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Coronary thrombosis

R. W. Karrer
University of Nebraska Medical Center

CORONARY THROMBOSIS

by

R. W. Karrer

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INTRODUCTION

The terms coronary thrombosis, coronary occlusion, and cardiac or myocardial infarction are often employed as synonyms, although there are useful differences in their meanings. In this thesis the author will deal only with that special type of coronary occlusion in which coronary thrombosis is the final event in the process of occlusion. Also, the thesis will be limited, more or less, to that type of thrombosis which is acute thrombosis of a coronary artery, rather than to the chronic type which is neither as spectacular a disease nor as clean cut in its clinical picture.

The definition of coronary thrombosis as given by Dorland (1935) is, "The formation of a clot in a branch of the coronary arteries which supply blood to the heart muscle, resulting in obstruction of the artery and infarction of the area of the heart supplied by the occluded vessel." Cecil (1935) modifies the definition in that he mentions the obstruction is generally acute.

The subject of coronary thrombosis should be of special interest because it is one of the most

common causes of so-called natural sudden death. Hammer (1934) finds that 91 per cent of sudden deaths from natural causes are due to the cardiovascular system, and 40 per cent of this 91 per cent is due to diseases of the coronary arteries. There is much controversy in the literature as to whether the incidence of coronary thrombosis is on the increase or not, but since few doctors were making a diagnosis of coronary thrombosis 25 years ago, and it is a common diagnosis now, there is very little statistical data which will support any conclusion either way. We do know, however, that heart disease is the leading cause of death, so it behooves the practitioner to be competent and able to diagnose any or all of the various cardiac disorders.

For this reason, it seems to the author that a thorough study of coronary thrombosis is important to any individual preparing himself for the general practice of medicine.

The literature written about coronary thrombosis is too voluminous to be reviewed completely in the time and space alloted for this thesis, so the author has attempted to review the most important and comprehensive articles written about the subject. These articles

will be used for the basis of this thesis.

The thesis will consist of the following chapters in the order of their arrangement.

I Introduction

II History

III Incidence

IV Etiology

V Pathogenesis and Pathology

VI Signs and Symptoms

VII Electrocardiogram

VIII Course and Prognosis

IX Differential Diagnosis

X Treatment

Coronary thrombosis is a comparatively new term for a pathological entity that has existed throughout the ages, but it had not been recognized by competent clinicians and pathologists before the latter part of the nineteenth century. When one reads some of the older literature one is impressed by the clear cut clinical pictures of coronary thrombosis that have been classed as some other disease, and although the pathological picture described can be easily interpreted as coronary thrombosis with a cardiac infarct in the light of our present knowledge, the older pathologists did not mention thrombosis of a coronary artery as the probable cause.

Many modern authors upon reviewing the case histories and autopsy findings of early clinicians find cases which seem to be typical of coronary thrombosis as we know it today. Reichert's (1928) review of Sir. Evard Home's account of John Hunter's attack is a typical example. In this account we find at autopsy that the coronary arteries were like bony tubes and on the under surface of the left auricle and ventricle there were two spaces,

white in color, nearly 1½ inches square. Reichart interprets this picture as being one of coronary thrombosis.

Hallowell(1835) discussing rupture of the heart gives a very clear and typical clinical picture of coronary thrombosis as we know it today although he does not mention disease of the coronary arteries as being a probable cause. His account will be given in brief. Patients dying from rupture of the heart are usually affected for a varying length of time before with symptoms of palpitation, frequent attacks of lipothymas(weakness) or pain beneath the sternum and tightness and weight across the chest. Difficulty in breathing, suffocation, cough and bloody expectorations are also common symptoms.

Rupture of the heart seldom occurs, but in patients advanced in life. Usually in persons over 58 years of age, with but few exceptions, and it occurs in men more frequently than in women.

At autopsy the rupture usually occurs in the left ventricle on the anterior wall near its middle. The heart muscle surrounding the rupture is usually soft (Hallowell, 1835). If one would label this case as coronary thrombosis it might well be taken for a

modern case report of the disease.

Sprague (1920) gives Marshall Hall the credit of being the first man to recognize that sudden death was often caused by interruption of the coronary circulation. In 1842 he said, "Many facts induce me to believe that the cases of sudden death arise chiefly from interruption of the coronary circulation."

Harvey (1847) five years later also intimated that the closure of the coronary circulation caused sudden death. He wrote "Sir Robert Darcy died in one of his paroxysms of distressing pain in the chest, and at the post-mortem there was found the heart rupture (left ventricle), and this vent was apparently caused by an impediment in the passage of blood from the left ventricle into the arteries."

Putney (1880) citing a case reported by Dr. Winsor gives an account of a patient who died after being diagnosed as having angina pectoris. At autopsy there was a rent in the left ventricle 7 cm. in length and the adjacent muscle showed degeneration. There was a blood clot in the left coronary artery.

The above clinicians all realized that impediment of the flow of the coronary circulation probably caused

the death in these cases, but they did not make a correct diagnosis before the patient went to the autopsy table.

Sprague (1920) and Parkinson and Bedford (1928) give Hammer the credit for being the first man to correctly diagnose coronary thrombosis during life. His report was in 1878. Levine and Tranter (1929) regard Dock as being one of the first to correctly diagnose coronary thrombosis antemortem and prove it at autopsy. His report was in 1896. Sprague (1920) gives him credit for being the first to introduce pericarditis into the clinical picture.

Porter (1896) produced experimental coronary occlusion in dogs and he came to the conclusion there was not enough collateral circulation to keep the area alive, and anemic infarcts were always produced.

During the period from 1880 to 1912 it was recognized that coronary thrombosis was a distinct clinical entity by some clinicians, but they all believed that death was the invariable result of infarction.

Most authors give two Russian writers, Obrastzow and Straschesko, the credit for publishing the first satisfactory clinical picture of coronary thrombosis.

Their article appeared in 1910. They emphasized dyspnea, gastralgia and severe and lasting retrosternal pain(Brown, 1930).

Osler (1910) writes "Blocking of a branch with a fresh thrombus is very common in cases of sudden death in angina." He mentions that oxygen should be administered in such cases of angina that are likely to be blocking of one of the coronary arteries, and mentions that if a pericardial friction rub follows an angina there is sure to be a blocking of a coronary artery.

It was Herrick, however, who first recognized that coronary thrombosis was compatible with life and he gave us the modern concept of coronary thrombosis. His article in 1912 was the first to maintain that the patient with coronary thrombosis could make a functionally complete recovery. His article in brief follows. "In stoppage of a large branch of the coronary arteries sudden death often does occur - yet at times it is postponed for several hours or even days, and in some cases a functionally complete recovery takes place." He mentions that the symptoms vary with the size of the artery occluded and classifies the different types of coronary thrombosis as follows.

Group I. Death sudden, seemingly instantaneous and painless with no agony or distortion of features. Group II. The attack is anginal, pain severe, shock profound and death occurs in a few minutes. Group III. Non-fatal cases with mild symptoms. Group IV. Symptoms severe but death is delayed for several hours, days or months and perhaps recovery might occur.

The first case that he ever diagnosed clinically showed symptoms of a weak pulse, feeble cardiac tones, rapid pulse, Rales,(moist and dry), dyspnea and cyanosis, low blood pressure, oliguria, pericardial friction rub, nausea and vomiting, ashy color, cold sweat and morphine was required to relieve the pain (Herrick, 1912).

Herrick writing in Levy's book in 1936 says "The fate of that early paper was a surprise to me and a keen disappointment. It had fallen like a 'dud!" (Levy, 1936).

It is true that the medical profession did not react favorably until 1918 or 1919 when Herrick reiterated the points he brought out in 1912. He also mentioned that the electrocardiogram was helpful in recognizing this condition (Herrick, 1918, 1919). Levine and Tranter (1918) brought out the fact that fever and leucocytosis were an important part of the

clinical picture. Pardee (1920) gave a comprehensive review of the characteristic electrocardiographic changes one would expect to find in coronary artery obstruction.

At this time many articles appeared in the literature and they are too numerous to mention, but even with the evidence Sir James MacKenzie was not making a clinical diagnosis in 1924 and Thayer (1923) classifies coronary occlusion with angina pectoris.

The clinical diagnosis of coronary thrombosis from 1919 on gradually became more widespread until now it is recognized all over the world by the laity as well as the general practitioner.

There is much controversy in the literature as to whether the incidence of coronary thrombosis is increasing or whether it is due to more cases being diagnosed because of keener diagnostic acumen. All authors agree, however, that it is an important cause of death and that it is being assigned as the cause of death more frequently now than ever before. Some writers assume that the increased incidence is due to the greater stress and strain of modern life (Wolferth, 1937). On the other hand, Cohn and Lingg (1934) maintain the increase is due to change in the fashions of diagnosis. There is no way to determine accurately at the present time whether there is an actual increase in the incidence of coronary thrombosis or not; time alone with accurate tabulation may settle this question in the near future.

Barns and Ball (1932) in a series of 1000 unselected postmortem examinations found 49 cases of infarction or 4.9 per cent of all cases coming to autopsy. In 685 cases 40 years or over there were 47 cases of cardiac infarction, or 6.86 per cent of the entire series above the age of forty.

Age.

The ages between 50 and 70 show the highest incidence of coronary thrombosis (White and Wolf,1926; Sprague, 1920). Conner and Holt (1930) place the usual time of onset between 40 and 60 years of age. One third of their cases had their first attack before the 51st year and 75 per cent had their first attack before the 61st year. The majority of cases had their first attack between the 56th and 60th years. The following tables give the age incidence of some of the authors.

Age	Parkinson and Bedford (1928) No. of cases	Master, Dack and Jaffee (1936) No. of cases	Levine (1929)	Appelbaum and Nicolson (1935)	Christian (1925)
30-39	2 %	8 %	3	3	5
40-49	20 %	23 %	29	25	11
50-59	33 %	32 %	44	36	16
60-69	35 %	27 %	55	56	28
70-79	9 %	10 %	13	19	11
80-89			1	3	
Total No. of cases	100	267	145	168	71

Sex.

Coronary thrombosis is predominately a disease of the male. Levine (1929) finds in his series that the

ratio between male and female patients is 3.5 to 1. Conner and Holt (1930) in their series of 287 cases found that 84.7 per cent of these were men. Parkinson and Bedford (1928) found in a series of 100 cases 93 males and 7 females. Master Dack and Jaffee (1936) found three times as many men as women with coronary thrombosis. Many other authors mention the fact that it is more common in the male than in the female, but do not give any figures on the ratio.

The cause of the predominance of this disease in the male is not clear cut. Some authors advance the theory that it may be due to the excessive use of tobacco, the more strenuous type of life and the more deleterious habits which are generally attributed to the male. None of these theories have been proven, however, and the answer to this problem will have to be left up to future investigators (Levine, 1929).

Race.

