Changes in the Serum Cholesterol and Blood Clotting Time in Men Subjected to Cyclic Variation of Occupational Stress

By Meyer Friedman, M.D., Ray H. Rosenman, M.D., and Vernice Carroll

With the technical collaboration of Russell J. Tai, M.D.

Accountants were selectively chosen as a self-controlled group for studying effects of cyclic occupational stress upon serum cholesterol and blood clotting time, since their routine work schedule is interrupted by urgent tax deadlines, associated with severe occupational stress. Forty male accountants (age 28 to 56) were bled biweekly for serum cholesterol and monthly for blood clotting time from January to June 1957. Complete records also were kept of weight, exercise, diet, relative work load, and any exposure to unusual avocational stress. When studied individually, each subject's highest serum cholesterol consistently occurred during severe occupational or other stress, and his lowest at times of minimal stress. The results could not be ascribed to any changes of weight, exercise, or diet. Marked acceleration of blood clotting time consistently occurred at the time of maximum occupational stress, in contrast to normal blood clotting during periods of respite. The possible implications of these results are discussed in relation to the problem of clinical coronary artery disease.

If the present high dietary intake of fat by upper class, middle aged Western man is chiefly responsible for his increased susceptibility to clinical coronary artery disease, then the relative immunity enjoyed by his female counterpart can only be explained by her failure to ingest a similar high-fat dietary or by her possession of some sex-linked protection against the presumed atherogenic qualities of a high-fat intake. However, when we studied the actual, individual dietary intake of 46 young American women and their husbands, the intake of fat was found to be identical in the 2 sexes. Furthermore, when the salient data available in the literature were analyzed, it became apparent to us that there was no clear-cut evidence to support the belief that the American female might enjoy some sex-linked protection against the supposed atherogenic properties of a high-fat diet.

These conclusions led us to consider a second possibility, namely that a high-fat intake of and by itself is not specifically responsible either for the greater incidence of clinical coronary artery disease in the American male, as compared either to the American female or to men of other races and societies ingesting lower amounts of fat. Again the available experimental and epidemiologic data bearing upon these possible relationships were surveyed. It soon became apparent to us that such data were frequently collected with little or no consideration of such possible important variables as the incidence of hypertension, the striking difference in the incidence of myocardial infarction as opposed to coronary atherosclerosis per se, the qualitative nature of the fats ingested, the means adopted to estimate the actual fat ingestion, changes in incidence of thrombotic accidents, and differences in amount of exercise. Then too, the possible influence of socioeconomic stress was not considered in such epidemiologic studies. Thus Bantus have been compared with American executives, and prosperous yet possibly harrassed Northern Italian merchants and industrialists, with calm Italian peasants of Southern Italy. Yet, despite the obvious social and economic dis-
parities between such groups, with their possible concomitant effects, only the difference in their fat intake has been accorded a serious relevance to the observed differences in incidence of cardiovascular morbidity and mortality.

The failure of such studies to consider the possible atherogenic influences of socioeconomic stress appears to us to be regrettable if only because, as we earlier have stressed, a better correlation can be obtained between its presence and the incidence of clinical coronary artery disease than between the latter and a high-fat intake.

It was decided therefore to initiate a closely controlled study of the possible effects of one type of socioeconomic stress upon the serum cholesterol and blood coagulation time of a group of intelligent, conscientious male volunteers. The results of this study suggest, we believe, that the factor of socioeconomic stress cannot be disregarded in any future experimental or epidemiologic study dealing with the pathogenesis of clinical coronary artery disease in modern man.

