

AMYOTROPHIC LATERAL SCLEROSIS AND DIABETES ON GUAM: CHANGING PATTERNS OF CHRONIC DISEASE IN AN ISLAND COMMUNITY

Robert L Haddock¹ and Kwang-Ming Chen²

¹Guam Department of Public Health and Social Services; ²Guam Memorial Hospital Authority, Hagatna, Guam, USA

Abstract. Amyotrophic lateral sclerosis (ALS) occurred on the island of Guam with unusually high incidence rates for many years but began to disappear with the island's westernization after WW II. The authors document these changes and suggest that they support a hypothesis that cultural changes could be responsible for both the virtual disappearance of this chronic degenerative neurologic disease as well as a concurrent surge in the prevalence of diabetes.

INTRODUCTION

The occurrence of a chronic neurologic disease, described as "hereditary paralysis", was noted on Guam more than 100 years ago (Leach, 1900). The first death recognized as amyotrophic lateral sclerosis (ALS) was recorded in 1910 (Office of Vital Statistics, 1910) but it was not until 44 years later that a significant epidemiologic study of this disease was conducted on Guam (Kurland and Mulder, 1954). Subsequent studies showed the incidence of ALS among the native Chamorros of Guam to be approximately 100 times the rate at which it occurred elsewhere (Mulder *et al*, 1954). Theories proposed for the cause of this epidemic included a possible infectious agent (Gajdusek and Gibbs, 1964), mineral imbalances (Yase *et al*, 1974; Garruto and Yase, 1986), a toxic food (Kurland, 1964; Whiting, 1964) and genetic mutation (Kurland, 1957). In 1985, before any of these theories had been confirmed, it was reported that new cases of ALS on Guam were experiencing a dramatic decline, and it was predicted that the incidence would soon match the rate elsewhere in the world (Garruto *et al*, 1985). By 1995, this prediction had been realized (Chen, 1995).

Clues to the cause of epidemics might be

Correspondence: Dr Robert L Haddock, Office of Epidemiology and Research, PO Box 2816, Hagatna, GU 96932, USA.

Tel: (671) 735-7299; Fax: (671) 734-2066

E-mail: rhaddock@dphss.govguam.net

uncovered by observing events associated with the onset of the epidemic, by studying risk factors associated with cases that occur during the progression of the epidemic or by observing events associated with the ending of the epidemic. The origins of Guam's ALS epidemic lie in the distant past, as evidenced by legends from the Spanish era accounting for its beginning, so it is unlikely that further study of this facet of ALS on Guam will provide useful information. Similarly, many of the best minds in neurology and epidemiology have studied the ALS cases of Guam, both prospectively and retrospectively, for a period spanning almost 50 years (1954 to present) and have likewise been unable to pinpoint the cause of its high incidence.

This leaves, as possibly the last opportunity to gain insights into the cause of this unusual epidemic, the study of circumstances associated with the virtual disappearance of ALS from the island. In an attempt to accurately define the populations affected by ALS, and when the presence of the agent or factor causing ALS may have declined, date of birth data were collected from death certificates mentioning ALS. To compare ALS prevalence trends with those of diabetes, the most prevalent chronic disease on Guam, year of death data were collected from death certificates mentioning either of these diseases, as well.

MATERIALS AND METHODS

Guam law requires that all deaths occurring on Guam be certified by a licensed physician and

registered with the Office of Vital Statistics, Guam Department of Public Health and Social Services. Death certificates filed for the period 1955-2001 were reviewed (1955 was selected as the first year of the study because in that year standard death certificates providing for the listing of multiple contributing causes of death were first used). Cases of ALS or diabetes were included in the study if these diagnoses appeared in any section of the death certificate (they may have been listed under "Other significant conditions" and not considered to be the underlying cause of death by the certifying physician). ALS cases were tallied by their birth year and incidence rates for each birth year cohort were calculated. Three-year smoothing was used to minimize statistical fluctuations caused by the relatively small numbers involved. In addition, the number of death certificates on which a diagnosis of ALS or diabetes (Type I or Type II) were present were tallied as a ratio of cases to total death certificates filed for the respective year and summarized by the decade of death.

