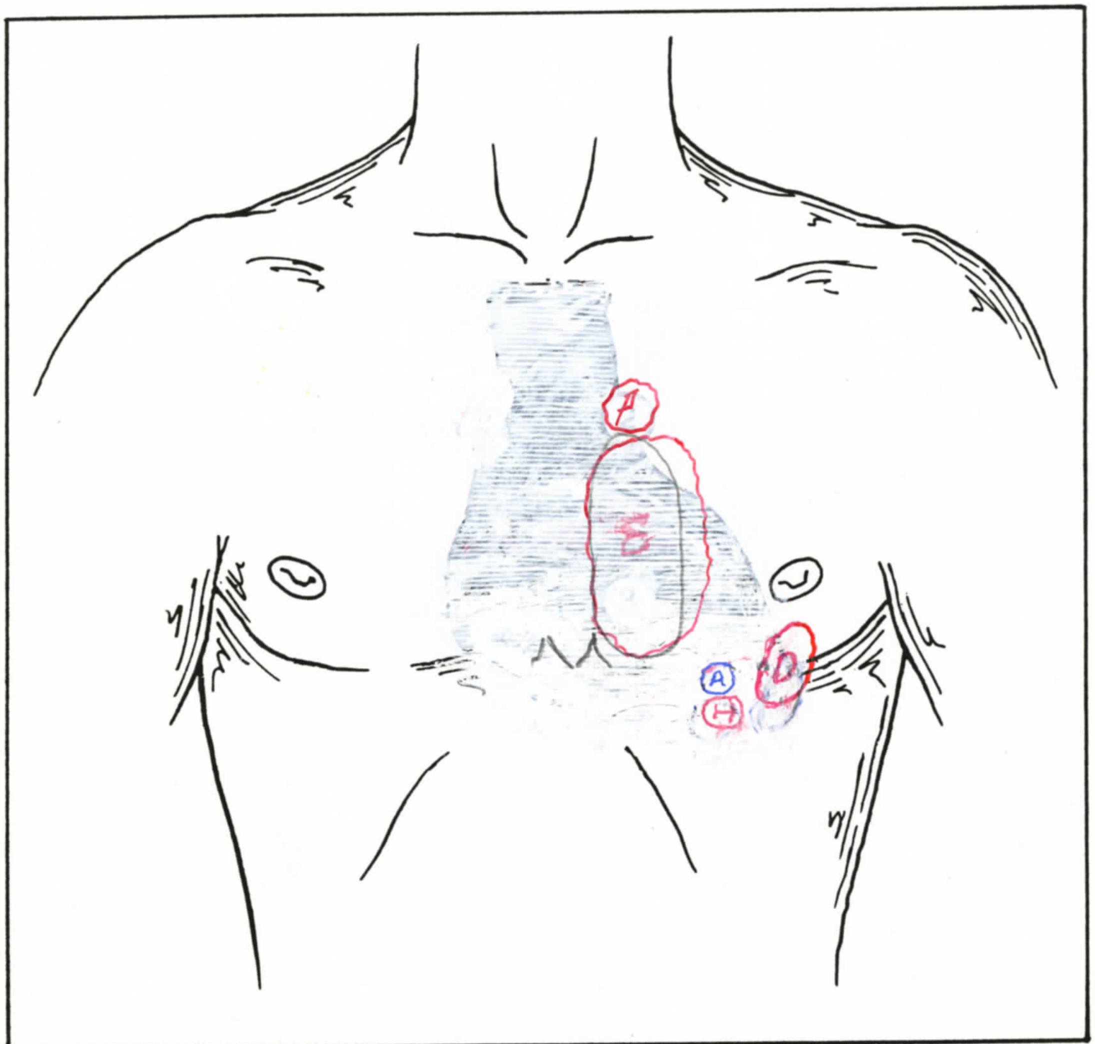
Report As

$\frac{118}{80}$ $\frac{118}{80}$ $\frac{118}{80}/10$

Fig 4

PRINCIPAL AREAS OF CARDIAC

Frequent reference will be made to the four areas illustrated in Figure 2. As you progress you will find that additional areas are essential in cardiac auscultation.



