PHYSICAL EFFORT AND CORONARY OCCLUSION

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> And now remains
> That we find out the cause of this effect;
> Or, rather say, the cause of this defect,
> For this effect defective comes by cause.
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> —*Hamlet*, Act II, Scene 2, line 100.

THE proposition that there is a direct causal relation between physical effort and the development of the condition that we know as coronary occlusion has been argued so often, particularly in law courts in the last twenty years, that the nature of our problem is fairly clear. Does muscular effort of mild or gross degree influence, directly or indirectly, the changes in the tissues with the associated characteristic symptoms and signs? Before proceeding, it is necessary to clear the ground in one respect; we must distinguish carefully between the disease of the vessels which results in their being unable to carry out their function of carrying the blood to the tissues, and the phenomenon of sudden obstruction which, of course, only occurs in diseased vessels. We need not consider here the factors causing the original vascular disease; this has developed over a long period and is essentially a chronic process, and in any case it appears to develop more often and more certainly in those subject to mental strain and anxiety rather than in those exerting physical effort. We will confine our attention, therefore, to the actual incident, almost invariably of sudden onset, when a person unexpectedly and rapidly develops coronary occlusion.

Very briefly, this condition is due to a sudden diminution in blood flow through some vessels (sometimes, but not always, due to physical obstruction of the lumen) so that the muscle of the heart, of the area supplied, does not receive its usual nutriment and oxygen and is unable to carry out its function. It may in fact die; but even short of death the disturbance of function is so great that the heart may not be able to continue to beat satisfactorily, and this will cause either the death of the patient or very serious general disturbance.

There have been great differences of opinion regarding the cause of this condition and, from the present point of view,

diametrically opposed opinions have been expressed, that is to say, some authorities have considered the immediately prior activity of the individual to be responsible, whereas others have maintained that this has no relation whatever. The purpose of this paper is to show that all available evidence is in the direction of the second view.

The assumption that there is a direct causal relation between the muscular effort and the development of coronary occlusion is based on two findings:

(1) the ordinary observation that, in some cases, there is a very distinct time relation, that is, there is muscular effort and shortly afterwards the condition develops; and

(2) the statements (I will not call them evidence because, as will be shown later, they are largely unscientific) of some writers, particularly the Canadian Paterson (1936, 1938, 1941) and others who followed him in an interpretation of pathological findings. This will be considered later.

The argument, based on the occasional and, indeed, casual observation of a chance association is, of course, a matter of *post hoc, ergo propter hoc.* It need not be emphasized how strong an influence this time relation has on people's minds and, even when it is appreciated that it is a false argument from cause to effect from mere precedence of circumstance, it still weighs strongly with the inexperienced and untrained person; but there may be twenty cases in which there is not this association for every one in which there is. This usually is not given sufficient attention.

Matters of this kind cannot be determined by simple observation; "a Hair, they say, divides the False and True".[1] It is necessary that we give every problem the most careful attention. At the same time, "the wrong way always seems the more reasonable",[2] that is to say, we must not be governed by our prejudices or fads; if we do, sooner or later they will be shown for what they really are.

It is thus necessary to collect a large amount of information from different sources. This is not always a congenial task because if one has a pet view, and it is difficult to avoid this

1. *Omar Khayyám,* tr. by Edward Fitzgerald, 2nd ed., Rubaiyat 50.
2. George Moore, *The Bending of the Bow,* Act III.

sort of thing, some of the information is going to be contradictory to it; but it is the only possible way if we really want the truth. We have in Medicine some striking examples of strongly held opinions, regarded as indisputable for centuries, which have since been shown to be quite wrong. For example, until relatively recent times it was thought that the male cell was responsible for the developing individual whereas, of course, we know now that the female cell is essential, growing after conjunction with the male cell; but, in some lower animals, it may form a new individual on its own—a complete reversal of the older view. Tumours, which were thought to arise in those parts of the body where found, are now known to travel there from other places where they really originated. The manner of transfer of infections from one person to another is now known to be quite different from what was originally thought. "It is a capital mistake to theorize before one has data",[3] so we must proceed to marshal our information. As Mr. Gradgrind used to say,[4] "Now, what I want is Facts . . . Facts alone are wanted in life."