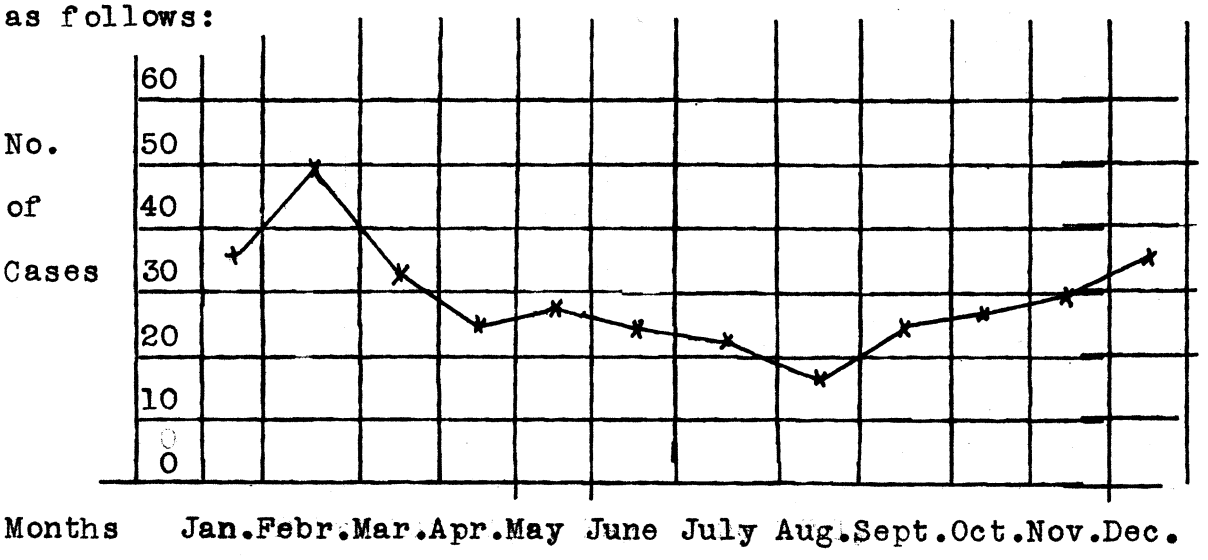
It is generally agreed that coronary thrombosis is more prevalent in the white race than in the colored (Hedley, 1935). Here again the cause is not clear cut and can not be answered satisfactorily. It is also found that there is not as high a percentage of male

patients in the colored race as compared to the females. Again there is no adequate explanation. Johnston (1936) computed the following table on race incidence.

	No. of patients	No. of patients with occlusion
White males	100	9
Negro males	100	4
White females	100	4
Negro females	100	2

Season.

Mullins (1936) found that in the New England states there was twice as many cases of coronary thrombosis during the months of December, January and February as there was during all the rest of the months put together. Wood and Hedley (1935) also found a similar picture. Again there is no explanation offered. Sprague (1920) also holds this view. Mullin's table is as follows:



In conclusion the author will show a chart taken from Levy's work on cardiac diseases showing the age, sex and color of the persons with coronary disease during the years 1930 to 1934 inclusive.

Death rates per 100,000 from Coronary Disease. (excluding Angina Pectoris) by Color, Sex, and Significant Age Periods. Metropolitan Life Insurance Company, Industrial Department, Weekly Premium - Paying Business 1930 to 1934.

Color;Sex;Age	1934	1933	1932	1931	1930
Total persons					
1-74 years	18.8	13.4	9.4	7.0	4.7
1-74*	19.7	14.2	10.3	8.0	5.6
45-74*	90.8	66.5	47.8	36.5	25.8
White Males					
1-74 years	25.9	18.4	12.9	9.9	6.4
1-74*	29.7	21.4	15.5	12.2	8.2
35-44	24.9	15.8	12.6	10.8	5.9
45-54	76.1	53.0	43.5	34.1	20.3
55-64	157.7	116.9	72.4	65.2	48.1
65-74	258.6	196.4	142.7	96.7	67.6
45-74*	136.0	100.0	71.0	55.7	38.0
White Females					
1-74 years	14.3	9.7	7.0	4.9	3.6
1-74*	11.7	8.1	6.1	4.5	3.5
35-44	6.3	2.9	2.3	2.5	2.2
45-54	18.8	15.9	10.4	9.5	6.9
55-64	62.1	41.2	34.7	23.0	20.2
65-74	147.4	102.1	74.7	50.4	37.7
45-74*	56.4	39.9	30.1	21.4	16.9
Colored Males					
1-74 years	17.0	14.5	10.1	6.3	4.1
1-74*	14.4	12.1	9.0	5.2	3.9
35-44	17.9	14.1	12.3	4.5	7.2
45-54	31.0	38.1	14.3	16.6	7.8
55-64	80.5	48.3	39.2	26.0	7.4
65-74	94.0	82.3	88.5	22.8	33.2
45-74*	58.7	49.5	36.0	21.8	12.3
Colored Females					
1-74 years	12.0	11.3	5.6	6.4	3.2
1-74*	9.1	8.2	4.5	5.3	2.8
35-44	10.0	6.7	8.1	7.3	2.8
45-54	27.5	28.2	7.5	8.5	7.5
55-64	33.9	50.3	15.6	28.8	10.4
65-74	69.3	42.4	42.1	42.9	21.6
45-74*	37.2	38.0	16.4	21.4	11.0

* Standardized

ETIOLOGY

The determining causes of coronary thrombosis are the same as those causing thrombosis in other arteries of the body. They may be conveniently classed into (1) those relating to changes in the walls of the blood vessel; (2) those associated with a slowing of the blood current; and (3) those involving such alterations in the blood itself as favor coagulation. These factors are frequently associated (Wood, 1936). In coronary thrombosis, however, most authors agree that changes in the vessel wall are the most important of the above three factors. Berger (1936) says "A thrombosis can form only in the presence of arterial disease." This statement is further substantiated by Wood (1936) who says, "So long as the endothelial lining of the vessel is intact, simple retardation of the circulation does not usually alone suffice to induce coagulation; but changes in the endothelium in a great variety of conditions, such as inflammation, degeneration, atheroma, calcification, and the presence of bacteria or their toxins, tumor, and foreign bodies favor its occurence, especially when associated with changes in the circulation or in the character and

contents of the blood." Levine (1928) says, "Thrombosis of a coronary artery may be considered as an episode in the natural history of coronary sclerosis, for the thrombus almost invariably forms in a vessel already the seat of atheroma or calcification." Most authors agree with the above. They are: Parkinson and Bedford (1928), (1931), Ernstene (1929), Klotz and Lloyd (1930), Luten (1931), Evans, Ambler, and Dodson (1933).

The most common pathology causing arterial disease in the age group of coronary thrombosis is arterio- and atherosclerosis. This is also generally agreed to by all authors, namely: Herrick (1919), (1931), Reisman (1923), Parkinson (1928),(1932), Ernstene (1929), Levine (1929), Klotz and Lloyd (1930), Luten (1931), Musser and Barton (1931), Levine (1932), Stroud (1932), Bancker and Evert (1933), Evans, Ambler and Dodson (1933), Appelbaum and Nicholson (1935), Berger (1936), and Wolferth (1937).

The above statements being true, all other factors must, of necessity, be secondary to the three primary factors of (1) injury to vessel wall, (2) slowing of blood current and (3) changes of the blood in the causation of coronary thrombosis. Of the three

sclerosis is the most important, but since almost all coronary arteries are sclerotic, (arterio or athero) after the fourth decade of life, it is these secondary factors that are of primary importance. Then these are the factors that the practitioner must combat to reduce the incidence of coronary thrombosis.

Two other important factors in the causation of coronary thrombosis, besides arteriosclerosis, are those associated with a slowing of the blood-current, and those involving such alterations in the blood itself as favor coagulation. All other factors pertaining to etiology must alter one of these three; either the development of arteriosclerotic changes, the rate of flow of blood through the coronary arteries, or the increase of the coagulability of the blood (Wood, 1936).

Many contributory causes of coronary thrombosis are listed in the literature. They are hypertension, angina pectoris, syphilis, diabetes, heredity, infectious diseases, focal infections and a miscellaneous group which includes age, sex, race, habits, etc.

Changes in the Blood Flow.

Changes in the blood flow, and changes in the

blood itself are important in the formation of a thrombus in any part of the body, and are equally important in thrombus formation in the coronary arteries. (Herrick, 1931). Variation in the blood flow, namely slowing, may be caused by atheromatous placques occluding the lumen of a vessel, spasm of the vessel, profound anemia, lowered blood pressure or hypotension, low diastolic pressure especially as seen in aortic regurgitation, in shock, increased viscosity of the blood, acute angulation of the coronary arteries, and cardiac factors which include weakening of the heart muscle and marked bradycardia.(Luten, 1931; Herrick,1931; Stroud, 1932; Berger, 1936).

Berger (1936) in reviewing blood current change as an etiological factor list them as follows:

I Slowing of the blood stream
  (1) Stenosis of the blood vessel.
  (2) Weakening of the heart muscle,
  (3) Pressure on a blood vessel.

II Sudden changes in blood pressure or rate of flow.

III Back pressure or blood-eddy which permits platelets to settle on the intima and thus form the starting point of a clot.

IV Aneurysmal dilatation.

There is little doubt, theoretically at least, that slowing of the blood current caused by one or more of the above listed factors is important in thrombus formation.

Stroud (1932) says, "There must be changes in the coronary flow in order to permit the development of coronary occlusion. Such modification of the coronary flow may be gradual or sudden, but it is due to one or more of three factors: (1) a change in the character of the blood, (2) a change in the coronary vessels, (3) a change external to the coronary vessels but involving their efficiency." He lists as examples of external factors, nerve tone variations, aortic sclerosis, and syphilitic aortitus involving the mouths of the coronary arteries. Luten (1931) correlates the lowered blood pressure and cardiac output, which cause slowing of coronary circulation, with the time of onset of most acute attacks of coronary thrombosis. He maintains that, in the normal individual, the blood pressure and cardiac output is lowest at four o'clock A.M., and finds that 40 per cent of acute attacks occur while the patient is in bed, and often occur

in the early hours of the morning. This theory of lowered blood pressure and cardiac output is also supported by the fact that the attack does not typically occur with exertion, as does angina pectoris, but rather when the patient is at rest. The above can be summed up by Lutens (1931) statement in which he says that most instances of occlusion occur under circumstances associated with lowering of diastolic pressure and lessening of systolic output.

The frequency of attacks of coronary thrombosis after a meal has been mentioned frequently in the literature. Luten (1931) maintains that this is probably on a vaso-constriction basis although there is no direct proof that coronary constriction is caused by visceral stimuli. Stoll (1933) says the position of the heart is changed by the dilated stomach and that the splanchnic vessels dilate taking blood from the heart, both of these tending to slow the blood flow through the coronary arteries.

The slowing of the blood stream, no matter from what cause, is important in thrombus formation because it allows precipitation of its formed elements. These elements, once deposited on the site of injury, or

irritation of a vessel, wall, or, in the case of coronary thrombosis, an atheromatous placque, are not washed away, with a resulting further coagulation and eventually thrombus formation.