1. Aortic Area (2RSB)
2. Pulmonic Area (2LSB)
3. Tricuspid Area (4LSB)
4. Mitral Area (Apex) (5MCL)

Principal areas of cardiac

A-Apical Area-dime sized 5LIS-MCL

H-Hypertrophied Apical Area ~~more~~ ↑ size, shifted inferiorly

D-Dilated area ↑↑ size shifted L laterally

E-Ectopic Area - ~~R sided~~ ~~anomalies~~ MI - dyskin

P -

Normal Heart Sounds

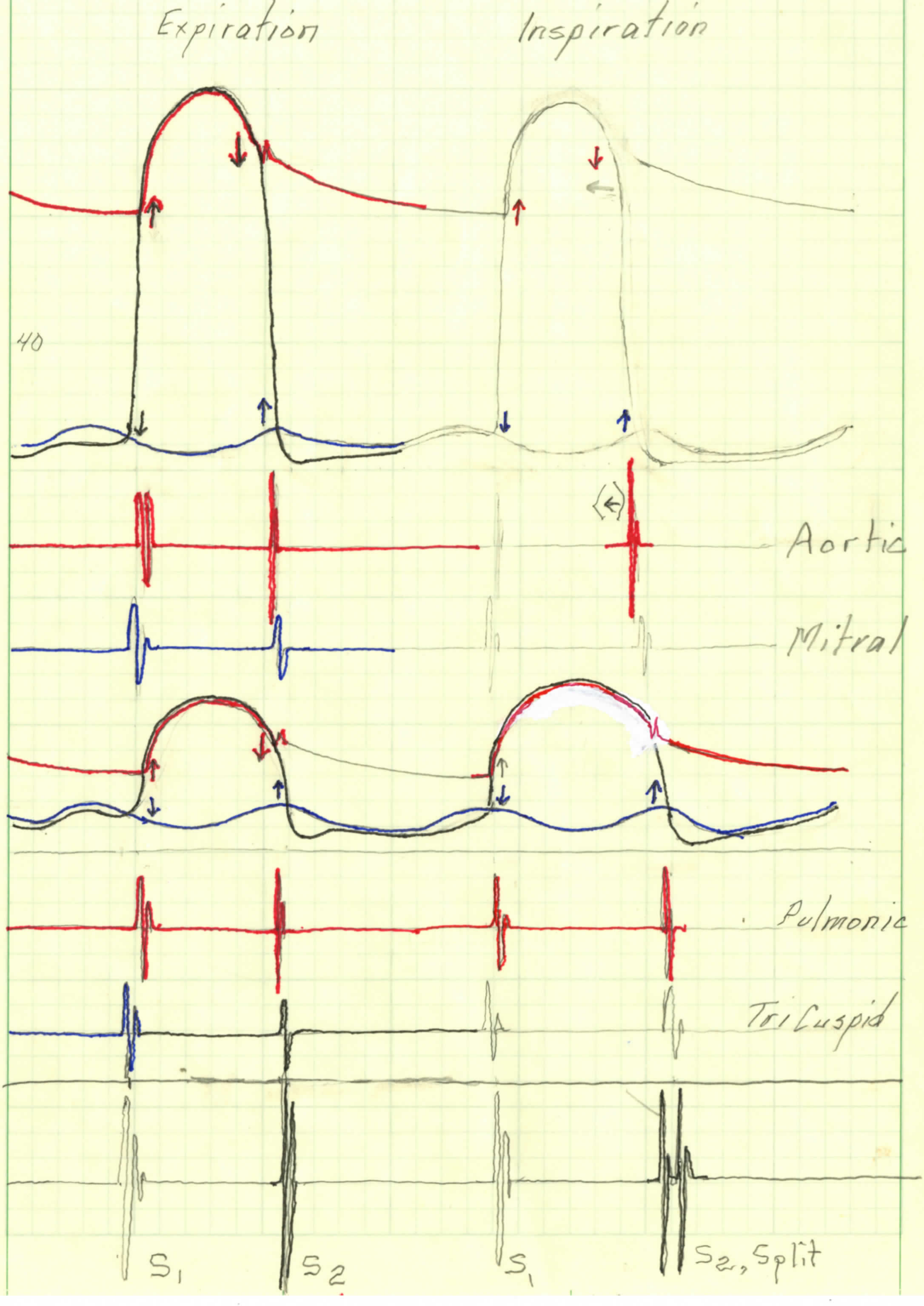
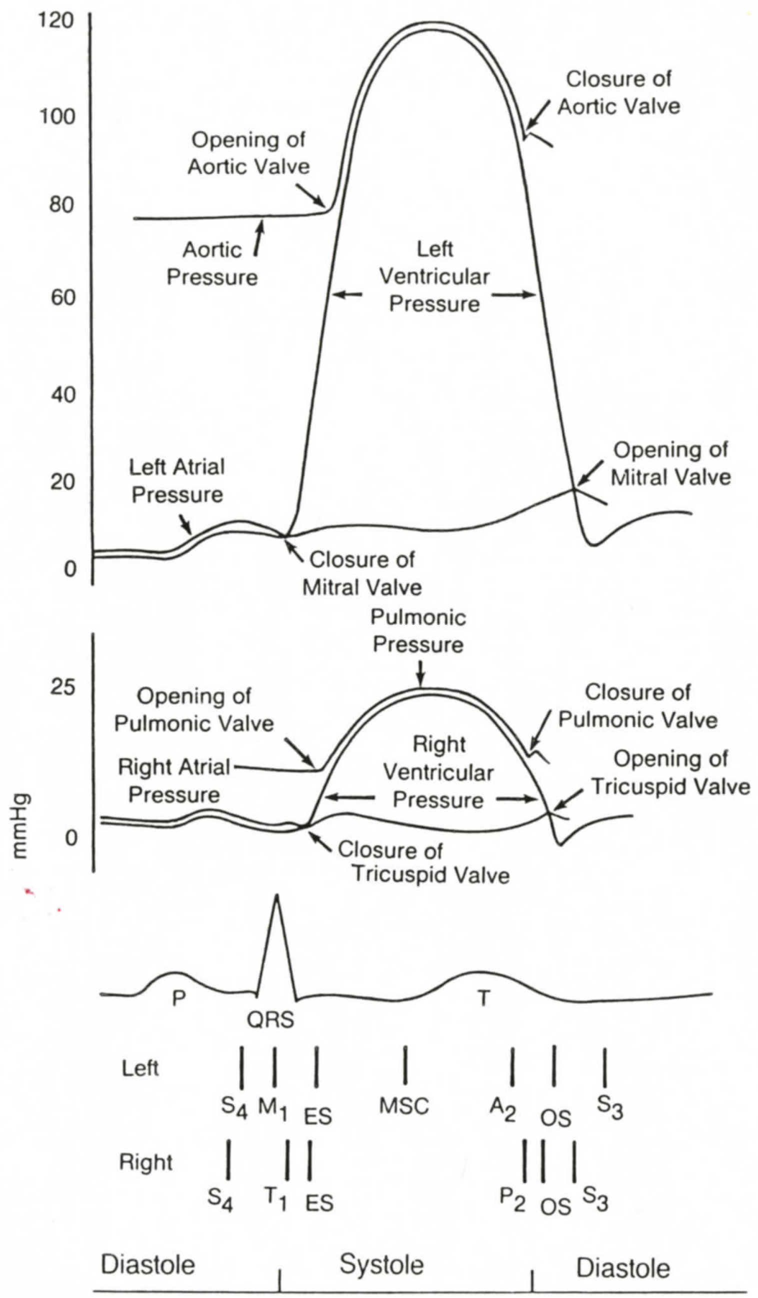