Of course, this immediately raises the question: what is a fact? The ordinary person would say that this is "something that has really occurred, or is actually the case". We do not need to be very deep students of philosophy to appreciate that this is an over-simplification. We do not have to be followers of George Berkeley, and believe that things exist only because they are perceived, to realize that we can be deceived by apparently clearcut and easily demonstrated observations. It has been said that a fact is an incomplete and inadequate observation of a natural phenomenon made by imperfect instruments.

Part of our problems are due to errors of interpretation. This has been emphasized by various demonstrations of which one of the best known is that of the "two clocks" of Arnold Geulincx. The two clocks, keeping perfect time, have an hour hand and a striking mechanism respectively. Casual observation would lead one to believe that the hand coming round to the hour was the cause of the striking of the other clock. There is also the relation of lightning and thunder, and many other examples could be quoted.

3. Arthur Conan Doyle, *Adventures of Sherlock Holmes,* "A Scandal in Bohemia".

4. Charles Dickens, *Hard Times,* Book I, Chapter 1.

Even when this aspect of our problem is overcome, there is still that of differences depending on the various angles from which we view it. We all know the story of the two knights who, after fighting almost to their deaths because they disagreed about the colour of a shield, found that it was different in colour on the two sides which they had each originally respectively observed. A similar idea is expressed in the Indian legend of the eight blind men touching different parts of an elephant. Thus, by looking at a problem from all angles, we are able to get a very different idea of it from what we would at first sight; the side, back, or internal view shows things to be very different from what the false front seems to indicate.

"It is a foolish thing to make a long prologue, and to be short in the story itself",[5] so we will proceed to examine our problem from various and different points of view, not only to see whether we can obtain a coherent and organized view of the matter, but also to determine whether observations made from one angle will agree with, or contradict, those made from another point of view.

Cardiac Conditions Related to Coronary Occlusion

Coronary occlusion is only one of several conditions in which there is a sudden disturbance of cardiac function with associated signs and symptoms. It is very important that they should all be differentiated from each other; indeed, that they have not always been carefully distinguished is one of the reasons for confusion of thought about coronary occlusion itself. The principal conditions are: angina pectoris, cardiac or coronary insufficiency, and cardiac contusion.

Angina pectoris is due fundamentally to disease of coronary vessels and diminution of blood supply to the heart muscle, but it has very characteristic distinctive features which will distinguish it from coronary occlusion. It frequently is due to exertion or excitement, although exposure to cold and many other factors may be the predisposing cause of an attack. The duration of the pain is usually short, and the pain will be relieved by drugs such as nitro-glycerine; this does not happen with coronary occlusion. When it is appreciated that, for a long time, the condition was not distinguished from coronary occlusion at all—a confusion only resolved in recent years—it will be

5. Maccabees, ii, 32.

seen that, since angina pectoris is so obviously related to injury or effort, the idea that, *a priori*, injury or effort gives rise to coronary occlusion was not unreasonable. However, the differences are now clearly recognized, and no argument regarding aetiology based on the phenomena in angina pectoris should be applied to coronary occlusion. Furthermore, no case of angina pectoris or one which is complicated in any way by this condition should be used as a precedent for any conclusion regarding the causal relations of coronary occlusion.

Cardiac or coronary insufficiency is a condition which comprises a number of different states in all of which, however, there has been damage to the heart muscle so that the heart is a less effective organ and indeed one in which changes are often progressing. It will be understood that although a normal structure is able to withstand astonishing stresses, one which is diseased may be seriously affected by even moderate strains, and indeed, this is a well-known phenomenon. In these circumstances, the stress associated with effort results in immediate signs and symptoms which may be progressive and end in the death of the patient, or may gradually subside. It usually differs from coronary occlusion in that with occlusion there is frequently a latent period between the onset of the condition and the effort which is assumed to have caused it. The important point is that, although we would unhesitatingly accept a causal relation between an injury or an effort and symptoms associated with cardiac dysfunction or failure in the case of cardiac insufficiency, this has no bearing whatever in the cases of coronary occlusion where, although the blood vessels are diseased, there is sufficient blood getting through to the tissues for them to be functionally relatively normal prior to the attack.

Cardiac contusion is an uncommon condition and one in which there is a bruising of the heart due to direct or indirect injury. This condition again is quite distinct from coronary occlusion, and although its relation to injury is indubitable, examples of this kind have no bearing on the relation of effort to coronary occlusion.