RESULTS

Deaths of persons on Guam for which the diagnosis of ALS appeared on the death certificate plummeted, beginning with the birth cohorts of the late twenties (Fig 1). In contrast, during the period that deaths associated with a diagnosis of ALS were decreasing, deaths associated with a diagnosis of diabetes were increasing (Fig 2).

DISCUSSION

The agent or risk factor responsible for the earlier high incidence of ALS on Guam must have become less prevalent on the island sometime after the late 1920's, since incidence rates for birth cohorts born after that period decreased rapidly (Fig 1). An alternative explanation could be that some other factor was introduced to the island that protected against the influence of the causative agent or risk factor responsible for causing ALS.

Based on the travel history of migrants to Guam who have developed ALS, it has been estimated that the incubation period for ALS was as

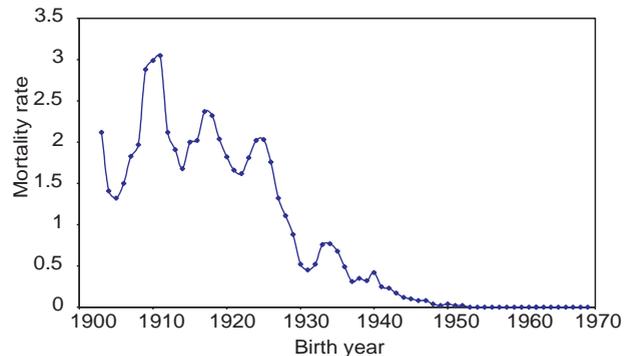


Fig 1—ALS mortality rate (cases per 100,000 births) by birth-year cohort, Guam, 1955-1999.

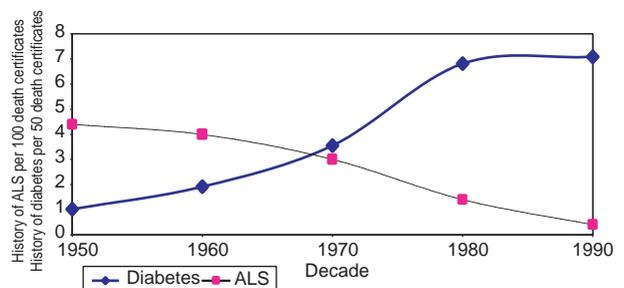


Fig 2—Changing mortality associated with ALS and diabetes on Guam, by decade of death, both sexes, 1955-1999.

long as 30 years, with a mean of close to 20 years (Garruto *et al*, 1981). If exposure to the ALS causal agent/factor is present at birth or occurs during infancy, this agent/factor must have occurred much less frequently on Guam beginning about 1927. If exposure to the agent/factor that causes ALS occurs more commonly in adolescence or in adulthood, this agent/factor must have occurred much less frequently on Guam beginning about 1940. The later date would place the proposed event nearly coincident with the Japanese occupation of Guam during World War II, an event that led to a dramatic change in the lifestyle of those living on Guam.

Prior to World War II, Guam was a subsistence culture with most food consumed on the island being produced locally. This dependence on locally produced food products was further exaggerated by the occupation of the island by Japanese forces in December, 1941, after which virtually all contact with the outside world, except

Japan, was cut off. Following the reoccupation of Guam by American forces in July, 1944, the dietary habits of island residents changed dramatically. Farming was largely abandoned in favor of salaried jobs, primarily with the local or US federal governments, and most food was imported, principally from the United States. Both physically and culturally, Guam abandoned its prewar aura of a tropical paradise and began to resemble more a typical American suburban community. Such westernization of traditional cultures, particularly changes in diet, have previously been observed to be associated with increased rates of certain chronic diseases, notably diabetes, among Polynesians migrating to New Zealand (Stanhope and Prior, 1980; Ostbye *et al*, 1989) and breast and colon cancers among Japanese migrating to Hawaii or California (Dunn, 1975). It has also been observed that rates of gastric cancer decreased among Japanese migrating to Hawaii or California (Dunn, 1975). We believe that the westernization of Guam, the virtual disappearance of ALS, and the concurrent increase in diabetes, are additional examples of the profound influence cultural changes can have on the prevalence of chronic diseases.