Changes in the Blood Itself.

Such changes in the chemistry of the blood which favor its coagulation must, of necessity, influence the formation of thrombi. These changes, according to Wood (1936), are obscure, but he lists anemia, the presence of bacterial toxins or of the bacteria themselves, and less frequent alterations due to haemolytic substances as in transfusion of alien blood, and the artificial introduction of certain animal and vegetable extracts. This might explain the widely held opinion that insulin is detrimental in the treatment of diabetics with coronary thrombosis. The changes as listed by Berger (1936) are agglutination or clumping of platelets, agglomeration of haemolized erythrocytes, haemolysis, and bacteria, especially the staphylococci. Herrick (1931) mentions variations in viscosity or albumen, and variations in the number of platelets or their fragility. All of these factors, of course, are

important only because they favor coagulation of the blood, which, in turn, predisposes to thrombus formation.

Hypertension.

The relationship of hypertension to coronary thrombosis is generally recognized and agreed to by all authors. Levine (1929) in his review of 145 cases states that 58 of his patients were known to have had a previous hypertension. He also states that hypertension is probably the most common, single, etiological factor in the development of coronary thrombosis. He interprets the hypertension as indicating that the small blood vessels of the patient were undergoing sclerotic changes. Tollman (1938) believes that hypertension plays a part because it hastens arteriosclerotic changes.

Evans, Ambler, and Dodson (1933) states that 44 per cent of his series of cases had a hypertension of 160 over 100, and quotes Levine as saying that in his series 40 per cent had this hypertension. Other authors do not believe hypertension is of much importance and, also, do not find as high an incidence as the above two authors. These authors find hypertension in only 25 per cent to 34 per cent of their cases. (Connor and Holt, 1930; Berger, 1936). While one man states that exaggerated hypertension plays

no part in etiology (Musser and Barton, 1931).

It seems reasonable to believe that hypertension does play an important role in that it hastens the formation of sclerosis, which is the natural effect of prolonged hypertension (Cecil, 1935). It is also important in that the finding of hypertension in a patient indicates a person who is susceptible to cardiovascular disease and arterial accidents (Cecil, 1935).

Figures quoting the incidence of hypertension in individuals suffering from coronary thrombosis may be misleading because many patients do not have their blood pressure recorded previous to the attack, and, since the blood pressure usually falls with coronary thrombosis, no accurate or reliable data is available.

Angina Pectoris.

It is generally true that coronary thrombosis is the end result of a previous angina pectoris, although the angina might not have been typical, and frequently has neither been diagnosed nor troublesome (Levine, 1929). The anginal attacks may precede thrombosis for months or years, and a single, spontaneous, prolonged attack of anginal pain strongly

suggests the approach of a typical coronary thrombosis (Sampson and Eliaser, 1937). Conner and Holt (1930) find in a series of 287 cases that 38 per cent of the patients had anginal attacks previous to their thrombosis. The above statements are also supported by Herrick (1919), Luten (1931), Stroud (1932), Cecil (1935).

In the absence of typical anginal attacks many patients show, previous to their thrombosis, symptoms of cardiac embarassment upon emotional strain or upon moderate or excessive exercise. These may be the feeling of constriction or oppression in the chest, or transient mild discomfort in the chest (Herrick, 1912; Conner and Holt, 1930; Levine, 1936). Parkinson and Bedford (1928) found in his series of cases that 45 per cent of his patients had typical anginal attacks before the onset of their coronary thrombosis, while 8 per cent had a typical pain, and 38 per cent had no previous pain of any kind.

These anginal attacks are important in the etiology only because they show evidence of coronary artery disease which predisposes to thrombosis. They should forewarn the practitioner of the serious malady which may follow, and he should be quick to differentiate coronary thrombosis from the previous angina when it

does appear, and immediately institute proper treatment.

Syphilis.

There seems to be much controversy in the literature as to whether or not syphilis plays a part in the etiology of coronary thrombosis. Stroud (1932), Banker (1933) and Berger (1936) maintain that syphilis plays an etiological role, while Wearn (1923), and Appelbaum (1935) say that syphilis has no effect as far as the etiology of coronary thrombosis is concerned. Levine (1929) says that syphilis rarely is an underlying factor and that, when it is, the onset is at an earlier age.

Conner and Holt (1930) show that 14.2 per cent of their 287 cases showed positive serology. Brown (1934) and Wolferth (1937) believe that coronary occlusion due to syphilis is not common unless aortic insufficiency is present.

Aortic insufficiency would at least fulfill one of the criteria for the formation of a thrombus because low diastolic pressure present would result in a slowing of the blood current through the coronary arteries. Syphilitic aortitis is associated with secondary sclerosis of the intima of the aorta, which may obliterate or partially obliterate the

coronary orifices (Berger, 1936). This again would favor thrombus formation by slowing the blood stream through the coronary arteries.

In view of the conflicting reports in the literature, it can only be said that syphilis may play an etiological role, and that further studies should be made as to its proper place in the etiology of coronary thrombosis.

Diabetes.

Diabetes is secondary only to a pre-existing hyerptension as an etiological factor in the causation of coronary thrombosis (Levine, 1929). Although it does not alter the age of onset nor the prognosis, coronary thrombosis is twice as prevalent in the diabetic patient. In Levine's series, 23.7 per cent of his patients showed a glycosuria, although this does not indicate that all of them were diabetics, the majority probably were. 26 of Enklewitz's (1933) 92 diabetic patients showed coronary thrombosis. Of these, 20 appeared in the sixth and seventh decade. In Conner and Holt's (1930) series of 287 cases, 10.2 per cent of these were diabetics while in Blotner's series of 80 diabetics 10 per cent died of coronary thrombosis. Blotner believes that insulin has a

bad effect on the heart, which predisposes to coronary thrombosis. Other authors also mention diabetes as an etiological factor. They are: Stroud (1931), (1932), Evans, Ambler, and Dodson (1933) and Banker(1933).

Diabetes in itself is probably not a predisposing cause, but it is the arterial sclerosis, which is associated with it, that causes the higher incidence of coronary thrombosis in the diabetic patient.(Conner and Holt, 1930). It is the belief of some authors that the diabetic is a patient with a vulnerable vascular system, and for this reason is especially prone to develop coronary thrombosis (Levine and Brown, (1929).

However, no matter why, it seems to be definitely proven that there is a higher incidence of coronary thrombosis in the diabetic patient, although the diabetes does not alter the age of onset nor the prognosis of the coronary attack if the patient is treated properly.

Heredity.

Heredity is of considerable importance in that the individual may inherit a vascular system which has a greater susceptibility to degenerative or chronic vascular disease.(Levine 1929). Some authors

go so far as to say that poor cardio-vascular heredity is the most important single etiological factor (Banker, 1933). While others state that it plays no part (Wearn, 1923). In proof that it is important, Levine (1929) cites a family in which three brothers died of coronary thrombosis. Musser and Barton (1931) also cites families in which coronary thrombosis has been found in several members. Evans, Ambler, and Dodson (1933) support the above views.

It is a well known fact that some family groups have a tendency to develop arteriosclerosis earlier than others, and for this reason it seems logical to believe that heredity would influence the development of coronary thrombosis in an individual developing arteriosclerosis early in life.

Infectious Diseases and Foci of Infection.

The relationship of foci of infection and infectious diseases is still subject to much controversy in the literature, although all authors agree that if it does play a part, it is a minor one. Slater (1931) cites three cases of coronary thrombosis occuring during active rheumatic infection, while Boyd (1935) states that, although there is definite evidence of an inflammatory basis for coronary

thrombosis, rheumatic infections do not favor its formation. Banker (1933) mentions in passing that focal infections are etiological factors. Levine (1929), Luten (1931) and Evans, Ambler, and Dodson (1933) maintain that foci of infection and infectious diseases play no part in the etiology. When we refer back to our three primary factors, which are necessary to the formation of a thrombus, we find, however, that infections, theoretically at least, could be of considerable importance; becuase they may alter two of these three primary factors, the chemistry of the blood and the character of the vessel wall (Wood, 1936).

Like so many things in medicine, however, the theoretical does not hold true when adapted to the human body. It can only be said that further studies should be made and infections studied specifically for their influence on the incidence of coronary thrombosis.

Miscellaneous.

Many contributory causes to the formation of coronary thrombosis have been listed in the literature. Most of them seem to be of minor importance and

subject to much controversy by various authors.

Tobacco is frequently listed as a contributing cause, and this view is supported by Reisman (1923), Stroud (1931), (1932), and Niehaus, while Wearn (1923), Evans, Ambler, and Dodson (1933), Appelbaum and Nicolson (1935) maintain that it plays no part. Stroud (1931) (1932) in an article dealing with the prevention of coronary thrombosis, stresses the importance of protecting the patient from focal and general infections, toxic effects of end products of food metabolism, nicotine-coffee, tea, etc.,faulty intestinal and renal elimination, diabetes, obesity, excessive physical effort over long periods, long hours of nervous tension and mental concentration, inadequate vacations, and most important of all, external nervous stimuli and internal psychic phenomena. Other authors also stress the speed of modern life as being an etiological factor (Niehaus). Alcohol and coffee have been frequently mentioned in the etiology of coronary thrombosis, but the concensus of opinion is that they play no part (Wearn, 1923); Evans,Ambler, and Dodson, (1933); Appelbaum and Nicolson, (1933).

Age, sex, race, occupation and season have been mentioned in the etiology but these have been taken up more fully under incidence of coronary thrombosis.

In order to understand coronary thrombosis, with its resulting infarction of the myocardium, it is essential that one have a thorough knowledge of the anatomy of the coronary arteries and the regions of the heart they supply.

The heart receives its blood supply from the right and left coronary arteries;the orifices of both are located in the Sinuses of Valsalra (Berger, 1936).

Gross (1921) gives a detailed and complete description of the areas of the heart supplied by the different arteries and their branches. His description will be quoted here. "The right coronary artery in the typical average heart supplies the entire right ventricle, with the exception of the left third of the anterior wall. Besides this, its rami ventricularis sinistri supply the right one-half of the posterior wall of the left ventricle, and a small strip of interventricular septem. The left coronary artery, on the other hand, supplies the whole remaining part of the left ventricle, the small left anterior portion of the right ventricle not supplied by the right coronary artery, and a small anterior strip of

the interventricular septem. The area of junction on the posterior surface of the left ventricle and on the anterior surface of the right ventricle, where these divisions meet, are supplied by both vessels. Thus, the intervening portion of the interventricular septum is supplied by branches from the ramus descendens posterior dexter and the ramus descendens anterior sinister."

It is important when considering the pathology of coronary thrombosis to first consider the pathology in the coronary arteries which lead to the formation of a thrombosis with the resulting infarction usually following. This pathology in practically all cases is athero or arteriosclerosis. These changes usually begin in the fourth decade although they may start much earlier. Elevated, greyish-white or yellowish placques of various size are found; these bulge inward when the artery is opened. Upon degeneration of these placques calcium is deposited and as they become large they may occlude the lumen of the vessel almost entirely. When the lumen is greatly narrowed the thrombus usually extends only a very short distance. When there is less advanced sclerosis the thrombus

may extend a considerable distance in the artery.