A few of the features which will distinguish these various conditions from each other are set out in Table I. Once these diagnostic difficulties are overcome (and they have, in the past, constituted serious red herrings) the main question of evaluation of the evidence available regarding coronary occlusion itself may be considered.

TABLE I

Some features of differentiation of conditions which may resemble coronary occlusion.

	Coronary Occlusion	Angina Pectoris	Cardiac Inefficiency	Cardiac Contusion
Duration of Pain	Prolonged	Transitory	Variable—often absent	Variable
Shock	Present	Absent	Present	Present
Blood Pressure	Falls	Same or rises	Falls	Falls
Effect of Nitro-glycerine	Ineffective	Symptoms relieved	Ineffective	Ineffective
Pathological Findings	Infarction—often extensive	Nil	Infarction—focal microscopic	Myomalacia
Predisposing Factor	Coronary sclerosis	Coronary sclerosis	Coronary sclerosis	Nil
Exciting Cause	None recognizable	Exertion Excitement Cold	Exertion Haemorrhage Injection	Injury

Evaluation of Evidence

Information of various kinds may be obtained and may be considered in different ways. First of all, there are the clinical observations of the patients, and various forms of information may be obtained from individuals and groups. Secondly, there are the pathological examinations made of the hearts at autopsy. There are again several groups of these, and it is important that, where practicable, they should be related to the clinical evidence. In addition, it is possible to consider changes which will occur where physical conditions are comparable with those known in the body, and conclusions can be reached, regarding pressures in vessels and the like, on a theoretical but nevertheless controlled basis and various hypotheses regarding the mode of development of coronary occlusion may be assessed.

Clinical Observations

Many statements have been the result of observation of relatively few cases. Scientifically and statistically, answers to most questions demand examination of a large series of cases;

for this reason, many statements are quite valueless. Some of the material which is being presented this evening is the result of observations of cases occurring locally in this city, but in addition I have drawn heavily on those of R. M. Master, who is Chief of the Cardiac Laboratory, Mount Sinai Hospital, New York City (Master, Dack, and Jaffe, 1937–41).

Observed Relation to Effort

In order to obtain an accurate concept, a detailed history of the activities of the patient is necessary, both immediately prior to the attack and during the preceding hours and even weeks. The accumulation of a series of cases is thus a long-term matter, since many cases have to be excluded because of the absence of adequate history. Cases in which there is any question of compensation should be excluded, since the history given by such patients has frequently been found to be unreliable.

In a series of over 1,100 cases the types of activity at the onset of the attack were as follows:

Patient asleep or resting	52%
Mild routine activity	21%
Walking	16%
Moderate activity (painting, baking, etc.)	9%
Unusual physical exertion	2%

When we consider the ordinary activities of individuals we find that about half of the day is usually occupied in sleep or at rest; the other forms of activity occur in about the proportion mentioned above. It is apparent, therefore, that the occurrence of the attacks in relation to the various kinds of activity must be regarded as coincidental.

In practically all individuals, some severe effort is performed during a day, that is to say, any individual who is about to have an attack will perform some heavy work some little time prior to this. If the effort were related, then one would expect to find the proportion of cases in which there is a clearcut history of severe effort just prior to the attack in a much larger proportion than has been found. It is to be concluded from this, therefore, that on a statistical basis there is no relation between types of activity and the occurrence of occlusion.

Relation to Occupation

Conflicting opinions have been given with regard to this (Master *et alii,* 1937). Some writers have stated that the condition

is much more common amongst the labouring classes, while others have been equally emphatic that it is amongst individuals of the sedentary groups such as business executives and professional people that most cases occur.

In a series of over 1,200 cases the occupations were:

Manual workers	35½%
Housewives	19½%
Business men	11%
Retired persons	10%
Office workers	9½%
Professional individuals	9%
Store workers	5½%

Such figures are valuable of course only if they are compared with the distribution of such individuals in the community generally. This was investigated in the community for these particular groups (rearranged from the above series) and the following results were obtained:

Groups	% of Cases of Coronary Occlusion	% in Community
Workers and labourers	51%	55%
Store, office and business men	37%	37%
Professional individuals	12%	8%

From the close correlation it would seem clear that occupation is not a factor in the development of coronary occlusion, and the importance of this is that if the condition were precipitated by effort the incidence of the strenuous occupations should be much greater than is shown here; actually, although the figures are not really significant, the suggestion is in the reverse direction. This, therefore, supports the conclusions drawn from the first group considered.

