

*M. A. O. Malik, M.B., B.S., Ph.D., D.M.J.Clin. and Path.*¹

Emotional Stress as a Precipitating Factor in Sudden Deaths Due to Coronary Insufficiency

The association of attacks of coronary insufficiency to episodes of physical effort is now seldom in doubt. On the other hand their association with bouts of emotional stress has not been so well recognized or universally accepted. A large number of autopsies were performed for the coroner on victims of sudden coronary deaths. The case histories of a number of these victims indicated that death was precipitated by some emotional factor. The intention here is not to present a statistical epidemiological analysis of the situation—largely because this is an impracticable proposition for it is often difficult or even impossible to obtain a proper and reliable eyewitness account of the attendant circumstances—but rather to describe some relevant, reliably documented cases of sudden coronary deaths related to a range of emotional behavior patterns, including anger, grief, depression, fright, and excitement.

Case Reports

Case 1

Male aged 40. On returning home one evening he found his mother standing at the door where she complained to him that the neighbor's children were again annoying her. On hearing this he flew into a rage and said he would beat them if they did it again. As he finished speaking, he collapsed and died.

Case 2

Male aged 68. He had been relaxing in a chair that evening watching television. When the program finished, he went out to leave some empty milk bottles at the door. He then saw a car parked there. He had been objecting to cars stopping there at night as their engines disturbed him and his family. He became angry; and as he was remonstrating with the car driver, he collapsed and died almost immediately.

Case 3

Female aged 76. At about 7 p.m. she had an argument with her daughter with whom she lived. The argument became heated; and when it ended, this woman walked only a few yards down the road before she collapsed. She was found dead on admission to the hospital a few minutes later.

Case 4

Male aged 63. At about 8 p.m. some children were playing football outside his house which greatly annoyed him. He went out and complained to them about this, but they did

¹ Department of Pathology, Faculty of Medicine, P.O. Box 102, Khartoum, SUDAN.

not respond. He returned to the house indignant and told his wife that he was going to complain to the police. She noticed that he looked very pale although he did not complain of feeling unwell. He then left the house to go to the police station; but before he had walked a few yards, he suddenly collapsed onto the pavement and died shortly afterwards.

Case 5

Male aged 56. He left home one night after having a row with his wife. As he walked a few steps down the road, he felt unwell. He called at a neighbor's house where he was put to bed, but he was dead a few minutes later.

Case 6

Female aged 64. She resided at an old people's home, and about 11 p.m. one night she had a heated encounter with another resident. At 11:30 p.m. the matron found her dead in bed.

Case 7

Female aged 69. She lived with her brother. One morning she prepared his breakfast and called him as was her custom. When she got no response, she went into his bedroom where she found him apparently collapsed in bed. She became alarmed and went to call a next door neighbor for help. When they returned and she realized that her brother was already dead, she herself collapsed and died.

Case 8

Female aged 57. She attended her sister's funeral in the afternoon. In the evening she was sitting in a chair in the living room of her deceased sister's house; and, apart from looking grieved, she made no complaint. At about 7 p.m. she suddenly collapsed and died soon afterwards.

Case 9

Male aged 77. He was a retired teacher who, since his wife's death two years previously, had been depressed and often stayed in hostels. One afternoon he visited a funeral director and discussed arrangements for his own funeral. That evening he retired to bed as usual but was found dead in bed the next morning.

Case 10

Female aged 62. At about 9 p.m. one evening someone called to inform her that her sister, who lived in the same street, had collapsed suddenly. She immediately rushed out, obviously alarmed at the news; but as soon as she left the door, she collapsed and died almost immediately.

Case 11

Male aged 62. He went one afternoon to the church to attend the funeral service of a close friend. Apart from looking overwhelmed with grief, he appeared normal and made no complaint to those around him. While on his knees praying during the service, the man next to him saw him slump forward. He died soon afterwards.

Case 12

Female aged 76. She had lived in Ireland until her daughter came over from England to take her back to stay permanently with her. They boarded the steamer at Belfast Harbor at 8 p.m. The mother was sitting in a chair in the lounge evidently in deep emotional dis-

truss about leaving Belfast. At 8:30 p.m. just as the steamer started to sail, she collapsed and died without uttering any complaint.

