

Spectrum of neurological disorders in Singapore

Shih-Hui LIM M Med, MRCP, *Chor-Hiang TAN MBBS, MSc(PH)

Clinical Neuroscience Society, Singapore, * Ministry of Health, Singapore

Abstract

Data from the Ministry of Health and an out-patient survey conducted by the Clinical Neuroscience Society, Singapore, were used to review the spectrum of neurological disorders in Singapore. Admissions for neurological disorders to public and private sector hospitals in Singapore increased during the period from 1980 to 1994. Cerebrovascular disease (CVD) was the commonest neurological disease resulting in hospital admission, followed by seizure disorders, central nervous system infections, Parkinsonism and brain tumours. The increase in admissions was due mainly to an increase in CVD cases which in turn could be due to an aging population. Increase in the number of neurological specialists and improved neuroimaging facilities probably also contributed to the increase in the number of patients diagnosed to have neurological disorders. The estimated average annual incidence for viral meningoencephalitis for the period 1986-1994 was 10 per 100,000 population; as for tuberculous meningitis, it was 0.7 per 100,000 population. Headache & facial pain, CVD, seizure disorders, neuromuscular diseases and movement disorders accounted for more than 75% of neurological disorders seen in out-patient practice. Stroke was the 3rd commonest cause of death in Singapore over the last 15 years. Trends suggest an ongoing increase in the incidence of neurological diseases in Singapore.

Keywords: epidemiology, disease pattern, neurology practice, Singapore, cerebrovascular disorders, CNS infections, CNS neoplasms, mortality

INTRODUCTION

There have been no published data on the spectrum of neurological disorders in Singapore. This report describes the types of neurological disorders seen by neurologists in the in-patient setting and out-patient practice, as well as neurological cause of death in Singapore.

MATERIALS AND METHODS

Information on the types of neurological disorders resulting in hospital admissions was obtained from the former Research and Epidemiology Department, Ministry of Health, Singapore (this Department has been reorganized in 1996 into Department of Monitoring & Evaluation, and Department of Epidemiology & Disease Control) ¹. This Department was responsible for the collection of medical information on patients discharged from all hospitals in Singapore. Upon discharge from hospital, each patient's principal medical conditions for the relevant admission are coded based the International Classification of Diseases 9th Edition (ICD-9, which has been used by Ministry of Health since 1980) ². The coded information is gathered by each hospital's

Medical Records Department, and routinely submitted to the Research and Epidemiology Department of the Ministry of Health. Thus, information on the types of neurological diseases resulting in hospital admissions was readily accessed via this database. Admissions for traumatic brain, spinal cord or/and nerve injury were excluded as these patients were managed either by general surgeons, neurosurgeons and/or orthopedic surgeons.

The Registry of Births and Deaths (RBD) maintains records of all births and deaths which occur in Singapore. Information on the types of death due to neurological disorders was obtained from the annual reports of RBD ³.

The spectrum of neurological diseases seen in out-patient practice was obtained from a prospective 2-week survey conducted by the Clinical Neuroscience Society, Singapore. Fifteen neurologists (13 from the public sector and 2 from the private sector) participated in this survey which was conducted in July and August 1994. In addition, information on the number of neurology outpatient clinic attendances at public hospitals was obtained from the Ministry of Health's Annual Reports ⁴.

TABLE 1: Hospital admissions for neurological disorders, 1980, 1985, 1990 & 1994

Neurological Disorders	Number (% of total neurological admissions)			
	1980	1985	1990	1994
CVD	2378 (36.8)	3248 (41.1)	3948 (41.1)	6086 (54.9)
Seizure Disorders	1338 (20.7)	1497 (18.9)	2160 (22.5)	2184 (19.7)
CNS Infections	439 (4.8)	377 (4.8)	365 (3.7)	404 (3.7)
Parkinsonism	110 (1.7)	170 (2.2)	285 (3.0)	336 (3.0)
Brain Tumours	93 (1.4)	144 (1.8)	195 (2.0)	303 (2.7)
Others	2108 (34.6)	2464 (31.2)	2660 (27.7)	1772 (16.0)
Total	6466 (100)	7900 (100)	9613 (100)	11085 (100)
% of Total Hosp. Adm.	2.44	2.82	2.86	3.23
No. of Total Hosp. Adm.	265,463	279,790	336,787	343,342

RESULTS

(A) Pattern of Neurological Admissions

Hospital admissions for neurological disorders for the years 1980, 1985, 1990 and 1994 are summarized in Table 1. Cerebrovascular diseases (CVD) was the leading neurological disease resulting in hospital admission. This was followed by seizure disorders, central nervous system infections, Parkinsonism and brain tumours. Other neurological admissions constituted less than 1% of total neurological admissions and were grouped under "Others".

