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ANGINA PECTORIS *

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I do not know of any greater service I can render the fellows of this institute and the public than by considering, from a very intimate acquaintance, the time-worn affection that forms the subject of this article. I cannot hope to add much that is new, but I confidently hope to call attention to vital points that may have been overlooked by some practitioners, though of the highest importance to sufferers from this malady.

Just at the beginning of the world war, Sir Clifford Allbutt published an exhaustive work on diseases of the arteries and angina pectoris, in which he presents many arguments against some of the long-accepted views on these subjects. But the very comprehensiveness of the two large volumes places the matter far beyond the time limit of the average practitioner, and almost beyond that of the specialist devoted to diseases of the circulatory organs. A careful study of Allbutt's work and an analysis of sixty histories of angina pectoris, out of the 1,396 cases of heart disease that I find among my records of private patients (exclusive of all dispensary and hospital cases) has considerably modified the views I formerly held on this subject. Many of the patients were seen in consultations with other physicians or came to me from a distance, so that I saw them only once or twice. In most of them I did not learn of the final result, and in very few, because of their being private patients, have I been able to see the pathologic changes. Allbutt has been able to make extensive studies of pathologic changes in this disease; therefore I cannot speak with assurance on points when my former impressions do not coincide with his; but from the clinical standpoint alone I feel confidence in my own observations, and the views I shall present in this paper seem to me sustained by the facts.

SUBJECT AND DEFINITION

Angina pectoris is a paroxysmal painful disease of the circulatory organs in which the pain is usually located near the base of the heart, over the large

arteries and in the shoulders, neck and arms, most frequently confined to the left side, but often in the right side. It is often attended by dyspnea and commonly by mental depression or a sense of impending death, which must not be confounded with fear. It is questioned whether the group of symptoms attending angina pectoris should be dignified as a distinct disease, especially since the pathologic findings vary in different cases; yet the variation is much less than in many other affections recognized as morbid entities, so called.

Most authors also recognize pseudo, false or mock angina, which is of nervous origin and commonly associated with intercostal neuralgia. This is much more common in young people than in old, and more frequent in women than in men, although only three fifths of my series of cases were in women, which is a much smaller proportion than I had supposed. It is not a serious affection, although the symptoms are not very different from those of true angina. A careful distinction must be made between these purely neurotic manifestations and mild attacks of true angina associated with diseases of the arteries or of the heart. The neurotic or vasovagal cases are not angina pectoris, although many cases commonly classified under this head are really true angina. Indeed, most cases of so-called pseudo-angina are manifestations of the true disease. Out of sixty cases I observed, twenty-eight were classified as pseudo-angina and thirty-two as true angina; but in the absence of pathologic demonstrations I am inclined to think that in some of them my diagnosis was at fault and that they should have been classed as angina minor, that is, mild attacks of the true angina. Pseudo-angina thus appears to be much less frequent than was formerly supposed.

Many authorities recognize angina sine dolore, which is accompanied by paroxysms of cardiac dyspnea, and is usually quickly fatal, but not attended by pain, or at least, not by severe pain. This is quite different in its manifestations from the angina with which we are most familiar. It is considered by Balfour as one of the manifestations of true angina pectoris; and its frequent appearance in persons who at times suffer from severe paroxysms of cardiac pain with a sense of impending death, together with pathologic findings, support Balfour's view.

The commonly accepted views of the frequency, etiology and prognosis of pseudo-angina, true angina and angina sine dolore, I think, would be changed by a careful study of the evidence presented in this work. Such a study, I feel, would make clinicians more careful in their diagnosis and more helpful in their treatment of patients.

* Read before the Institute of Medicine of Chicago, March 28, 1918.

† The material for this paper was gathered by Dr. Ingals during the past summer; but on his becoming exhausted and being required to take a complete rest, he secured the assistance of Mr. Meeker, who arranged the material in readable form.