Fig 6



S_4 —Fourth Heart Sound

M_1 —First Main Component of First Heart Sound (S_1)

T_1 —Second Main Component of First Heart Sound (S_1)

ES —Ejection Sound

MSC —Mid Systolic Click

A_2 —Aortic Closure Sound

P_2 —Pulmonic Closure Sound

S_2 —(A_2 + P_2)

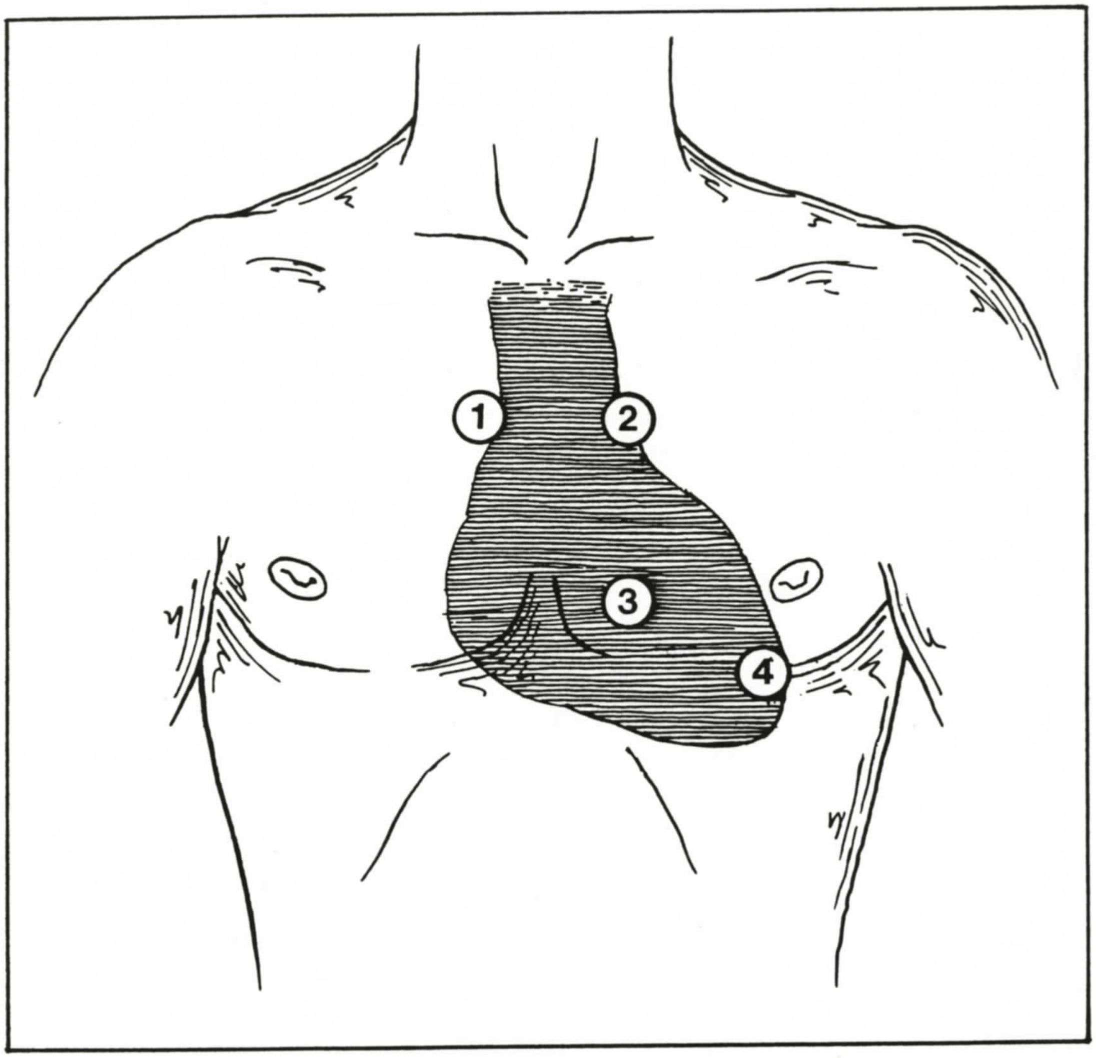
OS —Opening Snap

S_3 —Third Heart Sound

Fig. 7

PRINCIPAL AREAS OF CARDIAC AUSCULTATION

Frequent reference will be made to the four areas illustrated in Figure 2. As you progress you will find that additional areas are essential in cardiac auscultation.



1. Aortic Area (2RSB)
2. Pulmonic Area (2LSB)
3. Tricuspid Area (4LSB)
4. Mitral Area (Apex) (5MCL)

Figure 2. Principal areas of cardiac auscultation.