Relation to Injury

The possible rôle of cardiac trauma should be considered from two points of view. In the first place, a good deal has been written from time to time about its relation to coronary occlusion, and cases in which injury to the heart has occurred have been cited as evidence in favour of the association. This had been due to a lack of appreciation of the distinction between

the two conditions which has been discussed earlier. The distinction is now sufficiently well known for it to be unnecessary for us to go into the matter any further.

The second point is that there has been considerable confusion because people have not distinguished clearly between the effects of injury and effort. Of course, in one sense, strain from an effort can result in an injury to the heart in certain circumstances, but this is not what is meant when we speak of cardiac trauma.

We have no specific evidence here, but it is necessary to emphasize the complete difference between the two types of condition in order to clear the ground of a serious misconception which has been one of the numerous small factors which have influenced opinion regarding coronary occlusion.

Relation of Work to Subsequent Attacks

Individuals who have had an attack of coronary occlusion may develop one or more subsequent ones and, of course, the factors which determine of the first presumably will, in some measure, be responsible for succeeding ones. In a series of over 400 cases amongst whom over 200 returned and just under 200 did not return to work, the incidence of subsequent coronary occlusion was respectively 25 and 40, and within the period of observation 25 of the patients who had returned to work had died and 44 of those who did not work had died. It is appreciated that the patients who did not return to work would include some of those who were more seriously affected than those who did return to work, but at the same time many of the non-workers were such merely because of natural inclination or because of special advice by their physicians.

Thus it may be said that the number of subsequent attacks of occlusion and the mortality rate was not greater in those who returned to work than in those who did not. This would probably be of little significance by itself, but, again, it generally supports the evidence presented by other points of view.

Relation to Symptoms

An important observation made at the Royal Melbourne Hospital was that, in a considerable number of patients dying of coronary occlusion, there had been no definite history of symptoms nor of anything that would indicate just when the attack had occurred (Forbes 1952). This is contrary to current

teaching because it is considered that coronary occlusion is always associated with severe pain and that the onset of the attack can always be determined with accuracy. Regarding the observations referred to, it has been suggested that if histories had been sufficiently carefully taken, there would have been some evidence of severe pain in the chest. This may be so, but to be realistic we must remember that the people dealing with these cases were not omniscient, did not know what was going to be found at post-mortem, and therefore took what was an average reasonable history not specially referable to one part which was not obviously affected. Even if these patients had pain or other symptoms, these were not sufficiently gross for them to volunteer any statement about them to a medical practitioner who was investigating their illness.

The importance of this is that any correlation between an effort and the onset of the condition depends on certain symptoms indicating clearly when the condition does begin. In many cases this is found, but the evidence that the occlusion may have begun without any such symptoms and that the condition may have been there prior to the effort regarded as significant is an extremely important point. This is to be correlated with some of the points to be raised in the next section.

Frequency of Coronary Occlusion

It has been shown (Master *et alii*, 1939) in the U.S.A. that, after the age of 40 years, one male in 54 and one female in 89 suffer an attack of coronary occlusion in each year. To attribute a condition of such frequency to some one factor as muscular effort should be easily susceptible of demonstration but, as is being shown, all evidence points away from this association. We will now consider the question on a different plane.

Pathological Observations

The information gained by study of organs at post-mortem examination is necessarily the basis of our knowledge of any condition. It is of some interest that it is only during the present century that the pathological appearances and the clinical features of this condition have been correlated.

Attention must be paid to changes in the vessels as well as changes in the muscle which depend on the former. We will discuss these separately.

Vascular Changes

In all cases there is obvious and often gross thickening of the walls of the vessels so that the lumen is greatly diminished. The difficulty is to know just which particular part of the vascular tree of the organ is responsible for the disturbance of tissue and the death of the patient.

First, it was assumed that there must always be some obvious block in the vessel in the form of a blood clot, but this has been found not to be so, and very often the vessels supplying the part which has become affected, even though grossly diseased, are patent. Thus for a considerable time and, in some places even now, such obvious change in the vessel is sought for and, when found, is regarded as being the inevitable cause of the condition even though it may not be in the right place.