MORBID ANATOMY AND PATHOLOGY

True angina is generally supposed to depend on disease of the coronary arteries, causing their contraction or obliteration and thus interfering with the nutrition of the myocardium. But if, as held by some observers, it more commonly results from disease of the aorta or possibly of some of the other arteries, we can more readily understand the diverse seats of pain and we can better realize why very often the heart is not at all disturbed even by most severe attacks. Myocardial disease is not essential to angina pectoris, although it is present in many cases. It also seems proved that angina does not occur in the majority of cases of coronary occlusion.

As for the mechanism by which the pain is brought on, it is probably due to excitation of the nerve end organs in the sheath of the ascending aorta and other large arteries. It is the kind of pain that belongs to fibrous tissues.

PREDISPOSING CAUSES

In my series of thirty-two cases, four were under 30 years; five between 30 and 40; six between 40 and 50; seven between 50 and 60; seven between 60 and 70; two between 70 and 80, and one of more than 80 years. It is thus more common between the ages of 50 and 70. It is more common in men, as may be seen by my series which included twenty men and eleven women. The use of alcoholics, tobacco and coffee predisposes.

It is asserted that syphilis is a factor, especially in those under 45 years old. Typhoid, rheumatism, gout and influenza predispose in patients of more than 45. In some mild cases in which the patients seem to be benefited by exercise, it is probably of gouty origin. In those past 50 years of age, arteriosclerosis and high blood pressure, especially if associated with diseases of the aorta, are etiologic factors. It also occurs with mitral stenosis, thrombosis and pericarditis. Angina pectoris and aneurysm are often coincident, but the angina frequently appears a long time before the discovery of the aneurysm.

Occupation.—It is a curious fact that out of thirty-two cases classified as true angina pectoris, nine were in physicians, or nearly 30 per cent. I saw two others that were not included in the list because they were not my patients. I attach no significance to these figures because I do not know why I was consulted by so many physicians; but they serve to emphasize the danger of drawing conclusions from incomplete statistics, and are at least suggestive as to syphilis as an etiologic factor.

EXCITING CAUSES

Some vasomotor disturbance, worry, muscular effort, or annoyance of any kind may bring on an attack. Pain frequently comes on during or after a meal, especially breakfast. Minor attacks of angina are brought on in the same way as the more severe. Only a few cases seem due to a single effort, but two of my cases certainly started in this way, and in X, whose history follows, the first distinct substernal pain was brought on by a rapid walk.

Among the various hypotheses regarding the origin of angina pectoris are distention of the ventricles, cramp of the heart muscle, myocardial ischemia, obstruction and spasm of the coronary arteries, and neuralgia, or vasomotor storm.

The coronary disease is considered a cause by most physicians, but it has been found that a large percentage of those with coronary obstruction have not

suffered from angina pectoris. If the process is gradual, a patient may live with 75 per cent. of the coronary lumen occluded, or even with complete obliteration. The spasm hypothesis also seems untenable, though a sudden obstruction of the coronary arteries may cause pain like angina pectoris. In many cases, even though the coronaries may be obstructed, the myocardium remains practically normal. Blocking of the coronary arteries causes dyspnea but often no pain. In a large proportion of fatal cases of angina pectoris, no obstruction of the coronaries is found; but in most fatal cases there is some change in the coronary arteries and myocardial degeneration. These changes, however, are not the cause of the pain, but are one of the chief factors of death during the disease. Often the rhythm of the heart is unchanged and the blood pressure is not affected by the painful attacks.

As to the immediate cause of the pain, there are convincing arguments to show that it is not due to cramp of the heart, to distention of the left ventricle, or to undue systolic effort. The experience of X leads me to coincide fully with these views. The pains seem to result from an exalted state of the sensory paths, which appear to be along the aorta and larger arteries. Arteries, whether inflamed or not, are capable of pain, as shown in embolism and on compression for aneurysms, and angina is usually the result of inflammation in the aorta and larger arteries. From his own sensation, X feels that much of his pain comes from this source, as indicated by the sudden feeling of distention and by the location of the pain. The suprasigmoid portion of the aorta is probably the most sensitive, angina resulting when the fibrous outer investment is reached. The fact that the use of iodids sometimes stops the horrible pain of aneurysm, and also often stops pain in angina, indicates that the pain in these two affections may be due to the same cause. Tension of fibrous structures in any part of the body may cause pain, and this tension is the principal factor in angina pectoris. At the base of the heart there is most likely a point of exalted sensibility to blood pressure. Perhaps all arteries have their degrees of sensibility to blood pressure.