**METHODS AND MATERIAL**

**Selection of a Form of Socioeconomic Stress**

In an attempt to discover, hence select a form of socioeconomic stress possibly having a pathogenetic relevance to clinical coronary disease, we interviewed by questionnaire, 162 executives of a large oil company, a railroad company, and 3 advertising agencies. In addition, 47 physicians actually treating cardiac patients were interviewed. Despite the obvious differences existing in the background and training of these lay and professional groups, it was surprising to us that approximately 70 per cent of each group believed that the major cause of clinical coronary disease was a particular and rather specific type of emotional activity, namely that concerned with excessive “drive,” competition, meeting “deadlines,” and economic frustration. Thus both groups sharply differentiated this general form of socioeconomic stress from an anxiety-worry-fear complex, in that only 3 to 5 per cent of either group believed the latter form of emotional perturbation had etiologic significance in the pathogenesis of clinical coronary artery disease. It was of interest, too, that, despite the recent, widespread dissemination of data purporting to demonstrate a relationship between high-fat intake and coronary artery disease, only 6 per cent of the physicians believed that high-fat intake bore a primary role in the pathogenesis of the disorder under discussion. An even smaller minority blamed inadequate physical exertion.

These results therefore suggested that a form of socioeconomic stress should be selected for study that would impel the subjects to exert “drive,” or subject them to a deadline, in short, of imposing upon the subjects a “sense of urgency.” Moreover, the application of or exposure to such stress would have to be sufficiently and predictably phasic enough to allow periods of respite for control observations. After considerable study and deliberation, it was decided to study the effects of the type of socioeconomic stress to which certified public, public, and tax accountants are exposed during the first 5 months of the calendar year.

**Functional Classification of the Accountants**

Forty accountants volunteered for this study which extended for a total period of about 5 months, beginning January 8 and ending on June 10, 1957.

Eighteen of these volunteers (group A) were accountants chiefly concerned with tax returns. These accountants are referred to henceforth as “tax” accountants. It should be pointed out that each of these men was either the owner or a responsible partner of their respective firms. We had been aware from the beginning that only such proprietary individuals in the field of accounting actually experience periods of severe stress. Their average age was 38 years (range 28 to 50 years).

The remaining 22 accountants (group B) specialized in corporate finances. These accountants are referred to henceforth as “corporate” accountants. Again only responsible partner-members of accounting firms were studied. Their average age was 39 years (range 28 to 56 years).

Both groups of accountants made ideal subjects for this study in that they were far above the average in intelligence, sincerity, and finally in their understanding interest in the study itself. At all times, even during their periods of stress, their cooperation was immediate and complete, despite the demands made upon them by the study.

**Description of Economic Stress and Lull Periods of the Accountants**

Almost all accountants work long hours (as much as 70 hours per week) during the first 4 months of the calendar year, after which time they generally observe much shorter hours (as little as 30 hours per week). However, from our preliminary survey we had been forewarned to gauge the intensity of the socioeconomic stress not by the mere number of working hours but rather by the sense of urgency inherent in or engendered by their work activity. By this last criterion, it was
determined that 4 periods of socioeconomic stress (of the type we wished to study) might be encountered by accountants during the first 6 months of the year. For accountants occupying themselves with corporate finances (chiefly certified public accountants), the periods January 1 to 31 and April 1 to 15 were periods of severe stress and that of June 1 to 15 was one of moderate stress. The periods in between these, although possibly demanding long hours, did not carry any sense of urgency. For accountants concerned primarily with tax returns (chiefly public and tax accountants), the period of April 1 to 15 only was one of severe stress and that of March 1 to 15 was one of very mild stress. It should be pointed out that in the majority of the accountants' work, working against a "deadline" is almost inevitable because of the delay in the receipt of all of the clients' data by the accountant. Sometimes indeed these data may become available to him only during the last few days preceding the April 15th or other "deadline."

Recording of Individual Exposures to Other Types of Personal Socioeconomic Stress of the Accountants

The above-mentioned stress periods in the first 5 months of the calendar year of an accountant represented the most intense and harrowing emotional periods for our subjects considered as a whole. Nevertheless, during this same period of time, it was obvious that individual accountants, as the result of various personal experiences and exposures, might incur stresses of similar but far more intense nature than those experienced at the usual critical phases of the accountants' life occurring during the January-June period under study.

