Effects of Periodic Mental Stress on Serum Cholesterol Levels

By Scott M. Grundy, B.S., and A. Clark Griffin, Ph.D.

The effects of academic final examinations on serum cholesterol levels were studied on 2 groups of medical students. A significant increase in the mean total serum cholesterol levels were observed during examination periods as compared to control periods of relaxation. These findings support previous reports of the effects of mental tension on serum cholesterol levels.

During recent years many factors have been found that apparently influence the development of atherosclerosis. Factors such as diet, sex, hormonal imbalance, heredity, and exercise are among those being studied most extensively at the present time. There are several recent reports suggesting the possible role of emotional stress as still another factor in atherogenesis and in coronary disease. Friedman, Rosenman, and Carroll have reported increases in serum cholesterols and decreases in blood clotting times in man subjected to cyclic variation of occupational stress. Wurtlake and co-workers found evidence that serum cholesterol levels were elevated in students during periods of mental stress associated with examination schedules. In the present paper further studies on the effects of periodic mental stress on serum cholesterol levels have been carried out on a large group of medical students.

Methods and Material

Total serum cholesterol values were determined on groups of freshman medical students as described below. Blood samples were drawn for cholesterol determinations on a group of 50 male students during the middle of the winter quarter of medical school. This procedure was repeated on the same group of students during the first day of final examinations at the end of the winter quarter. Blood samples were again drawn during the middle and at the end of the spring quarter on a group of 47 male students. Comprehensive final examinations were given at the end of the academic quarters. No other examinations were given to these students during the quarters. The ages of the students ranged from 20 to 31 years. Blood samples were collected in the postabsorptive state, and total serum cholesterols were determined by the method of Pearson, Stern, and McGavack.

Results

Table 1 records the results of this experiment. During control periods in the middle of the 2 quarters mean cholesterol values were 213.0 and 215.7 mg. per cent. Mean values during the final examination periods were 248.2 for the winter quarter and 239.4 mg. per cent for the spring quarter. For both quarters the increase in serum cholesterol during the final examinations was statistically significant ($p < 0.001$). Figure 1 breaks down the total groups into the number of students at examination time showing changes in serum cholesterols of -25 to 0, 0 to +19, +20 to +59, +60 to +89, and +90 mg. per cent as compared to previous levels. During the winter quarter 50 per cent of the students showed an increase greater than 25 mg. per cent at examination time, and 44 per cent of the students had an increase over 25 mg. per cent during the spring quarter. The greatest change in serum cholesterol for a single individual was an increase from 150 to 295 mg. per cent.

Discussion

The exact relationship between elevated serum cholesterol levels and atherogenesis is not understood at the present time. The production of hypercholesterolemia in various experimental animals leads to severe atherosclerosis. The incidence of clinical entities resulting from atherosclerosis appears to be...
MENTAL STRESS AND SERUM CHOLESTEROL

higher in countries where serum cholesterol levels are relatively high than in countries where cholesterol levels are low.\(^5\) In this country, mean cholesterol values for patients suffering from coronary disease are higher than for the population in general.\(^6\) Thus any factor that leads to the production of higher serum cholesterol levels would appear to be worth studying as a possible factor in atherogenesis.

The present study suggests that emotional stress may be one such factor producing an increased serum cholesterol level in some individuals. Since quarterly final examinations are the only examinations given at the institution where this study was carried out, the emotional tension among the students should be at a maximum at this time. During the middle of the school quarters tension should be relatively low. The changes noted during the 2 quarters show remarkable similarities to each other, as do the results of this experiment when compared with those recently reported in the literature.\(^1\,\,^2\)

The mechanism for the effects of mental tension on serum cholesterol levels is not immediately apparent. Friedman and co-workers\(^1\,\,^7\) reported that increases in cholesterol values during occupational stress could not be explained on the basis of dietary changes. Stress of various types is known to produce endocrine changes in experimental animals.\(^8\) Since blood lipid levels are influenced considerably by hormonal changes of many types, an endocrine imbalance during stress must be considered as a possible cause of changes in serum cholesterol. The high incidence of diseases resulting from atherosclerosis among business executives and others under constant pressure has led many individuals to believe that a causal relation exists between stress and these diseases. Only recently has there been any acceptable evidence to support this concept. More extensive studies are needed to reveal the significance of these preliminary observations.

### SUMMARY

The effects of quarterly final examinations on serum cholesterol levels in two large groups of freshman medical students were studied. During the 2 periods of examinations studied the mean cholesterol levels were elevated significantly over control periods of relative relaxation. The 2 groups of 50 and 47 male students showed a 16.5 per cent and 11 per cent increase in serum cholesterol levels during winter and spring quarter examinations, respectively.

### SUMMARIO IN INTERLINGUA

Le efectos de final examines trimestral super le nivellos de cholesterol in le sero esseva studiate in duo grande gruppos de studentes medical in le prime anno de lor curso academic. Durante le 2 periodos de examines que esseva includite in le studio le nivellos medie de cholesterol esseva significativamente plus alte que durante periodos de controlo de re-

### TABLE 1.—Changes in Serum Cholesterol Levels during Examination Periods

<table>
<thead>
<tr>
<th>Period*</th>
<th>No. of subjects</th>
<th>Mean cholesterol standard error of mean (mg. %)</th>
<th>Mean increase in cholesterol (mg. %)</th>
<th>Percent increase in cholesterol (mg. %)</th>
<th>Significance (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control I</td>
<td>50</td>
<td>213.0±7.9</td>
<td>35.2</td>
<td>16.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Exam. I</td>
<td>50</td>
<td>248.2±7.9</td>
<td>35.2</td>
<td>16.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Control II</td>
<td>47</td>
<td>215.7±5.4</td>
<td>23.7</td>
<td>11.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Exam. II</td>
<td>47</td>
<td>239.4±5.4</td>
<td>23.7</td>
<td>11.0</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

laxation relative. Le 2 gruppos consisteva de 50 e de 47 studentes mascule. Illes monstrava augmentos medie de 16,5 e 11 pro cento respectfulemente in le nivellos de cholesterol serum durante le examines trimestral de hiberne e de primavera.

REFERENCES

Medical Eponyms

By ROBERT W. BUCK, M.D.

Adie Syndrome. William John Adie (1866-1935), Physician, Charing Cross Hospital and Royal London Ophthalmic Hospital, etc. discussed "Pseudo-Argyll Robertson Pupils with Absent Tendon Reflexes, a Benign Disorder simulating Tabes Dorsalis" in The British Medical Journal 1: 928-930 (May 30) 1931.

"I wish to draw attention to a benign symptomless disorder characterized by pupils which react on accommodation but not to light, and by absent tendon reflexes.

"Five of the six cases I am about to describe came under my notice in the course of a few weeks; the condition therefore cannot be very rare. Though harmless in itself it merits recognition because it is often mistaken for a manifestation of syphilis of the nervous system, with unfortunate consequences for the patients and their families.

"... The true Argyll Robertson pupil reacts promptly and fully, often excessively, on convergence, and dilates again as soon as the effort to converge the visual axes is relaxed. In these cases the pupils show the so-called mytonic reaction; they do not respond to light; they contract very slowly through a wide range during a sustained effort to converge, often remain small long after the effort ends, and, when they dilate again, do so slowly. . . .

"It seems to me more than probable that some . . . cases with non-leutic Argyll Robertson pupils but normal tendon reflexes are examples of a milder form of the same benign disorder that I have described here."
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