If, as maintained by some, the disease results from an affection of the coronary arteries with degeneration of the myocardium, it is difficult to understand why the heart's action is commonly almost normal, and why the pain usually referred to the precordial region is commonly felt over the aorta and radiates along the course of the larger arteries. The theory that the real seat of the disease is usually in the arterial walls and often in the external coat accounts for the incidence of the pain much better than the older theory.

SYMPTOMATOLOGY

The physical signs are not characteristic, but often there is moderate enlargement of the aorta and enlargement of the heart in many cases. There may be an aortic murmur and the rhythm of the heart may be affected, but all these symptoms may be absent.

The blood pressure may be excessive, but usually it is not affected. The pulse commonly remains nearly normal, but often, although regular, it may run as low as 40 or 50, and it has been observed as low as 21 per minute. I recall three cases of abnormally slow pulse seen at nearly the same time with nothing in common but the pain.

Profuse sweating is not an uncommon symptom, and salivation occasionally occurs.

Fever may sometimes be present from the acute aortitis. The face may be pale, flushed or normal.

There may be restlessness and tremors.

Flatulence and gaseous eructations are generally present.

Dyspnea is not a characteristic feature, but when the heart muscle is weak, it is likely to be present.

The pain in angina is usually paroxysmal, rarely a steady grind. It may increase from slight to extreme anguish. It may be short and sharp for an instant only, but it usually lasts from several minutes to half an hour or more, and occasionally continues much of the time for days. Sometimes it is confined to the chest; at other times it radiates to one or the other arm, rarely to the thigh. It is located sometimes in the neck and occasionally in the throat or larynx. It is sometimes felt on the radial side of the arms and may run down to the thumb. In some erratic cases, the pain may be confined to the periphery, as to the palm of the hand, or to a finger, and in one of my cases it was often felt in the rim of the ears. It may also be felt in the epigastrium, the apex of the heart or the abdomen. There are some cases in which the patient has a horror but an absence of pain. Angina without pain (*angina sine dolore*) is comparatively rare, but may be the cause of death in many of those who die suddenly without symptoms.

The heart pain in angina pectoris is usually said to be precordial; but in reality it is nearly always felt at the upper part of the sternum over the aorta. In one case that I have observed, it started in the region of the left subclavian and was so constant that the patient, a physician, believed there was an aneurysm of this artery. With X it usually started over the brachial artery in the middle of the right arm.

When the aorta is the seat of the lesion, the pain on exertion is likely to radiate to the shoulders, and it generally extends down the left arm, the reason for which proceeding is not apparent. It is sometimes relieved by eructations of gas, and such cases are very likely to be attributed to indigestion. In a few instances paresthesia or even paralysis of the arm follows the attack.

Immobility from a fear to move, or a feeling that one cannot move, is a common symptom. The feeling of impending death or of horror is not a reasonable apprehension, nor yet a fright, but an organic sensation, a feeling as though everything was going and nothing mattered. It may occur in only one or a few of the attacks, and sometimes is altogether absent.

The history of a single case illustrates most of the features of this disease so well that I will present it briefly at this point.

REPORT OF CASE

When 63 years of age, Dr. X suffered a comparatively mild attack of typhoid fever in which the temperature never exceeded 103.5 F. He was not delirious, lost only about 30 pounds in weight, and was confined to his home only three months. He had suffered from no infection nor sickness of any kind for forty years, although since boyhood he had often had rheumatic pains on exposure, and for about fifteen years had gouty pains with enlargements of the joints in one finger after another, each joint remaining tender for about eighteen months. This was a hereditary condition. His parents lived well on into the eighties, and of five brothers and sisters of which he was one, all are still living, the youngest being 55 and the oldest 72 years of age; and all are well except for a chronic gouty condition of the fingers.