Therefore, at the bimonthly visit, each accountant was questioned rather intimately about all forms of emotional perturbation he might have experienced. When such upsets were reported, he was asked to estimate as best he could their relative intensity in comparison with that felt in possible previous similar experiences and also with that noted during the aforementioned general periods of occupational stress to which all accountants were exposed. Thus at the end of the study, we had a complete record of each subject's exposure to various types of personal emotional difficulty, in addition to those specific periods of socioeconomic stress which he showed with all of the other accountants. Finally at the end of the study, we were able to obtain from each subject's review of the past recorded upsets, that one which he considered to have exerted maximal stress of the particular kind we were studying (i.e., socioeconomic stress as defined above). The subjects were asked to give as frank and truthful information as possible during those interviews. From the sometimes delicate and confidential events revealed to us during such interviews, we have good reason to believe that almost without exception, these subjects made every possible attempt to cooperate in this phase of the study.

Recording of Weight and Exercise

Beginning January 8 and continuing biweekly until June 10, 1957, each subject was weighed. He was also questioned at each visit concerning the total number of hours of physical activity indulged in during the past 2 weeks and this was recorded. At the beginning of the study, each accountant was asked to refrain from indulging in any more physical activity during a period of emotional respite than he did during a period of stress. Such a restriction ensured the continued control of this factor, considered by some to play a part in the control of the serum cholesterol level.

Recording of Dietary Intake

From the outset, we were aware of the possible influence of the diet upon the blood chemical values. We also were aware of the total untrustworthiness of any dietary survey that depends upon either the recall abilities of subjects or its calculation from government statistics. We decided therefore to employ the dietary system we had employed in a previous study. Each accountant (after suitable orientation) was given a mimeographed sheet providing space for the detailed daily recording for 7 days of his intake of all foods and beverages, both at regular mealtime and otherwise. Each then was asked to record his dietary intake for a period of 1 week, both during a period of maximal occupational stress (April 2 to 9) and again during a period of maximal respite (May 14 to 21).

Recording of Serum Cholesterol and Blood Coagulation Time

Beginning January 8 and continuing biweekly until June 10, 1957, each accountant was bled at 8:00 to 9:00 a.m. and the serum portion of this sample was analyzed for total cholesterol.

Beginning on February 19 and continuing monthly, 19 subjects (13 "tax" and 6 "corporate" accountants) also were bled for determination of their blood coagulation time. Unfortunately, these measurements were not begun until February. Actually we decided to perform this portion of the study only after the fatal coronary thrombosis of one of the accountants in January. For this determination, a 2-tube Lee-White method (2 ml. whole blood per tube) was employed. The time for coagulation was calculated as the average of the time of coagulation of each tube, recorded from the onset of free withdrawal of 5 ml. of blood into a dry syringe through a 21-gage needle. A uniform technic was employed and the coagulation times were determined by the same group of 3 technicians throughout the study period.
TABLE 1.—Average Daily Dietary Intake

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>April 2–9 May 14–21</td>
<td>April 2–9 May 14–21</td>
</tr>
<tr>
<td>Total calories</td>
<td>1787 (1000–2700)*</td>
<td>1805 (1350–2900)</td>
</tr>
<tr>
<td></td>
<td>1733 (1175–2375)</td>
<td>1825 (1300–3200)</td>
</tr>
<tr>
<td>Protein (Gm.)</td>
<td>62.6 (40–100)</td>
<td>66.0 (40–85)</td>
</tr>
<tr>
<td></td>
<td>65.3 (47–80)</td>
<td>61.0 (50–85)</td>
</tr>
<tr>
<td>Carbohydr. (Gm.)</td>
<td>165.0 (85–265)</td>
<td>181.0 (90–285)</td>
</tr>
<tr>
<td></td>
<td>161.0 (100–210)</td>
<td>180.0 (150–235)</td>
</tr>
<tr>
<td>Fat (Gm.)</td>
<td>86.0 (50–130)</td>
<td>89.0 (60–140)</td>
</tr>
<tr>
<td></td>
<td>87.6 (70–116)</td>
<td>83.2 (55–130)</td>
</tr>
<tr>
<td>% Dietary fat</td>
<td>43.2 (38.0–49.1)</td>
<td>42.2 (36.5–49.7)</td>
</tr>
<tr>
<td></td>
<td>45.5 (36.4–52.0)</td>
<td>41.0 (36.4–48.7)</td>
</tr>
</tbody>
</table>

* Range of values

RESULTS

General Health

Unfortunately, approximately 6 hours after the initial bleeding period on the morning of January 8, 1957, one of the "corporate" accountants (age 48 years) suffered an acute myocardial infarct and died about 2 hours after its clinical onset. At autopsy, a fresh thrombus was found occluding the anterior descending branch of the left coronary artery. This individual, similar to the other "corporate" accountants during the January period, had been under very severe work stress for at least a week prior to this accident. It was of interest that his dentist had communicated to us his amazement at the rapidity with which this man's blood clotted following some therapeutic incisions into his gum tissues the day before his demise.