The intensity of this sclerotic change varies in the different arteries. The anterior descending branch of the left coronary artery is the most frequent site of advanced sclerosis and this change is usually most advanced in the first part (Levy, 1936).

Klotz and Lloyd (1930) in describing the order of pathological events lists first endarteritis, then atheroma, calcification, stenosis, and thrombosis. Libman (1919) adds infarction and Levine (1929) adds infarction and myofibrosis.

The interruption of the blood supply to any part of the heart is followed by changes in the myocardium, endocardium and in some cases the pericardium. However, when death occurs suddenly there may be no visible changes in the heart muscle.

When the patient survives an acute coronary thrombosis, an anemic infarct and necrosis occurs and the heart muscle undergoes myomalacia.

(1) Early appearance. A yellowish mottling occurs soon after an occlusion. This color is due to necrosis and fatty changes in 24 to 72 hours liquefaction necrosis sets in, causing softening of the heart muscle (Berger, 1936). If this infarct

extends to the endocardial surface a mural thrombus usually forms; if the necrotic muscle lies just beneath the pericardium a fibrinous pericarditis results and a friction rub will be heard (Levy, 1936).

Immediately after the vessel has become occluded the margins of the infarcted area will show dilated anastomotic vessels. There will also be a leucocytic infiltration and later a proliferation of fibroblasts.

(2) Late appearance. The yellowish mottling is replaced by a greyish yellow or rusty brownish color. A vascular scar tissue surrounds the infarcted area. In approximately five or six weeks, the infarcted material will be absorbed and the necrotic muscle will be replaced by a greyish-red granulation tissue.

The mural thrombus found on the endocardial surface organizes and the endocardium over the infarcted area becomes thickened and opaque.

At any time during this period the necrotic heart muscle may rupture, an aneurism may form and there may be embolization from the mural thrombosis or the heart may enlarge (Berger, 1936).

Repair of Infarcts.

The infarcted area is replaced by a dense cicatricial formation and may later in its course

become calcified.

Colateral circulation is re-established by anastomotic coronary circulation and by the circulation which connects the capillaries and veins directly with the heart chambers.

Location of infarcts.

The location of the infarcted area of course depends on the artery affected. Occlusion of the anterior descending branch of the left coronary gives an anterior or apical infarct. Mid-ventricular infarcts are usually caused by occlusion of the left circumflex branch, and a posterior basal infarction is due to occlusion of the main trunk of the right coronary artery.

Berger (1936) finds that 90 per cent of all infarcts occur in the area supplied by the left coronary artery. Bell and Pardee (1930) find the left coronary artery is envolved in 83 per cent of the cases. Lambert (1931) finds the long descending branch of the left coronary thrombosed in 60 per cent of cases and the transverse branch of the left coronary in 23 per cent of the cases. In a series of 168 cases Appelbaum and Nicolson (1935) compiled the following tables.

Site of Occlusion.

	Left coronary			Right	Multiple
Art.	Main trunk	Descending branch	Circumflex		
Number	7	85	8	29	16

Site of Infarct.

	Anterior Apical	Mid-Ventricular	Post Basal	Other sites
No.	91	10	16	10

Barns and Ball (1932) find that gross infarction was almost always confined to the left ventricle and was in the posterior basal position in 24 cases, and in the apical and anterior portion in 28 cases. They maintain it is no longer justifiable to call the anterior descending branch of the left coronary the artery of coronary occlusion. Morit~~z~~ and Beck (1935) found in their series of 94 cases that the left coronary artery was occluded in 54 per cent, right 13 per cent and both left and right 33 per cent.

In conclusion it may be said that the artery thrombosed may be any coronary artery or any of its branches, but that the most common artery affected is the descending branch of the left coronary and the most common site for infarction is the anterior apical area.

The outstanding symptom of coronary thrombosis in a typical case is the severe heart pain accompanied by dyspnea, shock, nausea and vomiting, and numerous other minor phenomena, which may or may not appear later on in the course of the disease (Cecil, 1935; Moore and Campbell, 1929). It might be said that all of the signs and symptoms vary in intensity with the size and distribution of the artery affected (Bancker, 1933).

Pain.

The pain of coronary thrombosis, which is in the majority of cases severe and lasting from a few hours to a few days, is of utmost importance to the patient and should be relieved as quickly as possible by the physician. This pain is described differently by various patients, but the most common descriptions according to Levine (1929) are: (1) pressure-pain like a load of bricks on the chest, (2) " a death clutch in the throat and chest", (3) the chest feels as if it were in a vise, and some describe the sensation as (4) "just an awful pain." A burning or boring sensation in the chest is also described by some authors (Berger 1936)

while some patients complain only of an aching or gnawing sensation throughout the chest. Rarely patients may have no pain at all or extremely mild attacks of pain which consist of pains not unlike pleurisy (Herrick, 1931; Kilgore, 1933). In the majority of patients, however, the pain is described as viselike constricting or squeezing in character and is agonizingly severe (Wolferth 1937).

The location of the pain in the typical case is the lower sternum (Cecil 1935), although it may be anywhere in the chest or upper abdomen and may radiate to either or both arms, the neck or to the subscapular region (Wolferth, 1937; Parkinson and Bedford, 1928). Berger (1936) locates the pain in the following table: beneath the sternum - 82 per cent of cases, upper abdomen - 13.3 per cent, radiation to left arm - 22.4 per cent, radiation to both arms - 18 per cent, while Parkinson's and Bedford's (1928) table shows 68 per cent in the lower half of the sternum, 43 per cent of these in the epigastrium, 9 per cent in the upper half, and classes 16 per cent as just sternal, 28 per cent radiate to both arms, 25 per cent to the left alone, and 8 per cent to the right arm alone. These two series

of figures agree quite well and seem to present a true picture as to the location of the pain.

The onset of the pain as described in the etiology is usually when the blood pressure is low. Parkinson's and Bedford's (1928) table bears out those statements as he lists the onset as 33 per cent during sleep or while in bed, 26 per cent with no history of exertion, 22 per cent with moderate exercise, and in 19 per cent no history was available. Berger (1936) also maintains that the onset usually occurs when the patient is at rest or asleep, as does Hubble (1930). The onset of severe pain may be heralded a few days previously by mild symptoms of indigestion (Kilgore 1933), transitory pains in the chest (Conner and Holt 1930; Parkinson and Bedford, 1928); mild general discomfort and fatigue (Levine, 1936); and prolonged anginal attacks (Sampson and Eliaser, 1937).

The intensity of the pain is usually most severe at the onset and then disappears in several hours or days. After the severe pain disappears there may be a mild ache in the center of the chest or no pain at all. (Levine, 1929; Berger, 1936). Parkinson and Bedford (1928), in charting the duration of the pain finds that in 41 per cent of his 100 patients the

pain lasted 1 to 6 hours, in 24 per cent 6 to 24 hours, in 22 per cent 1 to 3 days, and in 13 percent the pain lasted longer than three days (Parkinson and Bedford, 1928).

Nausea and Vomiting.

Nausea and vomiting frequently accompany the onset of the pain or follow it immediately, and in some cases may precede the pain (Levine and Tranter, 1918, 1929; Wearn, 1923; Levy, 1932; Cecil, 1935; Berger, 1936).

The occurence of the epigastric type of pain accompanied by nausea and vomiting leads many clinicians to err in the diagnosis with a resulting laporotomy for abdominal pathology and death of the patient.

Shock.

Shock frequently occurs and may be intense at the onset of typical attacks of coronary thrombosis. Many of the associated signs and symptoms of shock are usually present in typical attacks. These are, face: an ashen countenance bathed in cold sweat with an expression of extreme anxiety (Levy, 1932). This peculiar ashen color and expression of anxiety with a fear of impending death is said to be quite characteristic by some authors and they place considerable importance upon it when making a diagnosis of coronary thrombosis (Levine and Brown, 1929).

The skin is cold and clammy with beads of perspiration. The pulse is rapid, feeble, and easily

compressible, and may be difficult to detect at times. The blood pressure falls and in the presence of a pre-existing hypertension a lowered blood pressure is a very significant finding (Wearn, 1923; Parkinson and Bedford, 1928; Levine and Brown, 1929; Bancker, 1933; Cecil, 1935).

Dyspnea.

Dyspnea is usually a prominent symptom in the typical case and may be accompanied by cyanosis. Marked dyspnea may be the outstanding finding when the patient does not complain of severe pain.

Bancker (1933) believes that the pain and dyspnea are both milder when the right coronary artery is involved. This might help one to locate the site of the myocardial infarct.

Herrick (1929) maintains that sudden dyspnea and a rapid drop in blood pressure are pain equivalents, and that manydiagnoses could be made that are otherwise missed if these facts are borne in mind.

Most authors list dyspnea as an important symptom and a few of these will be listed here: Wearn (1923), White and Wolff (1926), Parkinson and Bedford (1928) Levine (1929), Hubble (1930),Bancker (1933),Kilgore (1933),Stoll (1933),Smith Rathe and Paul (1935), Berger (1936).

The characteristic symptoms often attributed to coronary thrombosis; fall in blood pressure, narrowing of the pulse pressure, congestive failure (of which pulmonary edema is the outstanding feature), fever, leucocytosis, friction rub, faint heart sounds, gallop rhythm, abnormalities of cardiac mechanism and rhythm, sedimentation rate of red cells, and electrocardiogram changes are due to myocardial infarction rather than to coronary thrombosis per se.

The enfeeblement of cardiac action and the characteristic drop in blood pressure and narrowing of pulse pressure are probably due in part, at least, to the fact that the infarcted area being no longer able to contract, the remainder of the heart muscle is unable to carry on efficiently (Wolferth 1937).

The characteristic fall in blood pressure is mentioned by many other authors and is an important criteria in the differential diagnosis of coronary thrombosis and angina pectoris. The blood pressure usually falls within a few minutes to hours after the onset, and very rarely does it rise above the level previously present. Upon recovery, the blood pressure rises but not to its previous mark before it was interrupted by

the onset of coronary thrombosis. Many authors mention this blood pressure fall. A few of these are: Levine and Tranter, 1918; Wearn, 1923; White, 1926; Parkinson and Bedford, 1928; Levine, 1929; Moore and Campbell, 1929; Herrick, 1931; Levy, 1932; Bancker, 1933; Cecil, 1935).

Signs and symptoms of congestive heart failure are frequently found and are of considerable importance in confirming the diagnosis of coronary thrombosis. The signs of congestive heart failure, as usual, evidence themselves in the lungs. Pulmonary edema is almost a constant finding in all cases of coronary thrombosis, and it manifests itself as moist rales in the bases of both lungs and diminished breath sounds in both lungs. There may be, in rare cases, an acute pulmonary edema and in these cases the patients always die, according to Levine and Tranter (1918), Parkinson and Bedford (1928), and Moore and Campbell (1929).