Three or four days after leaving his room, he was able to go to his office for an hour daily. For several months he was troubled a good deal with dyspnea, on walking or attempting to carry even light weights. Gradually he regained strength and experienced no pain in the chest until after a brisk walk of about 500 yards in the autumn when he was 64 years of age. When he rested a little and walked slowly this pain subsided, but did not disappear for about twenty minutes. For several years he suffered frequent pains at the middle of the arms directly over the brachial artery, usually on the right side, and occasionally an aching pain in the elbow. The one in the right arm was especially severe sometimes shortly after breakfast or after exercise. These pains he attributed to rheumatism, as they usually occurred with changing weather or whenever he was chilled. He worked hard, but was very temperate in his habits, using no alcoholics, tobacco or coffee, and very little tea. His appetite and digestion were good, and he regulated the amount he ate so as to keep his weight down to the average for his size. He had no pain that he recognized as angina pectoris until the middle of May, 1913, when 64 years of age. For a few days he had found himself getting out of breath easily, and one night while in bed he had a distinct attack of angina pectoris, though not severe enough so that he called any one.

After this, the pain over the aorta came with increasing frequency and severity, so that within a couple of weeks he decided to go to Nauheim, Germany. But while waiting for a steamer he went daily to his office, where he lay on a couch most of the time directing the work of his assistants, unable to walk more than 4 or 5 paces without bringing on the pain. During these four weeks he at times took aspirin to relieve the pain, and several times tried nitroglycerin, but without any relief, probably on account of the fact that the preparation was too old. He also tried amyl nitrite, but without much satisfaction. He took no opiates, as they always disturbed his digestion.

He arrived at Nauheim very weak and unable to walk for more than a few yards without pain. There he took the regular cure of baths, went about all the time for six weeks in a wheel chair, rested an hour and a half or more every day, and had gentle massage of evenings. He felt so cold most of the time that he wore a heavy ulster and was wrapped in blankets all summer long, whenever he was outdoors. After his six weeks' course of treatment, he could walk slowly about 50 feet before the pain would compel him to stop, and after a few minutes could repeat the exertion. He gradually regained strength, so that on his return in the fall he could walk slowly for from 50 to 75 yards on a level, according to the weather, the temperature, etc. A few months later he discovered that fresh hypodermic tablets of nitroglycerin dissolved on the tongue would relieve the pain in two or three minutes, although they might cause dizziness and headache. The same tablets swallowed would not give relief for about ten minutes, and then only about half as much as when dissolved in the mouth. As sodium nitrite and erythrol tetranitrate quickly caused disturbance of his stomach, they could not be taken. At Nauheim he was advised to take theobromin, 15 grains, three times a day; but as he was very sensitive to all medicines, he took only 5-grain doses, and this only five or six times, as it greatly increased the heart pulsations and intermissions. Caffein appeared to make him worse. Strychnin or nux vomica kept him awake, and doses of digitalis sufficient to reduce the pulse to normal seemed to make his pains worse after a short time.

During this period the heart intermitted several times a minute, and the pulse usually ran from 85 to 120. The blood pressure was about 130 to 140 and never was found more than 148.

In the beginning of the disease, X, judging from the suddenness and location of the pain and from the feeling of distention, felt that the trouble must be in the arteries, although he found no confirmation of this theory until he read Allbutt's work four years later. Allbutt argues that pressure on an artery, as in treating aneurysm or an embolus, causes acute pain. X found that after sleeping for an hour or two

on the right side he would sometimes waken with acute pain in the right arm, which would quickly be relieved by his taking nitroglycerin. This seems to support the arterial theory, for there had been nothing during this sleep to disturb the heart except the weight of the body pressing on the right arm. The excessive fatigue which he experienced at times, however, even with no unusual exertion, points sharply to myocardial degeneration.

As the anginous pains came just as the thumb joints were recovering, he suspected that they were of gouty origin, and therefore, for about two years, gave up the use of meat almost completely. Frequent experiments convinced him that the white meat of fowl was to him as injurious as beefsteak or roast beef. Later, on account of the weak myocardium, he returned to the use of meat in moderation.