With this tragic exception, the remaining 39 accountants generally experienced good health throughout the 5-month period. None experienced previously or during the study any cardiorespiratory symptoms.

Weight and Exercise

As figure 1 illustrates, accountants as a group indulge in little physical activity, whether they are in a period of job stress or respite. Furthermore, little real difference was observed in their exercise habits during these same periods. Clearly then, no significant relationship was observed between physical exercise and the presence of socio-economic stress.

Likewise no significant changes in weight were observed in either group of accountants during the period of observation. Actually, in both groups, there were only 3 individuals who gained or lost more than 3 lbs. during the total period of study.

Dietary Intake

The average dietary intakes during the period of April 2 to 9 and also during the period of May 14 to 21 are shown in table 1. As can be seen, during the period of April stress, the dietary intake of calories and of fat of both groups of accountants was quan-
FRIEDMAN, ROSENMAN, AND CARROLL

titatively and qualitatively almost identical to that taken during the May period of respite. Again, as was noted in a previous study of upper class American males of this same age period, the total number of calories daily ingested was far below that commonly assumed by calculations derived from governmental statistics of "foods available for consumption."

Reactions to Socioeconomic Stress

It was quite obvious to even the casual observer that the subjects of both groups reacted emotionally to their respective periods of economic stress and this without exception. Such reaction revealed itself not only in their frank and candid admissions of a sometimes overpowering sense of urgency, and of the occurrence of irritation, insomnia, nervousness, and even quarrelsomeness with family and colleagues, but also by obvious changes in their demeanor, speech, and general attitude. Such changes clearly confirmed the presence of the phasic emotional strain of the type we wished to study.

Although such reactions were variously observed in all accountants during their respective periods of work stress, certain individual accountants of both groups during the 5-month period experienced 1 or more situations that were considered by them as

greatly diminished emotional stress his SC fell to 188 mg./100 ml. (g) The initial SC observed in this 50-year-old obese accountant was 165 to 170 mg./100 ml. Subsequently, during a time of severe emotional strain occasioned by a heavy work load, his SC rose to 240 mg./100 ml. and, during a time of added stress due to his wife's illness, it rose to 260 mg./100 ml. (h) The SC of this 62-year-old accountant varied between 165 and 170 mg./100 ml. during a period of severe work stress. (i) This extremely obese, 60-year-old accountant exhibited a SC of 184 to 185 mg./100 ml. early in the study period. During a subsequent period of severe work stress in which he became very irritated at his boss, it rose to 220 mg./100 ml. A day after the latter determination he resigned and while on "vacation" his SC fell to 165 mg./100 ml. One week later, at the beginning of the April tax period, he was employed elsewhere, and at this time his SC rose to 216 mg./100 ml. During the subsequent marked "lull" in activity his SC fell progressively to 190 mg./100 ml.