According to White (1926) acute emphysema frequently occurs with a resulting wheezy, asthmatic, prolonged expiration, cough, and a pink, blood-tinged frothy sputum or frank hemoptysis. This complication is not mentioned by other writers, however.

After the first signs of congestive failure appear they may recede, remain stationary, or progress. If

;hey progress, one may find the liver enlarged and ;ender, the abdomen quite rigid, and an icterus especially noticed in the sclera, due to hepatic ;ongestion. Here again, the unwary may make an erroneous diagnosis of gall bladder disease (Levine and Brown, 1929).

Physical examination of the heart itself may ;ield important data. The most constant heart findings are: faint, distant heart sounds, increase in rate usually between 100 and 120, enlargement of the heart, and an apex impulse, neither visible nor palpable. Murmurs, irregularities, and pericardial friction rub also frequently occur but are not as common as the above findings (Levy, 1932; Wearn, 1923; Levine, 1929; Bancker, 1933; Cecil, 1935).

All of the heart tones are in the great majority of cases muffled or distant, and this is especially true of the first sound at the apex. In fact, the first sound may be entirely absent, (Levine 1929). Many authors stress the tic-toc rhythm which is frequently heard (Bancker, 1933).

The murmur usually heard is an apical systolic murmur due to a functional mitral regurgitation (Herrick, 1931). This murmur is found in approximately one-half

of all cases (Levine, 1929).

Irregularities of the heart are frequently observed after thombosis. A gallop rhythm and pulsus alternans seem to be the two most frequently seen (Parkinson and Bedford, 1928; Levine, 1929; Herrick, 1931; Levy, 1932).

Levine (1929) lists the following as the most frequent irregularities to appear: (1) premature beats, (2) heart block, (3) drop beat, (4) auricular fibrillation(paroxysmal and absolutely regular), (5) ventricular tachycardia, (6) gallop rhythm. Bancker,(1933) lists: (1) heart block, (2) premature contractions, (3) auricular fibrillation, (4) paroxysmal tachycardia, and (5) inter-ventricular block as those appearing most frequently.

A pericardial friction rub, when it occurs usually appears from 24 to 72 hours after the onset of an attack (Berger, 1936). It occured in 20 of Levine's 145 cases (13.8 per cent) although he says the incidence is probably higher than that. Cecil (1935) finds that the friction rub is detected clinically in 15 per cent to 20 per cent of cases. He also believes the incidence is higher than the figures would indicate.

The friction rub is heard over the precordium

near the left nipple towards the sternum and is a to-and-fro rub (Levine, 1929). Although it does not occur very often and frequently when it does appear it is extremely transient, the importance of searching diligently for this important sign cannot be overestimated because when found, it proves the diagnosis without doubt. Wearn (1923), Moore and Campbell (1929), Herrick (1931), and Levy (1932) also mention the importance of the pericardial friction rub, but give no indication as to the frequency of its occurence.

Symptoms of a necrosing heart muscle are usually found 24 to 72 hours after the onset as evidenced by fever and leucocytosis. The fever and white count vary with the size of the infarct, although they are of little use in the determination of the extent of the damage.

Wearn (1923), Moore and Campbell (1929), and Berger (1935) find the average temperature to be from 100° to 102° F., and that it usually persists from 3 to 14 days. Levine and Brown (1929) stress the point that the temperature should be taken rectally, because due to the dyspnea, shock, etc., the temperature by mouth may be 97° to 98° F., while at the same time, the rectal reading is 100° to 102° F. He finds that the

temperature is present a few hours after the onset, and as rule, persists from 1 to 2 days, although it may last for 1 or 2 weeks. The average temperature is usually 100° F. and it disappears gradually over the course of the disease. Bancker (1933) finds the temperature to be lower than most authors, saying it ranges from 99° to 100° F. He also mentions that it varies with the size of the infarcted area. Parkinson and Bedford (1928) maintain that in the initial stage the temperature may be subnormal, but on the first or second day rises to 99° to 102° F. persisting from 3 to 10 days.

Leucocytosis varies from 12,000 to 20,000 and may persist from 1 to 3 weeks.(Moore and Campbell (1929). It may, however, go as high as 30,000 (Levy, 1932; Bancker, 1933). Most authors agree, however, that the typical count is from 12,000 to 15,000 with an average of 80 per cent to 90 per cent polymorphonuclear cells (Wearn, 1923; Parkinson and Bedford, 1928; Levine and Brown, 1929; Berger, 1936).

Many authors mention the patients extreme anxiety, restlessness, and fear of impending death. They attach much importance to these findings, maintaining that in no other disease is the anxiety and fear of impending

death so marked (Parkinson and Bedford, 1928; Levine, 1929; Moore and Campbell, 1929; Bancker, 1933; Berger, 1936). The extreme weakness of the patient is also an important sign which is almost always present.

Urine findings which are not uncommon are: suppression of urine, albuminuria, casts, and a glycosuria, even when the patient is not a diabetic. The albuminuria is transitory and usually appears in the first few days of the attack (Wearn, 1923; Moore and Campbell, 1929; Levine, 1929).

There are many bizarre and atypical symptoms which may be found in some attacks of coronary thrombosis, but since they are not included in the aim of this thesis, and time and space is limited, they will be omitted.

The diagnosis of acute coronary thrombosis can usually be made at the bedside using the physical signs and the history as the criteria, but the electrocardiogram has added much to the accuracy of diagnosis especially in those cases with atypical symptoms. The general practitioner, however, as a rule does not have access to the electrocardiogram so it does not have the value of a keen diagnostic ability. In the hands of a specialist the electrocardiographic changes are, in most cases, so characteristic that no other criteria is necessary to make a diagnosis of coronary thrombosis. The electrocardiographic changes vary of course with the artery affected.

The most reliable electrocardiographic evidence of coronary thrombosis according to Levy (1936) is a definite sequence of characteristic modifications of the ventricular complex. These changes begin to develop immediately after the accident and may require several months to complete their evolution. The tendency of the ventricular complex to change from day to day in a typical manner is of great diagnostic importance.

Cecil (1935) lists the following electrocardio-

graphic changes as pathognomonic of coronary thrombosis. They are:

(1) Disappearance of the iso-electric interval separating the end of the Q-R-S complexes from the beginning of the T wave, the returning S-T. line becomes a direct continuation of the S wave or of the R wave in the absence of an S.

(2) An elevation or depression of this R - T or S - T line as compared with the level of the iso-electric line.

(3) A sharp inversion of the T wave which is commonly preceded by a rounded hump in the S - T line, giving rise to what is called a cone - plane T wave. He lists other frequent abnormalities which are not pathognomonic as: diminution in the amplitude of electrocardiographic waves; slurring or splintering of the Q-R-S complexes and the development of a large Q wave in the third lead. He also emphasizes the fact that the electrocardiographic picture is prone to change from day to day and is of great importance in the diagnosis.

Parde (1920) makes the following observations: "The characteristic changes appearing in the electrocardiogram after a day or two are: The Q-R-S group is usually notched in at least two leads, and usually shows left ventricular preponderance. The T wave

doesn't start from the zero level of the record in either lead I or II though perhaps from a level not far removed from it, and in this lead quickly turns away from its starting point in a sharp curve, without the short straight stretch which is so evident in normal records preceding the peak of the T wave. The T wave is usually of larger size than customary and accordingly shows a somewhat sharper peak. The T wave is usually turned downward in lead II and in one other lead. Not all of these changes are to be found in every record, but enough of them are present to give it a characteristic appearance."

Master, Jaffee and Dack (1932) confining their report to P wave changes found that 80 per cent of their series of 40 cases showed definite P wave changes. The P wave amplitude was increased at least 0.5 mm. and occasionally there was notching or widening of the auricular complex. These changes were most frequent in leads I and II and appeared early in the course of the disease. The P waves were found to be larger when the R-S - T changes were present and returned to normal when T wave inversions appeared.

There has been considerable research done in attempting to localize the infarcts specifically

but so far the success has not been great (Robb,Hess and Robb, 1934). There has been success, however, in interpreting the electrocardiogram so that one can be reasonably sure whether the right or left coronary is the artery envolved. Bell and Pardee (1930) found that when the left coronary artery or one of its branches was envolved there was an associated inversion of the T wave in lead I or in leads I and II, whereas thrombosis of the right coronary artery was associated with inversion of the T wave in leads II and III. Ball (1932) also confirms the above work.

Parks (1931) published an interesting report in which he describes the electrocardiographic changes in a man after ligation of the descending branch of the left coronary artery. He found definite changes in the T wave. (a) Definite elevation of the take-off in lead I and depression of the R-T interval in lead III within 10 minutes after the operations. (b) Maximum changes within 48 hours. (c).In leads I and II it gradually descended on R and became iso-electric in 12 days inverted in 16 days and upright in 77 days.

This chapter of electrocardiographic changes in coronary thrombosis is just a resume' of some of the ideas of different authors. If the reader desires

a more complete and comprehensive review the author refers him to Chapter XII, The Electrocardiogram in Disease of the Coronary Arteries" written by Frank N. Wilson found in Dr. R. L. Levy's book, "Diseases of the Coronary Arteries and Cardiac Pain", the Macmillan Company, N.Y., 1936.

Prognosis.

There are few diseases in which the prognosis in any individual case is more difficult to predict than in coronary thrombosis (Levine, 1929). In general, however, it can be said that the patients with milder symptoms and in the younger age group have the more favorable outlook. This is only a general rule and should not be relied upon, because young patients having mild symptoms may be progressing nicely and then die suddenly, or an older individual with severe symptoms may progress to an apparent complete recovery. For this reason the prognosis in all cases should be guarded until a few weeks have elapsed, also, every effort in the way of treatment should be carried out regardless of the condition of the patient (Levine, 1929).

Wolferth (1937) says that, in general, the mortality rate is influenced by: (1) age of the patient (the rate being lower for relatively young people than for the older group), (2) number of attacks (the mortality is much less for the first than for subsequent attacks), (3) severity of clinical manifestation (higher mortality for severely ill patients), and (4) electrocardiographic appearances (according to Conner and Holt (1930), the patients who show minimal electrocardiographic abnor-

malities have a more favorable outlook than those with marked electrocardiographic changes).

Wood, Bellet, McMillan,and Wolferth (1933) find that posterior infarction offers a better prognosis than anterior infarction. Willius (1936) however, in his series of 370 cases, did not find this to be of any influence on the death or survival of a patient.

The general immediate mortality of coronary thrombosis was 53 per cent in Levine's (1929) 143 cases, 16.2 per cent in Conner and Holt's (1930) 287 cases, 40 to 50 per cent in Parsons-Smith's (1930) series, and 20.7 per cent in Master, Jaffee and Dacks'(1936) series of 267 cases. These figures are not a fair comparison, however, as Levine considered the mortality rate counting all patients that died, while other authors just included those patients dying during the acute attack. In general it can be said that persons in their first acute attack of coronary thrombosis have an even chance to survive (Levine and Brown, 1929).