The pains in this case were brought on by a variety of conditions, such as walking at an ordinary gait on a level, climbing a very slight grade, going up four or five steps, or feeling moderate excitement, pleasurable, or more particularly annoying. A moderately full meal or the act of putting on his shoes after eating, or even of brushing his teeth, or of reaching up to take down his overcoat, or of being in the slightest hurry were all followed by pain.

The sufferer from repeated attacks of angina is usually worse in cold or stormy weather. The latter is not necessarily the result of chilling, for it may and often does occur while the patient is in bed in a warm room. It is apparently due to the subtle meteorological conditions heralded by the pains in chronic rheumatism for hours before an approaching storm.

In the case of X, attacks were brought on by a chilling of the surface, by even slight changes of weather, and once by a wind storm that he encountered when traveling in a warm car. During the blizzard early in January, 1918, X suffered continually for about forty-eight hours with severe angina pains in or under the lower part of the sternum, and in the stomach and arms, when he was not under the influence of large and frequently repeated doses of nitroglycerin. The remedy seemed to be losing its effects, but these pains finally subsided under the influence of heat applied by means of an electric pad, which was kept hot for about twelve hours. During this time, it was sometimes necessary for him to take three or four doses of the nitroglycerin in the course of fifteen minutes, in order to be able to eat even a very light meal. The pain did not return with any severity for several weeks. It often came on while he was eating or addressing a company of his fellows. Indeed, almost anything that increased the rate of the pulse for a few seconds seemed sufficient to cause the pain in the arms or through the shoulders. The same exciting factor carried a trifle further brought the pain over the aorta, or if carried still further, brought on that awful horror which is spoken of as the sense of impending death.

During the pain, even though it was not very severe, he was afraid to move lest it be greatly increased, and once although the nitroglycerin was only 4 or 5 feet away, he hesitated some minutes before he could nerve himself to get it. He carried the tablets in a closely stoppered half-dram bottle in the pockets of every suit, and always had a bottle within easy reach of his bed.

By riding a light motor wheel, he was able to play golf during part of each of the last three summers; but on the days he played, he had to take from ten to twelve $\frac{1}{100}$ grain tablets in the course of a couple of hours. He found that frequently on the day after playing, he had no pain, whereas usually he had it several times a day.

In two years, he took three courses of saline baths of the same content as the bath most used at Nauheim. The most important feature of his treatment was an afternoon rest in bed for about two hours daily, with from eight to nine hours' rest at night, his daily work being limited to five or six hours. After the trial of many medicines, he settled down to nitroglycerin as often as needed, taking usually four to ten doses a day, and twice daily arsenous oxid, $\frac{1}{24}$ grain

with extract of digitalis, $\frac{1}{4}$ grain, extract of nux vomica, $\frac{1}{4}$ grain, and 1 $\frac{1}{2}$ grains of chlorbutanol to prevent insomnia. On this plan he has been able to continue his work in the past two years. He feels the pain often and has to take rather more of the nitroglycerin than formerly, but thus far he has found that it relieves the pain very soon if used in sufficient quantities. Recently, apparently on account of an unusual strain for a few seconds, the heart compensation broke, and he was obliged to take a prolonged rest. In spite of the rest, the pains have increased in frequency.

DIAGNOSIS

The diagnosis is usually based on substernal pain radiating to the arm, shoulders or neck, accompanied by a peculiar mental depression or a sense of impending death, aggravated by exertion or even by slight movements; but it may come on, as in the case of X, even during sleep. We should always suspect angina pectoris when pains result from exertion, no matter what their seat, especially in the aged or the syphilitic. The pain is often attributed to indigestion, but we must be suspicious if it is excited by exertion. I have known several men about 65 years old who, while apparently in excellent health, have been suddenly attacked with what the first physician to arrive termed acute indigestion; yet within a few minutes or at most a few hours, they were dead of angina pectoris. I have observed similar cases in which life has been saved by prompt and judicious treatment. When physicians realize that the pain of angina is seldom in the heart as usually described, but that it is commonly under the sternum or along the course of the larger arteries, so that it may even be in the stomach or bowels or other remote parts of the body, such errors and catastrophes will be much less frequent. If we have been taught to expect pain only over the precordia and down the left arm, we are apt to miss the significance of a pain over the upper part of the sternum and in the right arm, and we are much more liable not to recognize the disease when the pain happens to be centered in the epigastrium or even over the lower part of the abdomen.