Fig. 2. Serum cholesterol changes observed in 9 representative individual accountants. (Periods of unusually severe work stress are indicated by shaded blocks and periods of severe emotional stress due to other causes by diagonal-lined blocks). (Seriol total cholesterol == SC). (a) A 47-year-old obese accountant. His SC rose progressively from 269 mg./100 ml to 325 during a time of severe work stress, then fell to 267 mg./100 ml and, during the combined stress of the April income tax period and moving his household to a new residence, again rose to 325 mg./100 ml. During the subsequent "lull" in his work, his SC rapidly fell to 251 mg./100 ml. (b) A 32-year-old corporation tax specialist whose SC varied between 290 and 305 mg./100 ml. a period of severe work stress and then rapidly fell to 227 during a subsequent "lull." A progressive rise of SC to 352 mg./100 ml. then occurred during the following period of intense work stress in April. (c) This 33-year-old accountant exhibited an SC of 303 to 331 mg./100 ml. during a period of severe emotional tension consequent to severe work stress combined with the emotional strain of studying for the final examinations of his third year of night law school. Subsequently, and in association with administration of Rauwolfoid, his SC fell progressively to 224 mg./100 ml. (d) A 38-year-old accountant whose SC rose from 230 to 301 mg./100 ml. following a period of unusually heavy work stress during which a child also was hospitalized with an erroneous diagnosis of serious illness. Subsequently his SC fell to 250 to 255 mg./100 ml. (e) Age 39. While under severe emotional strain consequent to intense work stress while simultaneously running for local political office, his SC rose from 218 to 269 mg./100 ml. It then rapidly fell to 222, but again rose to 254 mg./100 ml. during the severe stress of the April tax period. Subsequently his SC fell to 194 mg./100 ml. (f) The SC of this 37-year-old accountant rose from 190 to 269 mg./100 ml. during a period of unusually heavy work stress in which he also engaged in an unpleasant court "battie" with his estranged wife over child custody. The SC subsequently rapidly fell to 227, but during the severe stress of the April tax period, again rose to 260 mg./100 ml. In the subsequent period of

Downloaded from http://circ.ahajournals.org/ by guest on April 29, 2017
more stress-inducing that the usual occupational deadline periods of stress associated with their work. Although most of these additional stressful situations arose again out of business activities, some came from extra-financial activities. Some of these situations and their particular effects are discussed further below.

**Serum Cholesterol Changes**

*Average Group Changes.* The changes in the average serum cholesterol concentrations observed in the 2 groups of accountants during the 5-month experimental period are shown in figure 2. Despite the fact that no significant change had occurred in the weight, dietary, or exercise habits of either group, it can be seen that significant changes occurred in the average serum cholesterol of these subjects.

The average cholesterol of the “tax” accountants (group A) varied between 206 and 217 mg. per 100 ml. during their January and February periods of respite but rose during the April stress period to a peak of 232 mg. per 100 ml. on April 15. Subsequently it began to fall, reaching a value of 215 mg. per 100 ml. on June 6. When the ratios of the individual serum cholesterols (average 206 mg. per 100 ml.) obtained on January 22, a period of respite, and those (average 232 mg. per 100 ml.) obtained on April 15, the period of maximal stress, were evaluated statistically, the change in cholesterol was found to be significant (p < 0.05).

It was of great interest to us that the “corporate” accountants (group B) who differed from the “tax” accountants in that January was as much or more a period of stress than April, exhibited just as high serum cholesterol during the former period as they did in April (fig. 3). Furthermore, a tendency of the serum cholesterol to rise was observed in June, during which time these accountants again were exposed to moderate stress. Once again however, similar to the “tax” accountants, they had lower serum cholesterol levels during the February and March periods of respite. During these periods however, their average serum cholesterol tended to be somewhat higher than that of the “tax” accountants. Whether this was due to the fact that “corporate” accountants rarely were as free of stress even during periods of time between tax deadlines is a matter of conjecture.

*Average Individual Changes.* In the preceding section the data indicated that the average serum cholesterol of each group was elevated during the usual and expected periods of severe work stress in the lives of the 2 groups of accountants. However, as was pointed out above, not all of the accountants believed they experienced their maximal emotional reaction to a socioeconomic stress at the usual periods. Thus, for example, one accountant felt, and perhaps rightly, that the stress creating the maximal emotional perturbation in him was not one of the tax deadline periods but a 2-week period in February when he was engaged in a legal battle with his former wife over child custody.

