Overwork, Stroke, and Karoshi-death from Overwork

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Abstract-

Karoshi, death from over-work, is usually the extreme result of acute cardiovascular events including stroke. Among 203 karoshi cases received worker compensation in Japan, sixty percent died of stroke. Karoshi is a term for social medicine originated from Japan. Literature reviews on karoshi found that long overtime at work, on duty in holidays, attending a new job with no family members around, and working at night shift are risk factors. Work stress increases secretion of catecholamines (epinephrine and norepinephrine) and cortisol which is associated with progression of atherosclerosis and increased risk of cardiovascular diseases and stroke. To avoid long working hours, stress management and treatment of hypertension, diabetes, and hyperlipidemia are key issues in preventing karoshi caused by stroke.

Key words: overwork, work stress, karoshi, stroke

Acta Neurol Taiwan 2012;21:54-59

In late November 2010, the death of a young attending physician at the Department of Neurology, National Taiwan University Hospital shocked Taiwanese medical society, especially the neurology society. He was forty years old and in good health except complained feeling tired sometimes before his death according to his colleagues. A 32-year old resident of surgery at a medical center has survived an acute myocardial infarction followed by an embolic cerebral infarct and finally still having amnesia. Sudden death has been noticed in university professors, physicians, engineers of the high tech companies, and in blue collar workers. Some of these cases did not have common risk factors of cardiovascular diseases such as hypertension or diabetes. What caused their stroke or myocardial infarction? Is overwork responsible for the event?

Association between work-related factors and cardiovascular diseases and stroke

Common risk factors for cardiovascular diseases and stroke include hypertension, diabetes, hyperlipidemia, obesity, smoking, and family history. These factors account for 30 to 40% of cardiovascular diseases[1]. The association between exposure to chemicals (such as carbon disulfide, carbon monoxide, methanol dichloride, and nitroglycerine) and physical factors (such as noise and low temperature) at workplace and cardiovascular diseases is well established[2,3,4]. However, the role of work stress and job content on development of cardiovascular diseases and stroke are not yet conclusive. Research based on Karasek's demand-control model has showed that "high demand-low control" jobs increased incidence of cardiovascular diseases[5,6]. Epidemiological

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Received August 25, 2011. Revised November 10, 2011.
Accepted February 23, 2012.

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studies in the United States and Japan found positive association between over-time work, shift work, and long-travelling time to work and cardiovascular diseases[2,7,8,9]. Studies in Europe found that low reward jobs, shift work, and working at night increased risk of cardiovascular diseases[10,11,12].

Karoshi, death from overwork, is a social medicine term first appeared in Japan in late 1970[13,14]. The first reported case of karoshi was in 1969 with a stroke death of a 29-year-old male worker in the shipping department of Japan's largest newspaper company[13]. It was not until the later part of the 1980s when several business executives who were in their prime years suddenly died without any previous sign of illness. This new phenomenon attracted media's attention in Japan, and was quickly labeled karoshi, denoting a novel and serious menace for people in the work force[13]. Karoshi is occupational sudden death. The major medical causes of karoshi deaths are heart attack and stroke due to stress[13]. There are Taiwanese social scientists retrospectively reviewed the developmental process of Japanese industry and enterprise[15,16,17]. They tried to explore factors associated with karoshi events from social science viewpoint. They have found two major factors associated with karoshi: 1. long working hours; 2. too much work stress. They also found that workers working with irregular duty hours, taking new jobs without family members around, working at night, and piecemeal jobs are associated with increased risk of karoshi. Furthermore, business and union leaders did not pay attention to the impact of work stress on karoshi, and this ignorance has contributed to the increase of karoshi in Japan.

Responding to the increased attention and awareness to karoshi, the Japanese Ministry of Labor began to publish statistics on karoshi in 1987[13]. Many companies, such as Toyota, have working hour policy to limit overtime work and stressed the importance of rest and urging workers to go home. Moreover, governments, including Japan and Taiwan, have faced increasing pressure and finally set legal criteria of karoshi for worker compensation. Taiwanese government passed the guideline for establishing occupational cardiovascular and cerebrovascular diseases in 1991 and revised in 2004 and in 2010. Table 1 described major medical causes of death and symptoms and signs of karoshi[13,18]. Most frequent medical causes of death are acute heart failure and subarachnoid hemorrhage. People under overwork stress may present with no obvious symptoms and signs of heart and/or brain problems but with depression and/or burnout syndrome[18]. Death and suicide due to overwork has been reported as new occupational threats to Japanese physicians[18].