The relief of pains by nitrites is considered a diagnostic feature; but this is not necessarily the case, for the nitrites do not always give relief, even under the best conditions. It must also be remembered that the nitrites are not effective when the preparation is old. The pains of pseudo-angina are relieved by the nitrites, and it is probable that still other pains may be relieved by these remedies, just as bronchial asthma is often promptly relieved.

It is asserted that angina pectoris in persons under 45 is usually of syphilitic origin. Possibly this is the explanation for the benefit that has sometimes been obtained from arsenic and the iodids. The value of a syphilitic history as a diagnostic point, however, cannot generally be relied on, as very few private patients will admit that they have had the disease if they can avoid the admission.

In pseudo-angina, the symptoms are much like those of the real disease; but the jactitation and absence of that awful feeling of impending death (I do not mean fear of death), together with the history and the position of the pain, usually make a diagnosis reasonably certain. I think that with many of us the crucial test has been found in the result. We have been accustomed to consider that the patient who recovered had an attack of pseudo-angina, whereas we are ready to admit that the one who died had the real thing.

PROGNOSIS

In the milder forms of the disease, suitable care and treatment may prolong life possibly for many years. For myself I know that I had come to think that with real angina pectoris, the first, second or third attack was almost sure to be fatal; but a careful analysis of my own sixty private cases and especially the experience of X, who, several times a day for four and a half years, has suffered more or less severe attacks, many of which might have been serious but for the means of prompt relief, have greatly modified this view. I unfortunately have not the end-results in many of my cases; but of the twenty-eight cases that I classified as pseudo-angina, three patients had already lived four years when my last notes were entered. Of the thirty-one cases in which I had no doubt about the reality of the disease, two patients had lived from one to two years; 3, two years; 4, three years; 4, from three to four years; 1, five years; 1, eight years; 1, twelve years; 1, fifteen years, and 1, thirty years. This would seem to indicate that those with true angina had outlived the pseudo-angina; but as I have records of death in only four cases with true angina and none in pseudo-angina, the figures have no significance as to end-results. They do show, however, that true angina is not nearly as hopeless as we are wont to believe, and that not a few may live to comparatively old age.

Allbutt makes a more hopeful prognosis than most authorities. This should be comforting to those who have experienced the pains and the awful mental depression that accompanies them. He thinks there is no close relation between the danger and the severity of the pain, but the degree of "angor" is the most ominous symptom. Without angor, angina minor may last for years or may even disappear. One of our fellows who had the pains often a few years ago is now quite free of them, although not young, and is very active in his profession. I have seen cases that lasted more than ten years, and I knew intimately one woman who suffered for thirty years, having at times very severe attacks. The celebrated John Hunter suffered from angina pectoris for twenty years before he finally died in an attack. During the four years, X has improved much in some respects, and if he can maintain a corresponding rate of gain for the next fifteen or twenty years, he hopes to be well.

In the majority of fatal cases, death is due to inhibition of the vagus, stung by pain. A fall in blood pressure resulting from mitral disease or from administration of nitrites relieves the vagus and saves life. An aortic murmur in syphilitic cases is of grave importance, indicating rapidly progressing changes. There are no physical signs that aid much in determining the probable duration, except that weakness of the heart sounds is indicative of myocardial changes, which add greatly to the danger. A sound heart can free itself from vagus arrest, but an enfeebled heart may fail. Chronic aortitis may suddenly end in angina pectoris.