This independence of the site of the muscle change which is the essential point, and obvious changes in the vessels does not present a serious problem because it is known, as with many organs in the body, that changes in their function need not necessarily go hand in hand with the more obvious structural alterations. This has been overlooked, and the important point is that hypotheses have been developed (which incidentally have been widely quoted in law courts) depending on the assumption that an obvious lesion is the cause of the condition and that this lesion may be related to effort.

It has been found, and emphasized by one group, that bleeding into the wall of a vessel — particularly an atheromatous plaque — may be found in quite a number of cases of coronary occlusion. This has been built up into an hypothesis that, since the haemorrhage in the wall of the vessel must be due to some increased pressure, this pressure will have been of a general nature and will have been due to general physical effort. This will be discussed further, but there are several points in direct observation which have a bearing here.

(1) Haemorrhages are frequently multiple and often do not occur at the site which would be significant from the point of view of the particular area of muscle degeneration that has occurred.

(2) An essential part of the hypothesis is that the haemorrhages occur on the inner aspect of the wall of the vessel, but even in the early descriptions and illustrations given by the proponents of this view

(Paterson, 1938) it will be seen that many of the haemorrhages are not in this position; in other words, the general phenomenon has been observed but it has not been correlated with the other features in the way in which it should have been to substantiate the theory.

(3) Many of these subintimal haemorrhages occur in people who have developed their condition while they were in bed. This may be shown by examinations made in 100 patients of whom 25 were in bed.

	Bedridden Patients	Entire Series
Thrombosis and occlusion related to haemorrhage	61%	58%
Thrombosis and occlusion unrelated to haemorrhage	36·5%	33·5%

Horn and Finkelstein (1940) have also shown that intimal haemorrhage and thrombosis are fortuitous events in atherosclerosis and not related to the actual state of coronary occlusion.

(4) If these haemorrhages were due to increased pressure they might be expected to be more common in patients with hypertension. In a series of cases in which there was actual thrombosis of the vessels it was found that in cases of hypertension 84 per cent of them showed haemorrhages into the intima, but in cases in which there had not been hypertension, 95 per cent showed such changes.

It will be seen here then that the allegedly close relation between subintimal haemorrhage and coronary occlusion, about which so much has been spoken and written, is not supported by any real evidence when we look into any aspect of the problem. Indeed, it is no more than a well-organized fantasy.

Muscle Changes

The changes in the actual muscle of the wall are the important features from the point of view of the immediately recent phenomenon. Some indication of the time which the condition had been present can be obtained, but very few careful groups of observations have been made into this matter. It will be found that quite often the age of the changes in the wall do not correspond with the clinical history.

It is quite obvious that if the changes demonstrated have been present for, say, ten days, and the alleged effort was three days before, unless very definite evidence of a superimposed second set of changes on the first can be shown, it is obvious that the alleged injury cannot be related to the condition. This is a matter to which insufficient attention has been given but my own observations would lead me to believe that there is sufficient lack of correlation to indicate clearly that no true dependence can be placed on the pathological lesion and the time of onset of the condition. In cases where there is a good correlation the matter is clear, but in many of the others this is not so, and the important question, from our present point of view, is that the mere presence of a pathological condition does not automatically associate this with some alleged physical effort.

The point here, then, is that if the general proposition of the relation being discussed had some substance the correlations mentioned should be apparent and demonstrable in a significant number of cases. This is just not so.

Theoretical Considerations

The hypothesis that has been developed has certain components:

(*a*) That the changes in the heart muscle are due to a sudden change in the vessels—a sudden diminution in the lumen.

(*b*) This must be due to either a clotting of the blood in the vessel or a sudden swelling of the vessel so that it protrudes into the lumen. Incidentally, when this happens as indeed it sometimes does, secondary clotting does take place.

(*c*) The haemorrhage into the wall is due to an increased pressure of the blood inside the vessels.

As indicated earlier, the first proposition is not necessarily true, but as this requires extensive consideration of physiological and physical theory it will be left for some other time.

We are able, however, to consider here the last proposition (*c*). A great deal is known about the pressures as they occur in the vessels and by application of physical principles changes in them can be deduced. I do not propose to go into the details but would refer briefly to a paper written recently (King, 1952). There are a few points which may be mentioned briefly.