Case 13

Female aged 69. She was the front seat passenger in a car driven by her husband when it was involved in a minor traffic accident. No one involved in the accident had been injured; but almost immediately afterwards, she collapsed and died without speaking. She was known to be of a "nervous disposition."

Case 14

Male aged 65. He was driving his car around a traffic circle when it collided with another car coming from the right side. After the impact he drove his car for about 15 yards, parked it, and walked back to the point of impact where the other car remained. He looked shaken as he spoke with the other driver. He suddenly asked him to open the car for him; but before the other driver could do so, the man collapsed to the ground and was found dead when the ambulance arrived a few minutes later. He had not sustained any injuries.

Case 15

Male aged 52. He was interrogated by the police in connection with a stolen television set. Then he was taken to the house where the set was kept. As soon as they entered the room, he said that he was not feeling well, sat down in a chair, and a few minutes later slumped back and died.

Case 16

Female aged 62. She was a widow and owned a shop opposite some hospital. About 10 p.m. she left the shop to go home in her car which was parked at the curb. As she was getting into the car, two men appeared and snatched her handbag from her. She ran back into the premises and used a telephone in a room of the flat above the shop which she rented to some nurses. She rang both the police and her son. As she was leaving the room, she met one of the nurses and told her what had happened. She looked very shaken, and the nurse went to assist her and offered to make her a drink. She declined the offer, then suddenly collapsed and died some minutes later.

Case 17

Male aged 79. About 11 p.m. he was sitting with his sister in the living room when they heard a noise downstairs. When the sister looked, she discovered two intruders attempting to get out. She shouted at them, and they ran upstairs because the house door was bolted. They pushed her and hit her, and she pleaded with them not to harm her brother as he had heart trouble. She started to scream, and the men ran out. She got up, and the brother went to help her; but then he stopped, leaned over a chair, collapsed, and died.

Case 18

Male aged 64. He attended the X-ray department for a barium enema for investigation of abdominal pain. He appeared normal although someone later commented that he seemed a bit nervous about the procedure. As soon as the procedure was over, he got off the table, suddenly collapsed, and died.

Case 19

Male aged 41. He stayed up late one night to watch an important boxing match on television. When his mother retired to bed, she spoke to him and he seemed all right then.

When she came again downstairs a few hours later, she found him dead, the television set still switched on.

Case 20

Male aged 64. One morning the police received a telephone call reporting that a man was lying in a car parked off the road. When they arrived they found him in the rear compartment, kneeling, dead, cold, and stiff. His knees were on the floor space behind the front passenger's seat, his trunk was over the back seat, and his hands were holding onto the back rest. He was fully clothed, but his fly was open, and his penis was uncovered. A contraceptive sheath containing semen was lying between his knees. The scene suggested that he had died just after sexual intercourse. He was a married man, and he and his wife had a grown son. Although the intercourse entails some physical effort, it is reasonable to suggest that the emotional strain of the exercise, particularly under such circumstances of secrecy, could have also played a part.

Case 21

Male aged 65. He was sitting in the grandstand watching a football game. He became excited over the game, stood up, looked unwell, and fell forward. He was dead on arrival at the hospital some minutes later.

Case 22

Male aged 58. He travelled with his wife by taxi to a chapel to attend the wedding of their son. During the journey he seemed in excellent spirits and was obviously excited about the occasion. They took their seats in the front row. A few minutes later, just as the service had started, he collapsed to the floor and died shortly afterwards. According to his wife, he would become easily excited or annoyed recently. On these occasions he often complained of pain in his chest.

Discussion

During the past two decades there have been a number of reports in the literature dealing with the correlation between emotional stress and cardiac insufficiency. Chambers and Reiser [1], in a study of 25 consecutive patients with congestive heart failure, found that in 19 of these patients the superimposition of an acute and overwhelming emotional experience was the factor immediately responsible for the onset of cardiac decompensation. Miles et al [2] found that the coronary patient tended to work harder, under more stress and strain though this was not necessarily of a physical nature. Jarvinen [3] has even suggested that the emotional strain associated with ward rounds precipitated coronary occlusion in some of the cardiac patients hospitalized at the time. Weiss et al [4] studied 43 patients with coronary occlusion from an emotional viewpoint as compared with a control group matched for age, sex, and race. Chronic stress occurred in 49 per cent of the coronary cases while there was no similar evidence in the control group; acute stress was a feature in 37 per cent of the coronary group, but it was present in only 4 per cent of the control group. They concluded that among the multiple factors implicated in coronary occlusion, emotional stress could well be significant.