It was considered of interest therefore to compare the average cholesterol of each subject obtained at the time that he considered he experienced his maximum stress with that obtained when he considered his emotional tension to be at its lowest. As can be seen by inspection of table 2, the average serum cholesterol at these times was significantly different. Thus the average serum cholesterol of all accountants was 252 mg. per 100 ml.
at the time they considered themselves under the greatest stress and only 210 mg. per 100 ml. at the time they felt most devoid of tension or a sense of urgency. The difference of the individual cholesterol values at these times was statistically highly significant ($p < 0.001$). In conformity with this observed stress-high cholesterol relationship was the fact that the maximum serum cholesterol observed in each individual during the 5-month period occurred in 91 per cent of the subjects at the time of his maximal interval of stress. Conversely, the minimal serum cholesterol occurred in 76 per cent of the subjects at the time of minimal stress. In only 4 instances was there a disparity between the maximal and minimal cholesterol values and respective periods of stress and respite.

It also was of interest that few patients showed a constant serum cholesterol throughout the 5-month period. Actually when the maximal and minimal observed cholesterol values of each subject were obtained and averaged, it was found that they differed by 63 mg. per 100 ml.

Specific Individual Changes. Figure 3 depicts the serum cholesterol variations in 9 of our patients who experienced a stressful situation in addition to the ones to be expected generally in their profession. The rapidity and sometimes the profundity of the rise of serum cholesterol following such unusual stresses are readily apparent, as is its subsequent decline with relief from the stress-inducing event or situation.

Unknown to us until the end of the study, one of the accountants (a 43-year-old senior partner of a very busy accounting firm) kept a detailed diary of his work load expressed in his own arbitrary units of 0 to 100. It is believed that this voluntary activity on his part was actuated by his extraordinary

---

**Table 2.** Average Serum Cholesterol at Time of Subject’s Maximum and Minimum Period of Emotional Stress (All Types)

<table>
<thead>
<tr>
<th>Serum cholesterol at time of</th>
<th>Actual range of each subject’s serum cholesterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum stress</td>
<td></td>
</tr>
<tr>
<td>Average: 252 mg./100 ml.</td>
<td>Maximum serum cholesterol</td>
</tr>
<tr>
<td>Range: (145–391)</td>
<td>263 mg./100 ml.</td>
</tr>
<tr>
<td>S.E. mean: ±7.5</td>
<td>(160–391)</td>
</tr>
<tr>
<td>Minimum stress</td>
<td></td>
</tr>
<tr>
<td>Average: 210 mg./100 ml.</td>
<td>Minimum serum cholesterol</td>
</tr>
<tr>
<td>Range: (138–354)</td>
<td>200 mg./100 ml.</td>
</tr>
<tr>
<td>S.E. mean: ±6.8</td>
<td>(127–314)</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td>Average: 42</td>
<td>Difference</td>
</tr>
<tr>
<td>Range: (2–125)</td>
<td>63</td>
</tr>
<tr>
<td>S.E. Diff. Means: ±10.1</td>
<td>(31–125)</td>
</tr>
</tbody>
</table>

---

**Fig. 4.** Correlation of serum cholesterol with accountants’ own diary of work stress. When heavily concerned with year-end statements, and while he simultaneously assumed the duties of head of a large corporation when its board chairman suffered a myocardial infarction, his serum cholesterol rose to 302 mg./100 ml., but during a subsequent distinct lull in work activity, it fell to 262 mg./100 ml. With the definite increase in stress of a deadline for quarterly tax returns his serum cholesterol again rose to 297 mg./100 ml. and subsequently again fell to 251 during the following period of very light activity. During the ensuing interval of severe work stress preceding the April 15 income tax deadline it again rose, to 292 mg./100 ml. and, during the subsequent marked decrease in work activity, in which time he also took a vacation, his serum cholesterol progressively fell to 231 mg./100 ml. He then entered a period of great emotional tension occasioned by the strain of working on several important and complicated tax problems. At the same time he was successfully competing to have his firm selected to do the accounting for a large Federal project. During this interval his serum cholesterol rose to 326 mg./100 ml., but during the subsequent decrease in his work load and associated tension, again progressively fell to 266 mg./100 ml.
interest in our project, due in part at least to the fact that he had known for several years that he suffered from xanthelasma and moderate hypercholesteremia. It is of interest that the serum cholesterol values, when placed upon the same graph (fig. 4), exhibited a striking direct relationship to phasic changes in his workload and its associated emotional tension.