Fig 8

Sound Diagram

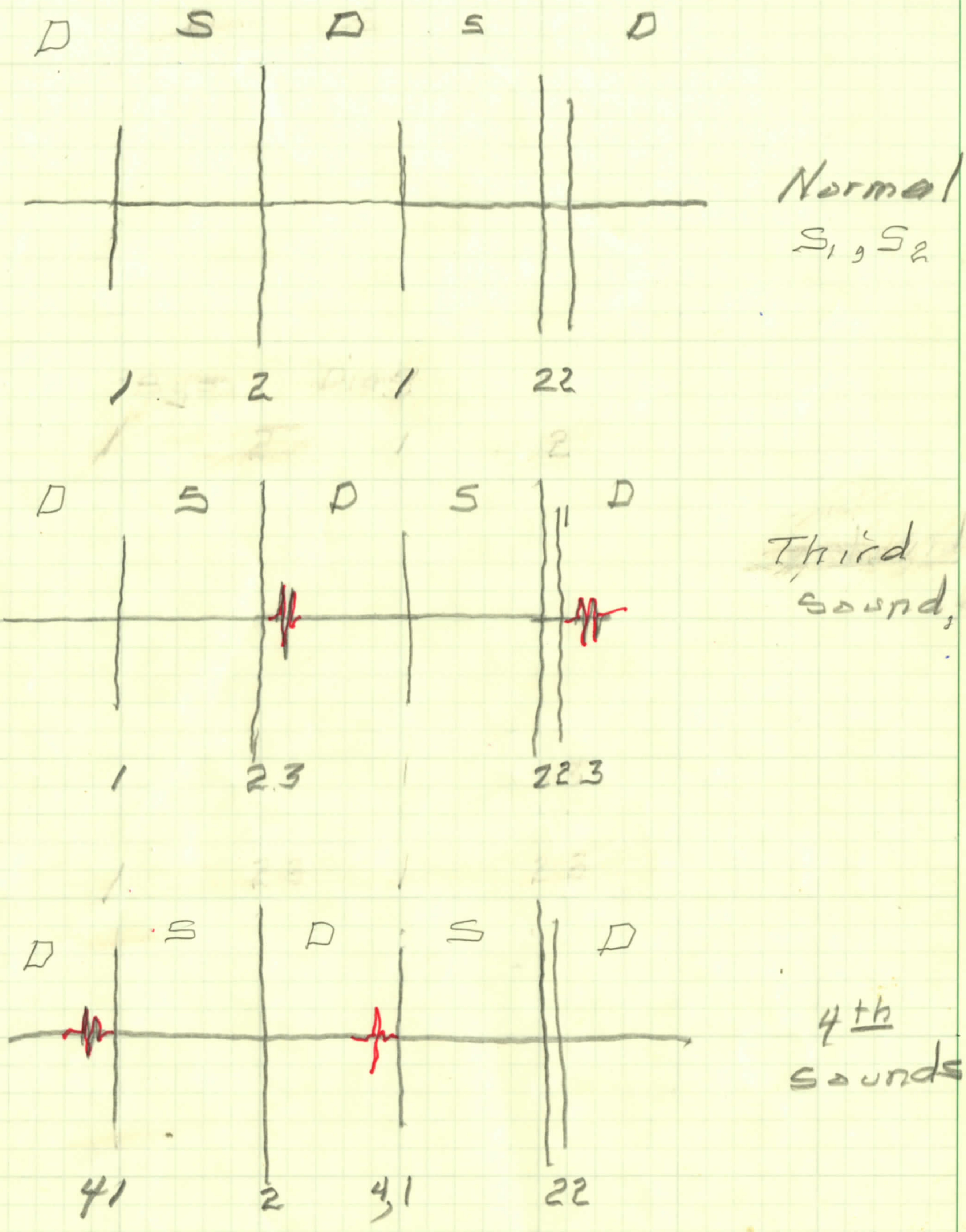
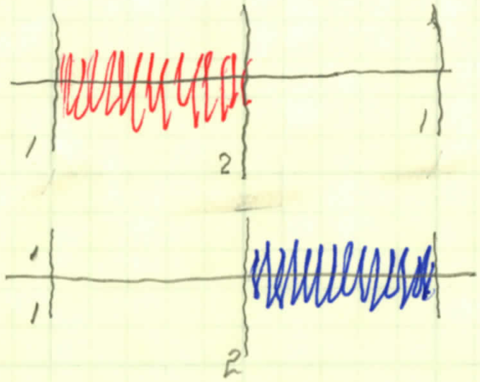