TREATMENT

Nitrites are among the most valuable remedies, but they are commonly given in insufficient doses. X found the most satisfactory preparation a hypodermic tablet of nitroglycerin of $\frac{1}{100}$ grain, which was found to act more promptly and effectively than otherwise, when allowed to dissolve on or beneath the tongue. In this way its full effects were experienced

in from one to three minutes, whereas, if it had been taken into the stomach, only about half the efficiency was experienced, and it did not appear for about ten minutes. Frequently two or more of these tablets were taken at once, and they were repeated every few minutes until the desired effect was obtained. Often as many as ten or a dozen were taken in two or three hours. As much as 15 to 20 hundredths of a grain three times a day has been recommended in severe cases. A physician told me of one patient who took 100 of the $\frac{1}{100}$ grain nitroglycerin tablets in one day with the effect of relieving a severe angina, and at that time he said the pain had not returned for three years. X usually took four or five of the tablets daily, and when the pain was worse or more persistent, ten or twelve. Frequently after these larger doses he would be entirely free from pain all the next day. From my personal observation, I think these large doses are often needed; and if the physician feels his way with gradually increasing doses, no harm will come from them unless they cause too much headache. Osler thinks nitroglycerin is too timidly used and is then abandoned as ineffective.* The preparation should be reasonably fresh, and prescribed in the original package. It may be carried in a small closely stoppered bottle to prevent evaporation, and renewed from the original package every week or two. The patient should be warned of the possible dizziness, the flushing of the face and the headache resulting from its use, and should be assured that these disorders will do no harm. I have found it a good plan to give the patient $\frac{1}{100}$ grain or more at once, so as to learn its effects before he leaves my office. After the susceptibility has been determined, it is best to give a full dose when attacks come on. It may be repeated as often as necessary to accomplish the result, except when it causes too much headache. The headache is sometimes relieved by repeating the dose. This remedy does no harm even from prolonged use. It is of doubtful utility when given only three times a day in the conventional dose of $\frac{1}{100}$ grain.

X did not like amyl nitrite because of its odor, and also because during an attack he found it difficult to dispose of the glass. It is asserted that although this remedy acts quickly it is not as certain as nitroglycerin. The few times that X used it, its effects were practically nil.

Sodium nitrite disturbed his stomach, by the time two or three doses had been taken. This drug seems to have some toxic property. Erythrol tetranitrate caused more headache and did not relieve the pain as promptly as the nitroglycerin, although some patients have found it more satisfactory because of longer duration of its effects.

The heart may be protected against inhibition shock by more or less continuous use of atropin. The dose employed is often too small. As much as 2 mg. or $\frac{3}{100}$ grain may be needed with some adults. In cases of extremely slow pulse, atropin has quickly relieved the inhibition. Calcium lactate is mentioned by some authors as a possible aid to check inhibition.

It is important to inquire into the cause; and if there has been syphilis, the proper treatment should be adopted, as potassium iodid and the arsenical preparations. Arsenic has been used since 1879, and is recommended in small or large doses to forestall the pain. The prolonged use of potassium iodid is said by some to be very effective. I myself have not seen much benefit from these remedies; but in view of the

contention that nearly all cases of angina pectoris in persons less than 45 years old are syphilitic, it is possible that many of them might be benefited by these remedies.

During the attack, if prolonged and severe, morphin, or morphin and atropin, given together hypodermically, are the most common remedies. They are undoubtedly necessary in many cases, but they usually disturb the digestion and make the patient feel bad for two or three days, so that it is much better to give the nitrites first and rely on them when they will answer the purpose. Whisky in quantities of about 3 ounces will also give relief. Hot applications over the sternum, as an electric pad, are sometimes helpful in relieving pain. Balfour recommended chloroform to be inhaled from a wide-mouthed bottle in which about a dram had been placed on a sponge. The bottle was to be held in the patient's hand so that, as he came under the influence of the anesthetic, the bottle would drop and roll away. Allbutt considers chloroform dangerous. I do not know its value from personal experience in angina pectoris, but have found this method of administration very effective and safe in some other painful conditions.