The life expectancy of the patient is very important, and the various authors again have widely different figures. Levine (1929) finds in his 143 cases that the average length of life is 24 months. White and Bland (1931) in an analysis of 200 cases find the

following: Of 101 cases known to be dead, the average duration of life after an acute infarction was 1.5 years with a range from a few hours to 11 years, of 94 cases known to be alive, the average duration was 3.2 years with a maximum of 17 years; the 195 cases had an average expectancy of 2.4 years. Five cases were not traced. White (1926) in his series found that the average duration of life of the patients that had died was 15 months with a range of a few hours to 7 years, while the average duration of life of those patients still living was 24½ months. Parsons-Smith (1930) finds that if the patient doesn't die in the acute attack the life expectancy is from 3 to 5 years.

Age as a Factor in Prognosis. - It is generally agreed, by all authors, that the younger patient with coronary thrombosis offers a better prognosis than does the older patient. In Levine's (1929) series the average age of the patients dying was 61 years, while the average age of those who recovered was 54.7 years (Levine, 1929 ; Wolferth, 1937). White (1926), however, claims that the age of the patient makes no difference in the prognosis. Master, Dacks and Jaffee (1937) compiled an interesting chart showing the age of the patients, and

the percentage of the patients that died. The percentage of patients dying rose steadily with their age. The average age of the patients who died was 57 years while the average age of the series was 54 years. Their chart will be shown here.

Age	Per cent of Attacks	Per cent of Patients Dying
27 - 39	8 %	10 %
40 - 49	23 %	13 %
50 - 59	32 %	15 %
60 - 69	27 %	21 %
70 - 87	10 %	22 %

Number of Attacks as a Factor in Prognosis.- It s generally agreed, by all authors, that the mortality ate is higher in subsequent attacks that it is in the irst attack of coronary thrombosis (Levy 1936; Wolferth, 937).

Master, Dacks and Jaffee (1936) found in their eries that the mortality rate in the first attack was per cent, in the second 22 per cent, and in the third 6 per cent. The mortality rate for all attacks was 6.5 per cent showing clearly that the mortality rate s much higher in patients suffering from a recurrent ttack than in those with their first attack.

Severity of Clinical Manifestations as a Factor in Prognosis. - Conner and Holt (1930) based the severity of symptoms on the intensity and duration of pain, degree, of dyspnea, severity of shock, pallor, sweating, vomiting, blood pressure fall, and changes in the pulse, and found there was a much higher mortality in patients with severe symptoms than in those with a mild course. Their chart follows:

Severity	Patients Dying		Patients Recovered	
	No.	%	No.	%
+++	28	68%	41	31%
++	9	22%	56	43%
+	4	10%	34	26%

Master, Dacks, and Jaffee (1937) went into detail on the prognostic value of different symptoms and signs, and have interesting figures which may help in predicting the outcome of an attack of coronary thrombosis. They are:

(1) Those showing cardiac insufficiency and heart failure. The mortality rate of those with heart failure was 30 per cent, of those without 4 per cent.

(2) Pulse rate. A fast pulse was considered to be a sign of cardiac strain. A slightly elevated

or normal pulse was found to be a good prognostic sign.

(3) Pulse pressure. A pulse pressure of below 20 mm. of mercury was found to be a bad diagnostic sign. 58 per cent of patients showing this died.

(4) Heart sounds. Faint heart sounds offered a poorer prognosis and the mortality rate of patients with poor heart sounds was 29 per cent, with fair heart sounds 9 per cent.

(5) Gallop rhythm. A gallop rhythm was found to be a poor prognostic sign, the mortality rate being 38 per cent while that of the general series was 13 per cent.

(6) Arrythmias. The arrythmias were found to be of no importance in the prognosis.

(7) Respiratory rate. If the respiratory rate was found to be above 28 per minute the prognosis was much poorer.

(8) Orthopnea. In patients showing orthopnea the mortality rate was 43.5 per cent. In those without orthopnea it was 3 per cent.

(9) Shock with cyanosis. In these patients the mortality rate of 29 per cent compared to a mortality rate of 9 per cent in patients

without cyanosis.

(10) Fever. In patients with a fever of less than 101°F the mortality rate was 18 per cent. If the fever was 101° F or higher the mortality rate was 26 per cent.

(11) Leucocytosis. Patients with a leucocytosis of less than 10,000 showed a mortality rate of 4 per cent; 10,000 -- 14,000 the rate was 26 per cent; 15,000 -- 19,000 was 31 per cent; and 20,000 or more, 22 per cent.

(12) Hypertension preceding the attack. In those patients, who were known to have had hypertension preceding the attack, the mortality rate was 24 per cent. In those patients without a previous hypertension it was 16 per cent.

Not all authors agree with all of the findings in the above chart although they agree with parts of it. White and Bland (1931) find that a previous hypertension is unimportant but agree that congestive failure, poor heart sounds, and cardiac enlargement add to the gravity of the prognosis. White (1926) maintains that hypertension is unimportant, agrees that poor heart sounds and congestive failure offer a graver prognosis, and also says that the occurence of pericarditis

gives a graver prognosis. Levine (1929) agrees that the degree of collapse and prostration are factors in the prognosis, and mentions unconsciousness as being a very grave sign. He believes that extra systoles, auricular fibrillation, and pericarditis do not alter the prognosis, but that the occurence of a heart block and ventricular tachycardia are grave prognostic signs. Ernstene (1929) looking on the brighter side, finds that a progressive rise in blood pressure and the improved strength in heart sounds are good prognostic signs.

In general it can be said that almost all authors agree that sex, a previous angina, previous syphilis, and hypertension do not alter the prognosis of coronary thrombosis (White, 1926; Levine, 1929; White and Bland, 1931).

In conclusion, the author cautions the practitioner to always give a guarded prognosis in a case of coronary thrombosis, no matter how mild the case appears to be.

Course of the Disease.

There is probably no disease that starts so abruptly and with so little immediate warning as does coronary thrombosis. One minute a man is well and healthy, and the next he is dead or at death's door in excruciating pain. This pain, as described in the

chapter of signs and symptoms, may last for a varying length of time, usually from a few hours to a few days. The accompanying symptoms of shock and dyspnea are usually of approximately the same duration or perhaps last a little longer. Sudden death is not uncommon during this period and is usually due to ventricular fibrillation (Levy, 1932; Wolferth, 1937). Death may be almost instantaneous or may occur within a few minutes. Herrick as early as 1912 described the instantaneous death as seemingly painless and with no agony or distortion of features (Herrick, 1912). White and Wolff (1925) also comment upon the absence of terminal respiratory agony, distortion of features, and muscular contractions.

If the patient survives the immediate severe attack, the pain gradually diminishes leaving the patient very weak. Dyspnea or Cheyne-Stokes respiration may continue for a considerable time. The patient runs a slight fever and has a leucocytosis for about a week. On the whole, however, the patient feels very good when one considers the severity and seriousness of his disease. It is during this period that the patient's activity must be guarded very closely and the clinical course followed diligently, because

most of the complications appear during the first week.

At the end of the first week or two, if no complications have intervened and the patient is making a favorable recovery, the only objective sign may be a slight dyspnea. The patient, however, will probably still complain of some weakness, but may feel as well as he has anytime before the onset of the attack.

Hyman and Parsonett (1931) classify the course of the disease into three stages. They are: (1) stage of shock, pain and prostration, (2) 3rd to 10th day signs and symptoms of necrosing heart muscle, and (3) the stage of convalescence.

Complications.

The complications of coronary thrombosis usually occur during the first week of the disease and, in the majority of cases, these complications offer a more serious prognosis and often result in the death of the patient.

McNee (1925) lists the following as the common complications to watch for. They are: aneurysmal dilatation, cardiac rupture, and embolism. He believes that an embolus is the most common of

of the three. Brown (1930) lists irregularities, mural thrombus, embolism, fibrinous pericarditis, rupture of the heart, acute pulmonary edema, and congestive heart failure as the common complications.

Rupture of the heart. - Berger (1936) finds that rupture of the heart occurs in 3 per cent of cases and usually occurs in the 3rd or 4th week of the disease. The most common site for the rupture is at the apex. It is usually linear and is most commonly verticle or oblique. Death, of course, always follows this complication.

Mural Thrombus and Embolism. - A mural thrombus is formed so often over the site of an infarct that it could be considered a part of the picture of coronary thrombosis rather than a complication. Its importance lies in the fact that it is from this mural thrombus that emboli enter the blood stream and are disseminated to various parts of the body. The danger from embolism exists until the thrombus becomes fully organized, which is, in the majority of cases, about thirty days. The emboli may lodge in any part of the body, but the most common site is in the pulmonary arteries. Conner and Holt (1930) in their series of 287 cases found pulmonary embolism in 21, cerebral artery

embolism in 14, and 28 cases showed emboli in other arteries of the body. The lodgement of emboli may, of course, give rise to a variety of symptoms, depending upon the artery and organ involved.

Aneurysm. - An aneurysm of the heart wall may occur and always appears at the site of the infarct. After infarction, when the infarcted area is replaced by connective tissue, a weak portion remains at this site. The constant internal pressure stretches this area and an aneurysm is formed.

Cardiac failure. - Cardiac failure or decompensation is another common complication, and it may be acute with resulting death of the patient, or it may be gradual with death ensuing, or the patient may be incapacitated with a partial decompensation for a number of months or years.

Heart Block and Ventricular Fibrillation. - Heart block and ventricular fibrillation are seen frequently and are almost invariably fatal. The diagnosis of these two conditions is not easy unless an electrocardiogram is taken just before death. Negative post-mortem findings, except for those of a typical infarct,are suggestive because they leave no pathology which can account for a sudden death (Fulton, 1925).

DIFFERENTIAL DIAGNOSIS

Almost any condition capable of producing acute pain or distress in the same area as coronary thrombosis may at one time or another present a problem in differential diagnosis (Wolferth, 1937). The most common difficulty is to distinguish an attack of coronary thrombosis from one of angina pectoris (Levine, 1929). The next most common is to differentiate coronary thrombosis from some of the acute abdominal conditions such as perforated peptic ulcer, gall stone colic, acute pancreatitis or ptomaine poisoning (Reisman, 1923; Acker, 1919). Many other conditions are mentioned some of which are; acute appendicitis and acute intestinal obstruction (Bancker, (1933); pulmonary infarction and spontaneous pneumothorax (Parkinson,1932); mesenteric thrombosis, diabetic crisis and diabetic acidosis (Reisman, 1934); pneumonia and diabetic coma (Levine, 1929). The list could be carried on indefinitely because typical and atypical attacks of coronary thrombosis with their complications can simulate almost any condition in the body.

The differentiation between coronary thrombosis and angina pectoris although it may be difficult, can usually be made with a fair degree of certainty.

This differentiation may however require some study. The following table copied from Stroud (1931) has been used by many authors, who will not be listed, as a criteria for a differential diagnosis. It is an easy and comprehensive way to present this more or less difficult problem.