Stress hormones in health and illness: the role of work

Two neuroendocrine systems would be of specific interest in the study of health impact from stress[19]. The sympathetic adrenomedullary system secrets two catecholamines, epinephrine and norepinephrine, and the hypothalamic pituitary adrenocortical system secrets

Table 1. Major medical causes of death and symptoms and signs in karoshi

Major medical causes of death (%)[13]	SAH*(18.4%)
	Cerebral hemorrhage (17.2%)
	Cerebral infarction (6.8%)
	Myocardial infarction (9.8%)
	Heart failure (18.7%)
	Other causes (29.1%)
Pre-event condition[18]	Common symptoms and signs
Burnout symptoms	Easy fatigue, forgetful, tight neck and shoulder, headache, myalgia, chest tightness, body weight change.
Depression	Poor concentration, feels blue easily, insomnia, suicide idea or attempt

*SAH：subarachnoid hemorrhage

cortisol. These hormones have often been used as stress indicators because they can be measured in blood and urine. In response to stress, epinephrine and norepinephrine are rapidly secreted into blood stream with pronounced effect on the cardiovascular system and caused release of energy, glucose and free fatty acids. The stress response could be life saving for human especially while facing emergency. When an individual encounters stressful life events (stressors), he or she uses self-coping mechanisms to resolve the stress. The response to a stressful event may vary depending upon the physiological and psychological state of the person. If failed to achieve complete resolution, a prolonged stress stimulus or residual stress can cause psychophysiological responses (i.e., stress response) which may result in increased vulnerability to or directly cause organic diseases[20,21]. The physiological response of residual stress may increase sympathetic nerve activity and elevate blood catecholamine levels which may be detrimental to health over a long period. Therefore, long-term stress could result in sustained higher serum level of catecholamines and elevated blood pressure. Folkow[22] has proposed a model in which elevated blood pressure responses could lead to thickening of artery walls and narrowing of the blood vessels, thus increasing peripheral resistance in the cardiovascular system. The catecholamines also contribute to elevated blood lipid levels, increased blood clotting, and atherosclerosis[19]. Epinephrine and norepinephrine are associated with hypertension, myocardial infarction and stroke. On the other hand, cortisol affects cell metabolism and fat distribution, and has been linked to cardiovascular disease, type 2 diabetes, reduced immune function and impaired cognition[19]. Lundberg and Hellstrom[23] found that women regularly worked more than 50 hours a week had double cortisol levels compared with women with a more moderate workload.

Psychosocial work environment and work stress

Over the past few decades, stress has come to be recognized as one of the most pervasive and potent health hazards in the work environment. Occupational stress

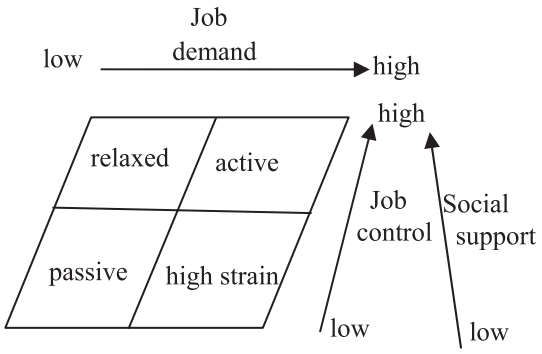

Figure 1. A three-dimensional model for psychosocial work environment (adapted from Karasek and Theorell[24])

refers to negative environmental factors or stressors (e.g. work overload, role conflict/ambiguity, poor working conditions) associated with a particular job or workplace [21]. Karasek and Theorell[24] present a three-dimensional model (Figure 1) integrating three psychosocial aspects of the work environment and their association with worker's health. These three aspects include job demand, decision latitude (job control), and social support at work. The underlying theory of the model is that stress is the result of a lack of balance between three work factors: work demands, work supports, and work constraints such as monotonous tasks that limit workers to have control on their performances. These three factors encompass almost all aspects of the workplace that workers encounter, both physically and psychologically. Job decision latitude is the worker's potential control over job-related decision making; this involves control over the use of skills, time allocation, and organizational decisions. Job demands refer to the need to do jobs in a demanding way such as doing jobs very fast or very hard, or having a disproportionate amount of work to be done within a limited time frame. They found that the primary work-related risk factor appears to be a lack of control over how one meets the job's demands and how one uses one's skills; elevation of risk with a demanding job, in many cases, appears only when these demands occur in interaction with low control on the job[24].