If bleeding is to occur in the wall and cause the inner layers to project into the lumen of the vessel the pressure must be greater in the wall than in the lumen. The pressure in vessels is proportional to their size, and since the very small vessels in the wall from which bleeding occurs are smaller than the vessel itself the proposition is an impossible one, stated in this form.

It can, of course, occur if the lumen of the main vessel is already very grossly diminished in size but what is always overlooked by the proponents of the view that the pressure is so significant here is that if this were so, then the blood vessel has such a small lumen that it is ineffective as a functioning unit and even if it were obstructed it would not have any significant effect on the condition of the heart muscle.

A further point is that, the assumption that a person performing the effort will have a very significant rise in his blood pressure is, of course, not supported by observation. Some rise of blood pressure in the main part of the circulation may occur (and does in fact occur with severe exercise), but a rise which would be sufficient to affect the small capillaries where the pressure is much lower does not in fact occur.

In resumé, it is appreciated that many of the points here have been dealt with in only a cursory manner, but in covering a large field of this kind this is inevitable. However, it is not intended to deal in detail with any part but to indicate that a consideration of this problem from many points of view gives the same kind of result in each part. As we have walked round our object and viewed it from all angles, we have been able to get a general view and to form opinions which are found to be equally true from whatever angle we consider the matter.

Summary

Biological phenomena are extremely complex processes in which a great many different factors take part. These vary from example to example, and thus many of the factors may be effective in some conditions but not in others. We have made no attempt to consider the influence of age, sex, climate, or very many other factors which may and presumably do have some effect. What has been done here is to consider the influence of muscular effort on the condition.

This has been considered from three main aspects: various forms of clinical observations, direct observations of the tissues,

and theoretical considerations of the changes which may occur in the blood vessels of the heart in the conditions mentioned.

In all these cases we find that there is an extraordinary absence of any direct evidence for the influence of physical effort. The problem arises because physical effort might have been expected to play some part, particularly since it does have a very obvious effect in other conditions of the heart which were, in the past, confused with coronary occlusion. It is possible to build up an hypothesis of a relation between effort and coronary occlusion based on some casual observations and the misapplication of physiological and physical principles.

However, when we ignore the single case which may appear to support this hypothesis, but instead examine groups of individuals and determine what happens in a reasonable series of cases which have been carefully and exhaustively considered, we find that various phenomena occur with equal frequency in cases where there has been and in those where there has not been some question of physical effort.

When all these are considered, even though some of them individually might not necessarily be regarded as of great consequence, it is apparent that factors which are as yet not well understood, but certainly have no obvious relation to physical effort, are responsible for the condition. In other words, coronary occlusion occurs as the result of "natural causes", and is neither influenced nor determined by physical activity.

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Discussion

MR. C. I. MENHENNIT said that he thought that the paper which had just been delivered might prove to be of great value to lawyers confronted with Workers' Compensation cases. However, changes in legislation and developments in medical theory

together made it very difficult to forecast the lines along which this branch of the law would develop. He had always been puzzled by the theory that inadequacy of blood supply to the heart was aggravated by physical effort, which the layman would assume made the blood supply greater. One of the answers to the suggestion that effort increased blood supply had been, as he understood it, that a clot obstructed the flow of the blood, but Professor King had demonstrated that this was not a real answer because the position of the damage to heart muscle and the position of the clot did not correspond. Professor King's paper had demonstrated that the Paterson theory that intimal haemorrhage was provoked by effort was unfounded.

One difficulty which confronted Counsel in the conduct of Workers' Compensation cases was the difficulty of finding a starting point. Too often everyone assumed that the death certificate provided a starting point, but in fact there was no high degree of probability that the statements in the death certificate were correct. This difficulty might be overcome if post-mortem examinations were performed more frequently than is now usual.

Under the present Workers' Compensation legislation, there were two problems of equal importance, one of causation and the other as to the time at which the pathological or physiological change occurred. Professor King had pointed out that the onset of symptoms does not necessarily occur at the same time as the damage to the heart. He suggested that it might be possible to make post-mortem examinations compulsory in cases where a Workers' Compensation liability was likely to arise.