ACKNOWLEDGEMENTS

The authors wish to thank Carolyn Garrido, Territorial Registrar, Guam Office of Vital Statistics, for her assistance in accessing original death certificates and Cynthia L Naval for reviewing the manuscript.

REFERENCES

- Chen KM. Disappearance of ALS from Guam: implications for exogenous causes. *Clin Neurol* (Tokyo) 1995; 35: 1549-53 (In Japanese with English abstract).
- Dunn JE. Cancer epidemiology in populations of the United States with emphasis on Hawaii and California and Japan. *Cancer Res* 1975; 35: 3240-5.
- Gajdusek DC, Gibbs CJ, Jr. Attempts to determine a transmissible agent in kuru, ALS, and other subacute and chronic nervous system degenerations of man. *Nature* 1964; 204: 4955: 257-9.
- Garruto RM, Gajdusek DC, Chen KM. Amyotrophic lateral sclerosis and parkinsonism-dementia among Filipino migrants to Guam. *Ann Neurol* 1981; 10: 341-50.
- Garruto RM, Yanagihara R, Gajdusek DC. Disappearance of high incidence amyotrophic lateral sclerosis and parkinsonism-dementia on Guam. *Neurology* 1985; 35: 193-8.
- Garruto RM, Yase Y. Neurodegenerative disorders of western Pacific: the search for mechanisms of pathogenesis. *Trends Neurosci* 1986; 9: 368-74.
- Kurland LT. Epidemiological investigations of ALS. III. A genetic interpretation of incidence and geographic distribution. *Proc Staff Meet Mayo Clinic* 1957; 32: 447-62.
- Kurland LT, Mulder DW. Epidemiologic investigations of ALS. I. Preliminary reports on geographic distribution, with special reference to Mariana Islands, including clinical and pathologic observations. *Neurology* 1954; 4: 355-78, 438-48.
- Kurland LT. Introductory remarks. Proceedings of the Third Conference on Toxicity of Cycads, Chicago. *Fed Proc* 1964; 23 (6 pt. 1): 1337-9.
- Leach P. Sanitary report on Guam, Ladrone Island. Report of the Surgeon General, US Navy, to the Secretary of Navy. Washington, DC: Government Printing Office, 1900: 208-12.
- Mulder WD, Kurland LT, Iriarte LLG. Neurologic disease on the island of Guam. *US Armed Forces Med J* 1954; 5: 1724-39.
- Office of Vital Statistics, Department of Public Health and Social Services, Government of Guam. Death certificates, 1910; 1: 458 (Cert No. 2415).
- Ostbye T, Welby TJ, Prior IA, Salmond CE, Stokes YM. Type 2 (non-insulin-dependent) diabetes mellitus, migration and westernisation: the Tokelau Island Migrant Study. *Diabetologia* 1989; 32: 585-90.
- Stanhope JM, Prior IA. The Tokelau island migrant study: prevalence and incidence of diabetes mellitus. *NZ Med J* 1980; 92: 417-21.
- Whiting MG. Food practices in ALS foci in Japan, the Marianas, and New Guinea. Proceedings of the Third Conference on Toxicity of Cycads, Chicago. *Fed Proc* 1964; 23 (6 pt. 1): 1343-5.
- Yase Y, Yoshimasu F, Uebayashi Y, Iwata S, Kimura K. ALS: interaction of divalent metals in CNS tissue and soft tissue calcification. *Proc Jpn Acad* 1974; 50: 401-6.