Differential Diagnosis of Angina Pectoris and Coronary Thrombosis.

	Angina Pectoris	Coronary Thrombosis
Onset	During exertion	Often during sleep or rest
Site of pain	Sternum, often mid-sternum	Sternum, often lower half or epigastrium
Attitude	Immobile	Restless
Duration of pain	Minutes	Hours or days
Shock	Absent	Present
Dyspnea	Absent	Often present
Vomiting	Rare	Common
Pulse	Unchanged	Small, often rapid and irregular
Temperature	No fever	Fever follows
W.B.C.	Normal	Raised
Blood pressure	Normal or rise	Fall
Heart sounds	Normal	Distant, sometimes gallop rhythm or pericardial friction rub
Congestive failure	Absent	Commonly follows
Electrocardiogram	Often normal	Often diagnostic

Of considerable importance is that group of patients who present a picture simulating an acute surgical condition of the abdomen. Among the older practitioners, he who hasn't operated upon one of his patients with a diagnosis of acute gall bladder colic, perforated peptic ulcer or some other abdominal condition, to find to his sorrow that the patient was suffering from a coronary thrombosis, is extremely lucky to say the least. However, with the illiciting of a previous history of angina, the presence of a pain mainly in the epigastrium with possibly a falling of constriction in the sternum, a squeezing ache in the arms or the presence of some dyspnea during the attack, the correct diagnosis may be made (Levine, 1929). The electrocardiogram, if available, is tremendously helpful in these cases and when combined with auspicious heart findings should confirm the correct diagnosis without much doubt.

A diabetic acidosis may be confused with coronary thrombosis due to the shock, stupor and dyspnea found in both conditions. The patient with coronary thrombosis frequently shows sugar in the urine further complicating the true clinical picture. The electrocardiogram again is helpful in the diagnosis and should be used when the physician is in doubt.

Pneumonia, with symptoms of pain in the chest, rales, dyspnea, cough, fever and leucocytosis which are commonly found in coronary thrombosis, may lead one to an erroneous diagnosis. The pain is usually sternal in coronary thrombosis and lateral and aggravated by breathing in pneumonia. The heart findings are again important and the electrocardiogram although helpful, should not be relied upon entirely as E K G in pneumonia may present a somewhat similar picture. A flat X-ray plate of the chest will of course definitely make, or rule out, a diagnosis of pneumonia.

Acute cholecystitis or cholelithiasis is worthy of mention because outside of angina pectoris there is probably no condition for which coronary thrombosis is so often mistaken. The difficulty is in the location of the pain, which may be the same in both instances, and the symptom of jaundice which may occur in coronary thrombosis. The gall bladder function tests are of little value because the patient of this age may frequently have a non-functioning gall bladder. The history may be misleading because too mild gall bladder attacks may be twisted into a history of angina by an over-zealous questioner. The diagnosis then, should rest upon a careful examination of the

cardio-vascular system especially the heart and the electrocardiographic findings.

To the above discussed list may be added pulmonary embolism, fibrinous pleurosy, neuroses, arthritis of the spine, etc., but a detailed discussion would be too lengthy for the time or space permitted for this thesis.

The discussion of the treatment of coronary thrombosis will be divided into four phases as used by Niehaus. They are: (1) onset or acute stage, (2) the healing phase, (3) the convalescent, and (4) the permanent management. In addition, a chapter on the management of complications will be included.

The treatment of coronary thrombosis should be designed to afford a maximum degree of rest for the injured heart and to maintain a circulation sufficient to sustain life during the period of its recovery (Levy, 1936).

Onset. Pain.

There are two measures that practically all authors agree are indicated at the onset of coronary thrombosis. These are, complete physical, mental, and emotional rest, and the control of the intolerable pain by the use of adequate amounts of morphine hypodermically. Although all authors agree that morphine is the one drug that is indicated in all cases with pain, they all have minor differences in the dosage and manner of giving the drug. In reality the drug should be given in doses large enough and frequently

enough to accomplish its desired action of controlling the pain and allowing the patient to rest. Nevertheless, the author will give the methods of administration of this drug used by some of the leading cardiologists in the world. It is only fitting that S. A. Levine's method should be given first as he is certainly one of the men best qualified to treat coronary thrombosis. Levine (1929) says that the morphine should be given subcutaneously, and the initial dose should never be less than one-fourth grain. If it is anticipated that more than this amount will be necessary, the initial dose may be one-half grain. The administration should be repeated as freely and as frequently as necessary, and often a whole grain can be given in a few hours. When the desired effect is obtained the acute pain subsides, and, although a dull sense of oppression in the chest may remain, the patient is apt to fall asleep. If the pain returns, or if the patient is restless and cannot sleep and the patient's respirations have not been particularly depressed, further injections of morphine are indicated to assure rest during the following hours. If the morphine is of no avail and the patient still complains of intolerable pain, it is not inadvisable to administer

light ether anesthesia (Levine, 1929). Levy (1936) in his account agrees entirely with Levine's method of administration, although he mentions that pantapon, 20 milligrams (one-third grain) may be used as an equivalent to one-fourth grain of morphine. Bancker (1933) administers one-fourth to one-half grain at the initial dose and repeats the dosage every two hours if necessary. Christian (1925) uses an initial dose of one-half grain and then gives one-fourth grain every quarter hour until the pain is eased. Hyman and Parsonett (1931) give one-half grain as the initial dosage and find that 2 per cent of their patients require ether anesthesia. Master, Dack, and Jaffee (1937) believe that dilaudid is superior to morphine since it does not have as much of a constipating effect. Moor(1930) gives morphine, one-third grain, intravenously rather than subcutaneously and in one case, relieved the pain in 30 seconds. He makes the observation that he is sure this method of administration is effective but he is not sure of the safety of the procedure. Many other authors mention the use of morphine subcutaneously, but their methods, which are essentially the same as Levine's and Levy's are not worthy of mention. These authors are: (Reisman,(1923); White,

(1936); Gager, (1928); Brown, (1930); Parkinson, (1932) ; Master, Jaffee, and Dack, (1936).

Rest.

Complete physical, mental and emotional rest is regarded by many authors as the most important procedure in the treatment of coronary thrombosis. The objective is to protect as much as possible an already seriously damaged heart which may, with the slightest extra load, cease to function.

The patient should be put to bed immediately and should not be allowed to make the slightest exertion. Examination by the doctor should be as infrequent as possible, and visitors should be restricted (Levy, 1936). Levine and Brown (1929) mention that in some cases it is better not to move or undress the patient during the first few critical hours. The patients should not be allowed to feed themselves nor to turn over by themselves in bed. The bowels need not move in the first two or three days, and enemas as well as cathartics are contraindicated (Brown, 1930; Levine (1932).

Good nursing care is essential and here is one place where a good nurse can do more for the welfare of the patient than can the doctor with his case full of drugs. All writers agree that rest is an essential part of the treatment, but give no details as to how

it should be carried out, therefore, their names willbe merely listed. They are: Herrick, (1912); Reisman, (1923); Christian, (1925); White and Wolff, (1926); Gager, (1928); Brown, (1930); Parkinson, (1932); Kilgore, (1933); Master, Dack, and Jaffee, (1936) (1937).

Shock.

Shock occurs so frequently at the onset of coronary thrombosis that it can not be regarded as a complication of the disease but rather as part of the clinical picture.

The shock which is present is, of course, treated along with the pain when morphine is given. In addition, the patient should be kept warm with blankets and hot water bottles. The hot water bottles should be placed especially over the precardium and around the feet (Brown, 1930; Hyman and Parsonett, 1931; Berger, 1936; Master, Dack, and Jaffee, 1937). The patients head should be kept elevated in view of the dyspnea rather than lowered as it usually is in surgical shock (Berger, 1936). In addition to the above measures some authors, Bancker (1933), Levy (1936), Master, Dack, and Jaffee (1937), and Wolferth (1937), advocate the use of dextrose intravenously. Bancker (1933) uses 100 cc. of a 50 per cent solution, Wolferth (1937) 20 to 40 cc. of a 50 per cent solution, and Levy (1936)

50 to 100 cc. of a 50 per cent solution once or twice a day for the first few days.

In extreme shock and circulatory collapse, stimulating drugs may be used, especially if the blood pressure is under 100 mm. of mercury. Levine (1929) uses large doses of caffeine-sodium benzoate (0.5 to 1.0 gram), strophanthin, or adrenalin for this purpose. Brown, (1930) also advocates their use when the pulse is imperceptible, as does Christian (1925).

Administration of Oxygen in the Treatment of Dyspnea.

Most authors agree that the administration of oxygen is helpful in many cases of coronary thrombosis, but they disagree somewhat on the indications which call for its use. Kilgore (1933) gives oxygen routinely, a 50 percent concentration by means of an oxygen tent. He maintains that it relieves pain and reduces the amount of morphine necessary. All of the other writers the author has read, reserve the use of oxygen for those cases which show signs of anemia or respiratory embarrassment. These are: cyanosis, dyspnea, and pulmonary edema (Master, Dack, and Jaffee, 1937); dyspnea, air hunger and Cheyne-Stokes respirations, (Levine, 1932); and Levy (1936) relies upon cyanosis and the clinical picture of rapid heart

rate, feeble heart sounds (often with gallop rhythm), labored breathing, persistently low blood pressure, and moist rales at the bases of the lungs.

According to Levy (1936) the most efficient method of giving oxygen is by means of a tent. The patient should be in the tent on an average of five days. The concentration at the onset should be 50 per cent which is gradually lowered to 35 per cent in a 24 hour period. During the following 12 to 24 hours, it is gradually lowered to 21 per cent. After removal of the tent, the patient should be carefully watched and if the heart rate increases more than 10 beats per minute, or the respiratory rate increases more than 6 a minute, the oxygen should be continued until such a time when these increases do not appear.

Barach and Levy (1934) reported the following responses to oxygen therapy:

(1) Subjective improvement occurred in from one to three hours after the administration of oxygen was begun. The relief from pain was striking. Respiration became less labored and slower. The patient was no longer restless. It was therefore, possible to curtail materially, or even stop entirely, the use of morphine and other sedatives.

(2). Cyanosis was diminished or abolished.

(3) . Cheyne-Stokes breathing if present, gradually disappeared.

(4). The temperature in cases in which it was elevated, tended to fall.

(5). The heart rate became slower, the heart sounds grew stronger, and the volume of the pulse improved. Signs of congestion in the lungs became less marked. As the state of circulation improved, the arterial pressure rose and the venous pressure fell.

(6). Interruption of oxygen therapy before adequate readjustment of circulatory conditions had taken place, resulted in recurrence of the symptoms and signs just mentioned.

Levy (1936) goes on to say that these beneficial effects are not found in every case, but in some instances, oxygen may be responsible for saving a life.

Medication Other than Morphine During Acute Stage.

The purine bases have been used by various men in the treatment of coronary thrombosis. Berger (1936) says (1) they act as coronary dilators producing a sustained increase in the flow of blood through the nutrient coronary vessels, and, thus insuring a better blood supply to the myocardium; (2) they act as diuretics and thus assist in getting rid of any edema incident to myocardial weakness.