DR. H. B. KAY said that Mr. Menhennit's doubts about the relationship between effort and blood supply could be resolved by saying that as the demand for greater blood supply increases relatively less blood passes through the obstructed arteries, just as in the case of clogged water pipes. It was now realized that the three clinical syndromes, namely coronary occlusion, coronary insufficiency and angina pectoris, all arose from essentially the same pathological changes. Post-mortem examination might reveal very little change or it might reveal definite indications of thrombosis, or, in rare cases, of sub-intimal haemorrhage. The history of increasing tiredness revealed in these cases suggested that a slow process was going on before the final occlusion.

The statistics relating to the incidence of coronary occlusion in sedentary and labouring occupations had to be read with the qualification that there was often a hereditary tendency both to coronary disease and to sedentary occupation. It was possible to demonstrate that extra exertion or stress precipitated thrombosis in a number of people; this was most easily observed in the case of leg veins. It had been found to be unwise to encourage persons suffering from coronary disease to engage in physical activity. It was important to investigate what happened during the last few weeks before occlusion when patients found that they were getting increasingly tired at work.

In his view, it was often possible to demonstrate aggravation by exertion, but it was not possible to trace a relationship between occupation and coronary sclerosis itself.

DR. ALLAN WYNN said that the figures taken from Masters' work in America relating the time of onset of coronary thrombosis to physical activity made no provision for cases in which it was impossible to determine the time of onset. The Medical Research Council in the United Kingdom had shown that coronary thrombosis and occlusion occurred more commonly in people subjected to stress and strain than in those subjected to heavy effort. He felt that the only way to prevent a great waste of time and money and a considerable amount of injustice was to alter the law so as to provide benefits for all persons struck down by these complaints without examining minutely the relationship between disability and work. The present law led to an exaggerated importance being placed on the final event, which was really only the last straw imposed upon the long existing condition of disease.

MR. C. W. HARRIS said that, although the paper had denied a relationship between coronary occlusion and physical effort, the tables displayed by slide had stated that effort was the exciting cause of cardiac insufficiency. If this was taken in conjunction with Dr. Kay's observation that there is no distinction between cardiac insufficiency and coronary occlusion, a new door was opened for applicants to compensation as soon as the old door was closed.

DR. IVAN MAXWELL said that Mr. Harris's statement that a physician was unable to distinguish between cardiac insufficiency due to coronary occlusion and that due to other causes was

quite inaccurate. The operation of the nerve supply of the coronary arteries had not been mentioned during the evening. Upon exertion, adrenalin was liberated into the blood stream, which had the property of contracting most of the blood vessels of the body but not those in the wall of the coronary arteries. The result was that the general blood pressure rose, and in the normal young person the coronary arteries became dilated. This dilation could not occur in the case of diseased arteries. He suggested that it was possible that sudden death might in many cases be the result primarily of cardiac anoxia possibly associated with ventricular fibrillation rather than to blockage of the lumen. This anoxia would cause excessive histamine formation and local oedema in the diseased artery wall, which would in turn cause the artery to close, possibly inducing ventricular fibrillation and sudden death.

MR. P. D. PHILLIPS, Q.C., said that as a result of amendments of Workers' Compensation legislation, which had introduced alternative grounds of claim if the injury by accident arose either out of or in the course of the employment and as a result of a change in medical views which produced the result that the causal relationship between effort and coronary occlusion, was now, to say the least, hotly disputed, it might be desirable to reconsider the mental processes involved in holding that the kind of event under discussion was an accident at all. If a causal relationship between exertion and coronary occlusion were put out of consideration, the question in each case must be whether the alleged accident occurs in the course of the employment or not, and compensation will be payable or not payable according to whether the accident occurred at work or elsewhere. It could not be regarded as satisfactory to say that compensation was payable if the event happened in one place, but not if it happened in another place, and the anomaly of this position promoted the thought that it was time, in the light of modern knowledge, to reconsider the question whether the event constituted an accident.

DR. M. D. SILVERBERG said that there had been some oversimplification of the subject by the omission, except in Dr. Maxwell's comments, of a consideration of the physiological and psychological aspects of the cases. Autopsy will throw no light on these aspects, yet the element of excitement probably

plays a large part in precipitating the final event, the line of causation being by way of the various glandular and autonomic interactions mentioned by Dr. Maxwell. Masters's statistics should be regarded with reserve because later compilations of statistics do not lead to exactly the same conclusion.