Fig 9

Description of Heart Sounds and Murmurs

Diagram | Description

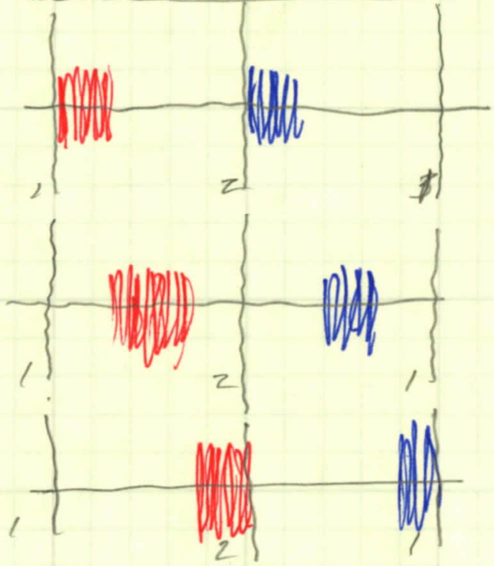
Timing: Interval



Systolic

Diastolic

Location in Interval



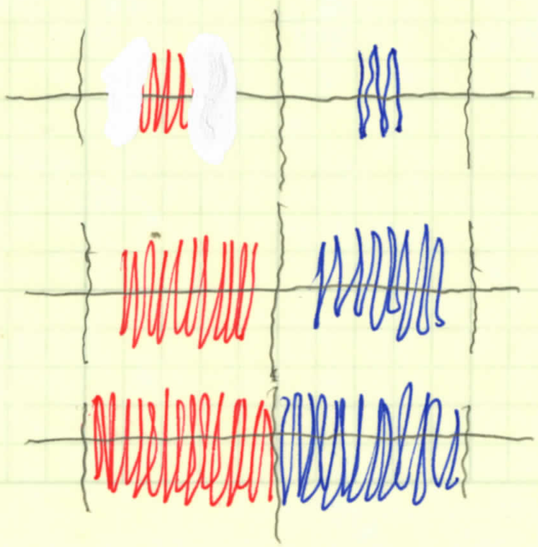
Early,

Mid

Late

Note "Pre-", "Post" = closely Associated c̄ another event eg pre systolic

Duration



short ("brief")

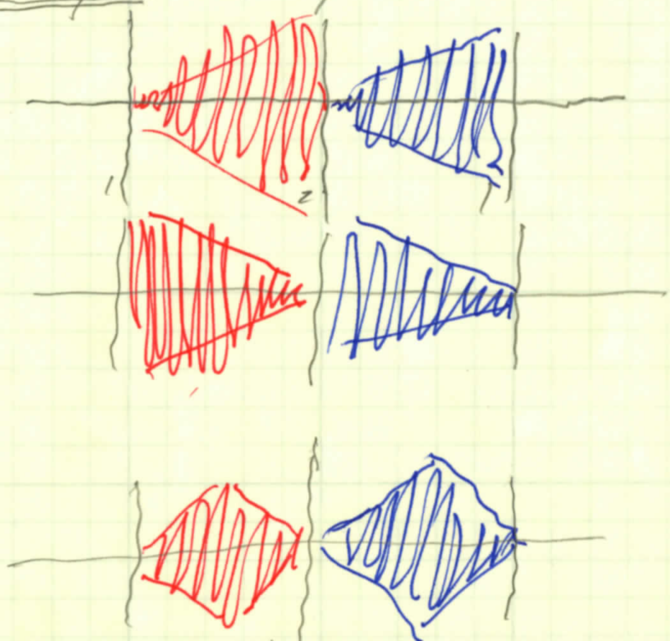
Long

(Entire Interval)
Pan or Holo

Fig 9. (m) Cont'd.

Diagram | **Description**

Shape - (Independent of duration)

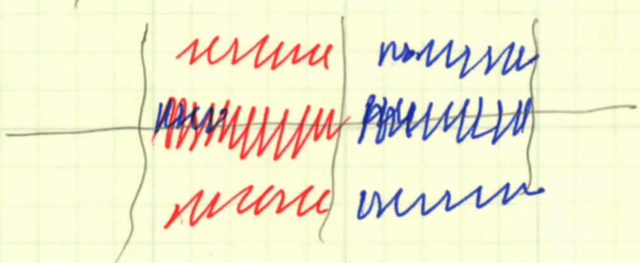


Crescendo (rising)

Decrescendo

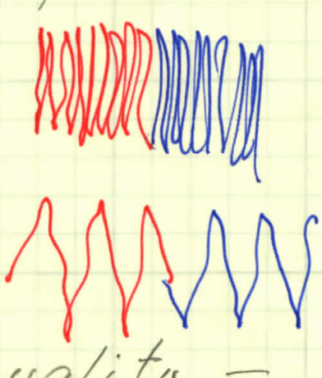
Crescendo, Decrescendo "Diamond shaped, triangular"

Amplitude (Intensity):



Grade:
1 - barely audible
2 - audible
3 - moderately loud
4 - loud
5 - v. loud
6 - heard c̄ stetoscope | may be palpable

Pitch (frequency)
optional on diagram



High, Low

Low

Quality — "Blowing", "soft", "quiet", "cooing" "machinery", "rumble"

Location, Variation c̄ respiration

Describe where loudest, radiation