Changes in Blood Coagulation. Surprising changes were observed in the blood coagulation time of both groups of accountants at the time of the April period of stress. The marked acceleration of clotting time that occurred in both groups during the April stress period, and its preceding and succeeding return to markedly slower values (fig. 5) during the periods of respite or moderate stress appeared to suggest an inescapable relationship between acceleration of clotting time and the presence of severe socioeconomic stress of the type under investigation. Thus in the February period, the average coagulation times in the subjects of group A and B were 8.1 and 7.0 minutes respectively, and on April 15, they were 5.0 and 5.5 minutes respectively, only to return to 8.8 and 9.7 minutes, respectively, on June 10. Statistical analysis of these changes revealed them to be highly significant ($p < 0.01$).

Discussion

The present studies appear to us to indicate an extreme sensitivity of the serum cholesterol to the occurrence of emotional duress of a particular type herein described as "socioeconomic stress." The possible effects of weight changes, and of dietary and exercise habits of our subjects were followed closely and not found to vary significantly from a period of stress to one of respite; it must therefore be concluded that the stress itself must be accorded primacy in the causation of the observed cholesterol changes. Although inconstancy of the serum cholesterol in serial determinations has been observed previously, particularly in persons with coronary artery disease, only recently has any possible causal relationship been recognized between the occurrence of emotional distress and either a rise or a persistently elevated serum cholesterol. If the exposure to such emotional stress as studied herein can by itself induce these often profound changes in serum cholesterol, then the results of any epidemiologic study of coronary arteriosclerosis predicated upon serum cholesterol differences, not taking this factor into account or confusing it with some other psychiatric entity such as simple anxiety states and psychoneurosis, are indecisive at best. As far as we know however, no epidemiologic study has taken such control precautions. Indeed, the results of most of the reported epidemiologic studies that generally incriminate the high-fat intake of upper middle class Western man as the major cause of their relatively high serum cholesterol could just as well have been utilized to support the concept that socioeconomic stress was the responsible factor. Indeed, it should be noted that various groups exhibiting a relatively low serum cholesterol (e.g., the Bantu, the Japanese peasant, the Southern Italian, etc.) purported by some to be due to a low dietary fat intake, also are not exposed to the type of socioeconomic stress described herein. Moreover, it should also be noted that certain other groups that are free of such particular forms of stress, exhibit similarly low serum cholesterol despite a high-fat intake. Finally, it should not be forgotten that Bronte-Stewart et al. remarked in their South African studies that if "job responsi-
bility” were employed as an indicator of stress, as good a correlation could be found between its variations and the varying incidence of clinical coronary disease in their subjects as that which they believed existed between the dietary fat intake and the latter.

The finding of a markedly accelerated clotting time in our subjects at the time of severe occupational stress appears as a possibly more important phenomenon than the elevation of their plasma cholesterol. When it is remembered that there has not been a significant increase in the serum cholesterol or dietary fat intake\textsuperscript{10,11} or in either the incidence or severity of coronary atherosclerosis per se\textsuperscript{12-14} in Western men, but only in the incidence of coronary thrombosis\textsuperscript{15-17} during the past 5 decades, the reason for this viewpoint becomes understandable.

**SUMMARY**

Serum cholesterol was obtained biweekly and blood coagulation time at monthly intervals from 40 volunteer accountants during the first 5 months of 1957, in order to study the effects of socioeconomic stress upon these 2 factors. Members of the accounting profession were selected for this study because of the sudden and marked phasic variations in their work stress uniquely imposed by the several “deadlines” in the tax calendar. The results indicate that severe occupational stress or other forms of unusual emotional tension are associated both with a sudden and often profound rise of serum cholesterol and a marked acceleration of blood coagulation time. The possible causal relationship of occupational and other socioeconomic stress both to coronary atherosclerosis and thrombosis is discussed briefly.

**ACKNOWLEDGMENT**

The authors wish to thank Frances Dahl, Dietitian, for analyses of the diet sheets.