On account of its reputed effect in contracting the arterioles, digitalis is not suited to relieve an acute attack. In those cases in which the heart's action remains practically normal, it is distinctly contraindicated. When the heart's action is feeble, however, this remedy and nux vomica are indicated. The two together will often yield results that cannot be obtained by either one given alone. X tried digitalis repeatedly, but became convinced that at times it made him worse, although he never had high blood pressure. In sixty cases I observed, in which the condition of the heart and pulse was recorded, the heart was apparently normal in thirty-six cases, and the pulse did not exceed 85 in twenty-six cases. In only eleven cases did the myocardium or valves appear to be involved, in only nineteen did the pulse run from 85 to 90, and in only twelve did it run higher than 90 at the time of my examination.

To prevent the attacks, it is of first importance that the patient live a regular life, and avoid over-exertion, mental excitement, chilling of the surface and, indeed, anything that brings on the pain.

Moderation in eating should be enjoined, especially on those who are overweight, and mild measures for reducing the obesity should be instituted. Tobacco, coffee and sometimes even tea should be avoided. Flatulence should be relieved by such remedies as rhubarb, gentian, and the carminatives, as peppermint, cardamom and ginger. The *Bacillus bulgaricus* has been quite effective in preventing flatulence in some persons. The secretions must be free and the bowels must be kept open.

Rest, especially in the early stages or when the attacks recur frequently, is of the utmost importance; but the patient's temperament must be considered, and the physician must not demand what to the patient seems impossible. I am impressed with the idea that rest and diversion with graduated exercise are the greatest factors in the beneficent effects of baths of the type given at Nauheim. Essentially the same baths may be given at home, by adding 9 pounds of sea salt and 10 ounces of commercial calcium chlorid to 40 gallons of water with or without carbonic acid gas. Calcium chlorid is probably the most essential ingredient. The carbonic acid gas appears to me neg-

ligible except for its psychic effect. As already pointed out, X improved markedly during his six weeks of treatment at Nauheim, and has continued to improve since. This case yields a hopeful aspect in prognosis and, I think, illustrates some important facts in treatment, the outstanding features of which are avoidance of exciting causes, heart tonics when needed, nitrites given freely to relieve pain, regular temperate habits, and abundant rest. I believe his improvement is due first to the free use of nitroglycerin, partly to the heart tonics he has taken almost continuously, partly to the care in diet, and largely to the hour and a half or two hours' rest every afternoon, added to the eight hours at night.

SUMMARY

The pain in angina pectoris is not usually in the heart and the left arm, but rather along the course of the aorta and larger arteries.

The pain appears, at least in many cases, to have no relation to the condition of the myocardium or to the obstruction of the coronary arteries.

A more hopeful prognosis than that of the usual conception of this disease may be assured under proper care and treatment, a very important part of which is abundant rest with heart tonics as needed.

The sublingual administration of fresh hypodermic tablets of nitroglycerin in large amounts to relieve pain is of great value. The failure of nitroglycerin is most often due to the wrong mode of administration, deterioration of the preparation, and inadequacy of the amount.

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PATHOLOGY OF ANGINA PECTORIS *

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When sudden occlusion takes place in an artery supplying blood to a place which no other artery can adequately supply, because anastomosis with neighboring arteries is not sufficient, the process is called infarction and the name is generally applied also to the changes which result in the region having its blood supply so interfered with; the lesion produced is an infarct.

There are very few if any arteries which in a strict sense are terminal, that is to say, so terminal that the entire tissue supplied by them must of necessity die when their circulation is obstructed.

Many so-called terminal arteries are so in only a small degree, which means that only part of the region they supply undergoes death by anemic necrosis when they are abruptly occluded. Indeed, the existence of so many different degrees of terminality, if such an expression is allowable, has resulted in a great deal of contention between those who have maintained that arteries for some part of the human body were "end" vessels, and others who with equal vigor have insisted that they are not. Naturally these differences of view have led to experiments of one sort or another, to estimate in some precise way the extent to which the normal circulation in some of these terminal arteries is essential to the healthy life of the region supplied.

Unfortunately for many of these experiments, lower animals have been used; and the conditions for

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