More recently Minc [5] suggested that cardiac maladaptation to emotional stress, either by its frequent recurrence or in combination with structural factors, may lead to ischemic changes. Sigler [6] observed that coronary disease occurred more frequently and more severely in highly-strung persons and suggested that repeated psychic trauma in emotionally disturbed individuals may be one of the underlying causes in the pathogenesis of

atherosclerotic heart disease and in inducing acute cardiac insults. Carruthers [7] commented on the strong association between aggressive behavior and atheromatous processes involving the heart. Murray-Parkes et al [8] found an increased mortality from coronary thrombosis and other arteriosclerotic and degenerative heart disease among surviving widowers during the first six months after bereavement and suggested that this was probably related to the associated psychological stress. Finally, according to Flavell-Matts [9], there seems little doubt that some correlation exists between the occurrence of coronary thrombosis and frequent exposure to stressful situations.

Various mechanisms—hemodynamic, neurohormonal, metabolic and electrophysiological—have been advanced to explain the possible adverse effects which can be caused by emotional stress on cardiac function thereby precipitating a cardiac insult.

It is now a well recognized clinical observation that emotional stress is followed by an accentuation of the hemodynamics of the circulation, including a rise in pulse rate, stroke volume, cardiac output, peripheral resistance, and arterial blood pressure. This was demonstrated, for example, by Brod et al [10] when they subjected eight normal reclining persons to stressful mental arithmetic so that they became tense, nervous, and embarrassed.

It has also been shown that mental stress, by affecting the psyche, leads to biochemical changes via the neurohormonal influences. Thus emotional strain has been found to result in a shortened clotting time and an increased viscosity of the blood [11]. A rise in serum cholesterol has also been observed [12]. Both adrenaline and noradrenaline produced under conditions of stress result in an increase in free fatty acids in the blood due to lipolysis of glycerides in adipose tissue [7].

Raab [13] has shown that sympathomimetic catecholamines induced by emotional stress had a specific oxygen-wasting chemical effect on the heart thereby inducing myocardial hypoxia and consequent ischemic changes. Sarnoff et al [14] also demonstrated that the gradual introduction of increasing minute concentrations of noradrenaline into the myocardium of an isolated heart resulted in a great increase in its oxygen consumption, thus leading to a lowering of its mechanical efficiency.

It has been suggested by Sigler [6] that emotional stress, by causing sympathetic nerve stimulation, results in disturbances in the normal electrophysiology of the heart; and as evidence of this, he demonstrated changes in the electrocardiogram including myocardial ischemia, ventricular ectopic beats, and alterations in ventricular depolarization and/or repolarization. According to Hoffman and Cranefield [15] circulating adrenaline, which normally increases the excitability of the Purkinje fibers of the heart, has a greatly enhanced action when the fibers are already ischemic; they also suggest that a rise in circulating adrenaline may induce fibrillation by precipitously dropping the threshold for R-T stimulation.

The view has also been suggested that emotional stress may further act indirectly on the heart by altering the consumption by the individual of substances, such as fats, sugars, coffee, and tobacco, which have been linked statistically with an increased mortality from coronary disease. It is interesting to note in this connection that smoking, for instance, is accompanied by secretion of catecholamines, in particular noradrenaline, thereby causing rises in blood free fatty acids of up to 80 percent [16].

When all the available information is taken into account, it is reasonable to suggest that the mechanism of sudden death following emotional stress probably depends on a combination of myocardial hypoxia and a rise in circulating catecholamines. The former induces ischemic changes which render the ventricular fibers more susceptible to fibrillation, and the latter actuate fibrillary action by enhancing the excitability of the Purkinje fibers or reducing the threshold for R-T stimulation.