Many different purine "bases" are used. Reisman (1923) advocates the use of caffein-sodio-benzoate. Kilgore(1933) advocates the routine use of theobromine 0.6 gram, 3 times a day; Master, Dack, and Jaffee (1937) theophyllinethylenediamine used intravenously, and Bancker (1933) and Smith, Rathe, and Paul (1935) the use of euphylline or theophyllin. Theoretically, these drugs should be of some value, but actually there is some doubt as to their actual beneficial effects (Levy 1936). It is generally agreed, however, that they do no harm, so certainly they should be given a test.

Levine (1932) and Kilgore (1933) advocate the routine administration of quinidine sulphate, 0.2 gram, 3 times a day for 10 to 14 days as a prophylaxis against paroxysmal ventricular fibrillation, which is one of the common causes of death. Brown (1930) and Master, Dack, and Jaffee (1937) also Bancker (1933) do not believe in its routine use but reserve it for the complication of paroxysmal ventricular tachycardia and auricullar flutter. Berger (1936) states that the drug tends to slow the heart, increase the refractory period, and also decrease the irritability of the heart.

Medication Contraindicated.

It is generally agreed by all authors that digitalis

is contraindicated during the acute stage of coronary thrombosis, although it is used in the intermediate stage where there are signs of congestive heart failure (Gager, 1928).

Master, Jaffee, and Dack (1936) maintain that nitroglycerine, amyl nitrate, adrenalin and ephedrine are contraindicated, while Brown (1930) uses nitroglycerine routinely if the blood pressure is above 100 mm. of mercury and adrenalin, 0.5 cc. intermuscularly when the pulse is imperceptible. Most authors agree with Master, Jaffee, and Dack however, and reserve the use of the nitrites and adrenalin to extreme emergencies.

Insulin is another drug which is contraindicated after an acute thrombosis. Berger (1936) recommends that the diabetic who develops coronary thrombosis should not receive insulin for 30 to 60 days after the attack, because it may increase the pain, increases the burden on the heart and may precipitate another attack. Levine (1932) and Kilgore (1933) are of the same opinion.

Antisyphilitic medication should also be suspended for 1 or 2 weeks when a luetic develops coronary thrombosis. Berger (1936) believes the arsenicals predispose to thrombosis in the luetic patient when

the coronary arteries are diseased. When antiluetic treatment is started during convalescence, potassium iodide by mouth, mercury by mouth or intramuscularly should be used (Levine, 1932; Kilgore, 1933).

Treatment During Healing Stage.

The treatment during the healing stage consists in the main of rest, diet, and the management of the complications as they present themselves.

Rest. - Rest is just as important, if not more so in the healing stage, as it is in the acute stage because the necrosed heart muscle is weakest at this time and the danger of rupture of the ventricle cannot be overemphasized. The patient should have continued mental, emotional, and physical rest which is more difficult to obtain because he may feel well and want to get up. A bed pan should be used and the bowels regulated by enemas, and a mild daily cathartic may be given to prevent dessication of the stools and the resultant straining which is very disturbing and exhausting (Levine and Brown, 1929).

Bed rest should be prolonged. Parkinson (1932) and White and Wolff (1926) recommend one month; Brown (1930) Levine (1932) and Kilgore (1933) four to six weeks; Christian (1925) six weeks; and Bancker (1933)

two months as a minimum. Sedation for rest should be continued in this stage. Bromides and luminal are usually sufficient. Brown (1930) and Levy (1936) recommend barbituric acid derivatives or other hypnotics such as the bromides and chloral.

Diet. - The diet is an important part of the management during this stage. Most authors advocate a light diet with small meals given frequently. The light diet is especially important in obese overweight patients (White and Wolff, 1926). Kilgore (1933) advocates a high dextrose and vitamin C diet, claiming that the infarct will heal more swiftly under this regime. Levy (1936) reserves the use of undernutrition therapy for obese patients and those with peristant congestive failure. Master, Jaffee, and Dack (1936) enthusiastically favor undernutrition therapy. They maintain that it diminishes the patients pain after the first or second day and if the regular diet is resumed, the pain soon recurrs. Small meals were found to be the most agreeable.

They found that a decreased amount of food reduced the basal metabolic rate which in turn reduced the cardiac output. The basal metabolic rate was lowered as much as 20 to 30 per cent and the pulse rate fell to 50 to 60 beats per minute and occasionally to 45

beats per minute with a drop in the basal metabolic rate of 30 per cent. They showed that there was a 40 per cent reduction in the work of the heart. The following table shows the results of their work.

No. of Calories given	B.M.R.	Pulse Rate	Blood Press. Syst.	Blood Press. Diast.	Cardiac output	Cardiac work K.G.M./min.
800	-30	58	96	65	2.76	3.0
2000	- 5	71	128	86	4.15	5.9
Change due to low diet	-25%	-18%	-25%	-24%	-32%	-49%

This 800 calory diet is maintained for 3 to 6 weeks and consists of 100 gm. of carbohydrate, 50 gm. of protein, 20 gm. of fat, and vitamin and calcium. The diet in detail is given in the following chart:

Breakfast	Menu
100 gm. 12% fruit	½ medium orange
10 gm. cereal	2 tablespoons cooked cereal
200 cc. skimmed milk	1 cup milk (skimmed)
1 egg	1 egg
15 gm. bread	½ slice bread
Dinner	
60 gm. meat	2 oz. meat
100 gm. 12% fruit	3 plums
100 gm. 3% vegetable	½ cup spinach
15 gm. bread	½ slice bread

Supper

1 egg	1 egg
100 gm. 3% vegetable	¾ cup canned string beans
100 gm. 12% fruit	1 medium peach
15 gm. bread	½ slice bread
200 cc. skimmed milk	1 cup milk (skimmed)

(After Master, Jaffee, and Dack, 1936).

Their comparison of the mortality of different treatments is interesting and is of a sufficiently large group of patients (267) to be significant.

	Mortality Rate	Mortality Exclusive first 24 hrs.	Mortality First Attack.
Regular diet-+-Digitalis & Nitroglycerine	39.7%	33.6%	36%
Regular diet only	40.5%	33 %	37%
Undernutrition only	20.7%	16 %	10%

In view of these findings one can see the extreme importance of placing a patient suffering from an acute coronary thrombosis on a strict dietary regime.

During this stage oxygen should be administered if dyspnea is present, and those men advocating the use of the purine bases and quinidine sulphate in the acute stage, also advocate their use here.

The Convalescent Treatment.

The treatment in convalescence is much the same

as the convalescent treatment any patient receives when he is recovering from a serious illness. The diet should again be restricted so that the patient never over eats. He should be encouraged to take life easy, and should be allowed to resume restricted activities gradually. Levine (1932) recommends that one week should be taken in the process of getting the patient out of bed. No medication is necessary except that which is symptomatic. Diabetic patients should not receive insulin if it is possible for them to get along without it, and luetic patients should receive heavy metals in their treatment rather than the arsenicals (Hyman and Parsonett, 1931; Bancker, 1933). The patient should not be allowed to use tobacco, according to Reisman (1923), Bancker (1933), Niehaus and Wolferth (1937).

The Permanent Management.

Little is known as to how to prevent recurrent attacks of coronary thrombosis.(Wolferth, 1937). His impression is that patients who are willing to live their lives on a restricted plane avoiding severe physical and mental strain, being careful in their habits of eating, drinking and relaxation, and obtaining abundant rest, do better than patients who are un-

willing to submit to this restraint. He also believes that those who stop the use of tobacco entirely get along better, but does not know whether to attribute this fact to the possibility that tobacco is harmful to patients with coronary thrombosis, or to the fact that those who stop the use of tobacco are more careful in other respects. Niehaus; and Reisman (1923) also advise against the use of tobacco.

Overweight patients should be reduced and the patient urged not to eat heavy, large meals.

White and Wolff (1926) believe the patients should be sent to a warm climate the winter following an acute attack. This is based on their belief that coronary thrombosis usually occurs in the winter months.

The permanent management of the patient who has had an attack of coronary thrombosis can be summed up by advising him to rest first and act afterwards.

Treatment of Complications.

Complications of coronary thrombosis usually occur in the first week or ten days, although they may occur at any time during the course of the disease (Levine, 1932).

Congestive Heart Failure. - Most authors agree that digitalis is indicated when congestive heart failure appears (White, 1926; Parkinson, 1932; Levine, 1932;

Bancker, 1933). Levine (1929), however, does not digitalize the patients until two weeks after the onset of the attack. Hyman and Parsonett (1931) advise the use of digitalis, but in conjunction use diuretics, mainly metaphyllin.

Kilgore (1933) and Master, Dack, and Jaffee(1937) believe digitalis is contraindicated at any time, and Master, Dack, and Jaffee give mercurial diuretics and ammonium nitrate discontinuing the use of morphine before beginning medication because it has an antagonizing effect on the mercury.

Paroxysmal Auricular Fibrillation.- Digitalis is useful in this condition, and if this does not control the attack, quinidine sulphate may be employed in doses of .4 gm. by mouth, given every 2 hours up to a total of 2 gms. during the first 24 hours. On the following day the amount may be increased up to a total of 3 gms., and on the third day a total of 4 gms. may be given (Levy, 1936). Levine (1932) starts with a dose of 0.3 gm. and increases to 1 gm., increasing the dosage every four hours until the desired effect is obtained.

Ventricular Tachycardia. - The proper treatment here again is quinidine sulphate, no other drug having any effect on the condition (Levine, 1929). Levine

and Levy find that patients with myocardial infarction tolerate the drug remarkably well, and Levy gives as high as 6 gms. in the course of 24 hours, while Levine has given as much as 1.5 gms. 5 times a day. After the heart has again become regular, small doses of quinidine, 0.2 to 0.4 gms. three times a day should be given(Levy, 1936).

Stokes - Adams Syndrome. - Epinephrine should be given in doses of 0.5 cc. hypodermically every hour. This usually clears up the condition in 48 hours; if not, the hypodermics should be discontinued and ephedrine sulphate given by mouth(Levine, 1932). Levy (1936) says that Stokes - Adams syndrome should be treated by the uses of epinephrine, 0.5 to 1 cc. of a 1;1000 solution, intermuscularly and the dose repeated at intervals of several hours as needed (Levy, 1936). Barium chloride, 30 mgm., given orally 3 or 4 times a day is also indicated (Brown, 1930; Bell and Pardee, 1930). Bancker (1933) gives 2 grains every 4 hours in the case of any type of heart block.

Ventricular Asystole. - In prolonged ventricular asystole, intracardiac injection of adrenalin is indicated. If ventricular asystole tends to occur,

ephedrine sulphate is sometimes an effective prophylactic. The dose is 30 mgms. given three or four times a day.

Persistent Auricullar Flutter. - In persistent auricullar flutter, the patient should be digitalized (Brown, 1930; Levine and Brown, 1932).

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