The most adverse reactions of psychological stress occur when the demand of the job is high and the worker's decision latitude in the task is low, namely, "high-

strain" jobs. These jobs make up the most stressful work environment. Workers in this group seem to have a higher than average level of residual stress and risk of physical illness[6,24,25]. On the other hand, low job demands and high decision latitude imply an environment of "low-strain (relaxed)" jobs, and workers in this group are predicted to have a lower than average level of residual stress and risk of illness. A third category of jobs, in which control is high and job demand is also high, is "active jobs." Research has shown this group of workers to be the most active during leisure and popular activities outside of work, in spite of heavy work demands. Members of this group are predicted to have an optimistic set of psychosocial outcomes and high learning motivation to develop new behavior patterns that are conducive to high productivity. There is little residual stress in this case. The fourth category is "passive jobs", with low demands and low decision latitude, in which a gradual atrophy of learned skills and abilities may occur. For passive jobs, an average level of psychological stress and risk of illness, as in the case of active work, was proposed because the low demands situation means that fewer stressors are confronted[6,24,25].

Social support at work, the third domain of psychosocial aspects of the work environment, refers to the overall level of helpful social interactions available on the job from both co-workers and supervisors, and also inputs from families and friends that are beneficial in solving problems confronted at work. Social support at work can mitigate or buffer the impact of occupational stress on health which may aid psychological coping responses at work, and therefore, modify possible adverse health outcomes[24,25]. Exposure to a stressful psychosocial work environment can increase an individual's perceived stress at work quite significantly, and therefore, leaves the worker with a substantial level of residual stress after work[24,25].

Over-work, work stress and stroke

As described in previous paragraphs, most epidemiological studies done in the United States and Europe for the effect of work stress are on coronary heart diseases especially acute myocardial infarction. However, stress is still considered a risk factor for stroke[26]. Stress hormones (catecholamines and cortisol) can cause hypertension and atherosclerosis which could increase the incidence of stroke[19]. Uehata[9] analyzed the causes of death among 203 karoshi cases who had received worker compensation. Sixty percent cases (123/203) died of stroke, and long working hours was the most important factor. Eggers[27] reported that chronic dysfunctional stress response due to overwork and high job strain can cause stroke by stimulating platelet activation and resulted in a hypercoagulable state. Iso and colleagues[28] followed-up 73,424 Japanese during 1988 - 1990 and found that comparing with low strain jobs, female with high strain jobs has more than 2-fold risk to die of stroke (relative risk 2.24, 95% CI 1.52 to 3.31, $p<0.001$). On the other hand, a long-term cohort study in Sweden (n=33,346, from 1974-1992)[29] reported 2-fold mortality for stroke in male workers with high perceived stress (RR=2.04, 95% CI 1.07 to 3.88). Furthermore, during a mean follow-up of 11 years, a multicenter community-based prospective study[30] of 6553 Japanese workers reported a more than 2-fold increase in the risk of total stroke for men with high job strain comparing with low job strain (hazard ratio 2.73, 95% CI 1.17-6.38) after adjusting for age, education, occupation, smoking status, alcohol consumption, physical activity, and study area. However, there were no statistically significant differences for any stroke incidence for female workers. The epidemiological data for work stress and stroke in Taiwan are few. In a hospital-based case-control study,[31] we found that working 16 hours or more a day for a consecutive week increased 4-fold the risk of stroke. Stroke cases had higher weekly work hours (55.5 vs. 50.9 hours, $p=0.021$), less sleep (7.10 vs. 7.42 hours, $p=0.010$, on weekdays; 7.65 vs. 8.04 hours, $p=0.006$, on weekends), and more smoking (25.5 vs. 21.6 cigarettes a day, $p=0.071$).

CONCLUSION

Among working population, hypertension, diabetes mellitus, and hyperlipidemia remain major risk factors for stroke. However, overwork and work stress is associ-

ated with stroke to certain degree. People under overwork stress, including physicians, might aware no symptoms nor signs but just feeling fatigue even before the karoshi event. From preventive medicine viewpoint, health promotion of the work environment should include stress management, smoking cessation, and treatment of hypertension, diabetes, and high lipid as well. A healthy work and life style to prevent karoshi is important. Karoshi is not just a medical issue but also a social issue. To reduce work stress by cooperative and integrative effort of the government, employers, and workers is necessary to avoid karoshi.

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