Coronary occlusion by recent thrombus was detected in 8 of the above 22 cases while the remaining 14 cases exhibited merely severe narrowing of the lumen due to atheromatous thickening, either eccentric or concentric, of the arterial wall. These findings are consistent with the experience of others reporting on Coroner's autopsies. Branwood and Montgomery [17], for instance, found a recent thrombus in only 5 of 26 cases of sudden death while Crawford, Dexter and Teare [18] found that a thrombus was present in only 55 percent of such cases even after postmortem coronary angiography and microscopy of semiserial sections of the stenosed segments. However, it is interesting to note that of those 14 cases, at least 6 showed evidence of intimal hemorrhage, usually in an atheromatous plaque; and it is likely that this figure would have been higher had more exhaustive sectioning of the coronary arteries been done. This raises the question whether the additive effect of a repetition of this process may not be an etiological factor in the pathogenesis of coronary atheroma. Sigler [6] believes that this could well be the case. He has postulated that recurring increase in arterial pressure and distension of the coronary arteries during emotional stress over the years may cause intimal damage in these arteries. Tissue reaction to injury and capillary formation follows, and finally gradual development of atheroma is caused by deposits of lipids which later become calcified.

Summary

Twenty two cases of sudden deaths due to coronary insufficiency are described. In each case the history suggests that the death has been precipitated by an episode of emotional stress. The possible mechanisms involved are discussed, and it is suggested that emotional stress may play a role in the pathogenesis of coronary atheroma.

Acknowledgments

I am greatly indebted to Dr. T. K. Marshall, State Pathologist, Northern Ireland, and to Dr. D. J. L. Carson, his deputy, for their assistance, advice, and training. I wish to thank my colleagues in the Department of Forensic Medicine for the use of their cases. A training and research grant was provided by the Ministry of Overseas Development (The British Council).

References

- [1] Chambers, W. N. and Reiser, M. F., *Psychosomatic Medicine*, Vol. 15, 1953, p. 38.
- [2] Miles, H. H. W., Waldfogel, S., Barrabee, E. L., and Cobb, S., *Psychosomatic Medicine*, Vol. 16, 1954, p. 455.
- [3] Jarvinen, K. A. J., *British Medical Journal*, Vol. 1, 1955, p. 318.
- [4] Weiss, E., Dlin, B., Rollin, H. R., Fischer, H. K., and Bepler, C. R., *Archives of Internal Medicine*, Vol. 99, 1957, p. 628.
- [5] Minc, S., *Medical Journal of Australia*, Vol. 1, 1966, p. 856.
- [6] Sigler, L. H., *British Journal of Medical Psychology*, Vol. 40, 1967, p. 55.
- [7] Carruthers, M. E., *Lancet*, Vol. 2, 1969, p. 1170.
- [8] Murray-Parkes, C., Benjamin, B., and Fitzgerald, R. G., *British Medical Journal*, Vol. 1, 1969, p. 740.
- [9] Flavell-Matts, S. G., *British Journal of Clinical Practice*, Vol. 24, 1970, p. 545.
- [10] Brod, J., Fencel, V., Hejl, Z., and Jirka, J., *Clinical Science*, Vol. 18, 1959, p. 269.
- [11] Schneider, R. A. and Zangari, V. M., *Psychosomatic Medicine*, Vol. 13, 1951, p. 289.
- [12] Dreyfuss, F. and Czackes, J. W., *Archives of Internal Medicine*, Vol. 103, 1959, p. 708.
- [13] Raab, W., *Cardiologia, International Archives of Cardiology*, Vol. 22, 1953, p. 291.
- [14] Sarnoff, S. J., Gilmore, J. P., Weisfelt, M. C., Doggett, W. M., and Mansfield, P. B., *American Journal of Cardiology*, Vol. 16, 1965, p. 217.
- [15] Hoffman, B. F. and Craneheld, P. F., *American Journal of Medicine*, Vol. 37, 1964, p. 670.
- [16] Murchison, L. E., and Fyfe, T., *Lancet*, Vol. 2, 1966, p. 2.
- [17] Branwood, A. W. and Montgomery, G. L., *Scottish Medical Journal*, Vol. 1, 1956, p. 367.
- [18] Crawford, T., Dexter, D., and Teare, R. D., *Lancet*, Vol. 1, 1961, p. 181.