**SUMMARIO IN INTERLINGUA**

Le valores del cholesterol seral eseva determinate a intervallos de duo septimanas e le tempore del coagulation de sanguine a intervallos mensual in 40 voluntarios euje occupation eseva le contabilitate. Le studio eseva continuate durante le prime 5 menses del anno 1957. Su objectivo eseva determinar le influentia de stresses socio-economic super le 2 factores mentionate. Contabiles eseva seligite pro iste studio a causa del subite e marcate variationes phasic in le stress de lor labor que depende rigorosamente del varie “datas terminal” in le calendario del taxation. Le resultatos del studio indica que sever stresses occupational o altere formas de unusual tension emotional es associate con un subite e frequentemente marcate augmento del cholesterol seral e etiam con un acceleration considerabile del coagulation del sanguine. Es presentate un breve discussion del possibile relation causal de stresses occupa
tional e alteremente socio-economic con atherosclerosis coronari e con thrombosis coronari.

**REFERENCES**


---

Medical Eponyms

By Robert W. Buck, M.D.


“Professor Grocco thus designates a new symptom which he has often found in pleurisy with effusion. It consists in a triangular area of relative dulness on the posterior wall of the thorax opposite to the side involved. The internal border of this triangle is represented by the line of the spinous processes, the base by the lower limit of thoracic resonance (which varies somewhat over a space of 3 to 6 cm.), and the external border by a line which extends obliquely upward to the highest point reached by the level of the exudate. Over this area the impairment of sound is more marked toward the median line and toward the base, and the base line itself varies in length and degree of dulness with different positions of the patient as he lies in bed, and with variations in the amount of fluid. The fluoroscope and radiogram confirm the percussion findings. This is illustrated by the accompanying figure, which shows two radiograms, one taken during life, the other from a cadaver in which one pleural cavity was filled with a solution of lead acetate. The test on the cadaver tends to support the idea that the pleural sac, when full of fluid, extends beyond the median line sufficiently and in such a way as to explain the triangle area of dulness above mentioned.”
Changes in the Serum Cholesterol and Blood Clotting Time in Men Subjected to Cyclic Variation of Occupational Stress
MEYER FRIEDMAN, RAY H. ROSENMAN, VERNICE CARROLL and Russell J. Tat

_Circulation_. 1958;17:852-861
doi: 10.1161/01.CIR.17.5.852

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1958 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/17/5/852

An erratum has been published regarding this article. Please see the attached page for:
/content/18/1/75.full.pdf

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Circulation_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to _Circulation_ is online at:
http://circ.ahajournals.org//subscriptions/
NEPHROGENIC HYPERTENSION FOLLOWING OPERATIVE TRAUMA

from that in the case reported. Interestingly enough, however, in a case described by Boeminghaus, in which the postoperative hypertension was the result of renal ischemia following the ligation of an accessory renal artery (a situation more nearly comparable to that in our case) a temporary persistence of hypertension was likewise noted.

In passing it may be mentioned that the variability of the response of the renal parenchyma to a reduction of its main blood supply through the renal artery may well be due to the differences in the pattern and extent of the capsular arteries that constitute a potentially important collateral arterial bed.

**Summary**

A report is given of an instance of malignant arterial hypertension supervening on inadvertent surgical trauma and eventual thrombosis of the right renal artery, and cured by right nephrectomy. The sequence of clinical events, the pathologic findings, and the bioassay of the parenchyma of the removed kidney are interpreted as proofs that the hypertension in this case was a clinical counterpart of the experimental hypertension produced under certain conditions by the constriction or occlusion of the renal artery.

**Summario in Interlingua**

Es reportate un caso de maligne hypertension arterial, superveniente post trauma chirurgie accidental sequite—in le curso del tempore—per thrombos e del arteria dextero-

renal. Curation del patiente esseva effectuate gratias a nephrectomia dextere. Le sequentia del evenimentos clinice, le constata- tiones pathologic, e le bio-essayage del parenchyma del ren excidite es interpretate como provas que le hypertension in iste caso esseva un correspondentia clinice del hypertension experimental producute sub certe conditiones per le constriction o le occlusion del arteria renal.

**REFERENCES**


**Erratum**

On page 856, of the May 1958 issue, (article by Friedman et al.) the legends for figures 2 and 3 should be transposed.