For CVD, available data did not separate ischaemic from haemorrhagic strokes. In addition to stroke, admissions for transient ischaemic attacks (TIA) were included in the CVD group. Data on CVD admissions by age were available from 1986 to 1994 and are shown in Table 2. There was a slight increase in the percentage of stroke admissions for patients above 70 year of age and a proportionate decrease

in the other age groups during this period. Although the number of admissions for seizure disorders had increased over the last 15 years, they still accounted for about 20% of total neurological admissions. There was a decrease in the number as well as the percentage of neurological admissions due to infections of the central nervous system (CNS). The types of CNS infection are shown in Table 3. Due to the retrospective nature of this study, the authors could not verify the exact etiology of the infections. In some infections such as viral meningitis or encephalitis, it is the experience of many neurologists (personal communications) that culture and/or serology are often negative. Nevertheless, this Table shows the relative occurrence of different types of CNS infections in Singapore in the last 9 years. The estimated average annual incidence for viral meningoencephalitis for 1986-1994 was 10 per 100,000 population; for tuberculous meningitis, it was 0.7 per 100,000 population. As for

TABLE 2: Hospitalization for CVD by age, 1986-1994

Age Group	% of Total CVD Admissions								
	1986	1987	1988	1989	1990	1991	1992	1993	1994
<40 years	6.8	6.2	6.2	7.2	6.7	5.4	5.7	5.7	5.1
40-50 years	8.9	8.4	8.3	8.6	8.1	8.0	8.1	9.2	8.2
50-60 years	21.1	20.3	20.0	18.6	19.0	19.8	18.8	17.9	17.4
60-70 years	29.6	28.2	27.4	28.0	27.3	28.3	27.8	28.4	28.5
>70 years	33.6	36.9	38.1	37.6	38.9	38.5	39.6	38.8	40.8
Total	100	100	100	100	100	100	100	100	100

TABLE 3: Hospitalization for central nervous system infections, 1986-1994

Types of Infections	ICD No.	Years									Av No. per Year
		1986	1987	1988	1989	1990	1991	1992	1993	1994	
Viral Men.	047,048,049 062,322,054.3	173	189	229	139	133	144	175	217	161	173
Encephalitis/ myelitis	323	77	73	75	80	88	88	91	116	105	88
Bact. Men.	320,036	35	41	50	42	60	80	56	45	45	50
Abscess	324	16	25	41	36	17	28	17	34	29	27
Neurosyphilis	094	27	10	20	19	17	23	14	17	24	24
Tuberculosis	013	27	10	20	19	17	23	14	17	24	19
Fungal Men.	321	4	4	9	5	13	30	32	10	4	12
Cryptococcal Men.	321.0	0	16	8	3	1	2	1	2	7	5
Thrombo- phlebitis	325	1	5	6	4	5	4	2	1	6	4
Total		360	384	478	355	365	423	401	450	404	

Note:

- (1) Viral Men. : Viral meningitis or presumed viral meningitis
- (2) Bact. Men. : Bacterial meningitis
- (3) Abscess : includes intracranial and intraspinal abscess
- (4) Tuberculosis : includes meningitis, encephalitis, tuberculoma, abscess of brain and/or spinal cord
- (5) Fungal Men. : Fungal meningitis, excluding cryptococcal meningitis

Parkinsonism (which included patients with Parkinson's disease, secondary Parkinsonism, and Parkinsonian plus syndrome) and brain tumours, the admissions have increased in the last 15 years. The brain tumour group included only primary neoplasm of the nervous system (ICD code numbers: 191 & 192). The number of admissions for primary as well as secondary brain tumours between 1986 and 1994 is shown in Table 4.

(B) Causes of Death due to Neurological Disorders

The trend in mortality by broad disease groupings, between 1950 and 1994 is shown in Table 5. Diseases of the nervous system included infections, neuro-degenerative disorders, hereditary disorders and seizure disorders.

Deaths due to stroke were grouped under "Diseases of the Circulatory System". The principal causes of death for the years 1980, 1985, 1990 and 1994 are shown in Table 6. The overall leading causes of death were cancer, heart disease and cerebrovascular disease. Together, these conditions accounted for approximately 60% of all deaths in Singapore. Deaths due to primary brain tumours were grouped under "Malignant Neoplasm".

(C) Pattern of Neurological Disorders seen in Out-Patient Practice

Table 7 shows the neurology outpatient clinic attendances at public hospitals in 1980, 1985, 1990, 1992 & 1994, and Table 8 shows the types of neurological disorders seen in out-patient practice. For the latter, which was obtained

TABLE 4: Hospitalization for primary and secondary neoplasm of the central nervous system, 1986-1994

Types of neoplasm	ICD No.	Years								
		1986	1987	1988	1989	1990	1991	1992	1993	1994
Primary	191 & 192	213	184	205	182	195	222	224	267	303
Secondary	198.3	19	13	25	47	32	40	31	39	45

TABLE 5: Mortality by broad disease grouping, 1950, 1960, 1970, 1980, 1990 and 1994

Cause of Death	1950	1960	1970	1980	1990	1994
	% of Total Death					
Infective and Parasitic Diseases	21.5	8.8	6.8	3.4	2.5	2.4
Neoplasms	2.8	10.4	15.1	21.0	23.8	25.3
Endocrine, Nutritional & Metabolic Diseases	2.8	} 5.1	2.3	2.9	2.8	2.5
Diseases of Blood & Blood-Forming Organs	0.7		0.5	0.2	0.4	0.2
Diseases of Nervous System & Sense Organ	13.7	7.7	1.7	1.1	1.0	0.5
Diseases of the Circulatory System**	6.2	10.6	27.0	34.4	37.1	36.3
Diseases of the Respiratory System	16.5	11.9	13.7	15.7	15.2	17.0
Diseases of the Digestive System	12.4	8.7	4.2	2.9	2.7	2.6
Diseases of the Genito-Urinary System	2.0	3.0	2.2	2.9	2.5	3.0
Congenital Anomalies	0.6	1.6	1.4	1.5	1.4	1.0
Certain Causes of Perinatal Mortality	6.6	9.6	4.5	1.8	0.9	0.4
Accidents, Poisonings and Violence	4.0	5.0	8.0	7.2	7.2	6.4
Other Causes	10.2	17.6	12.6	5.0	2.5	2.4
Total	100	100	100	100	100	100

** Included cardiovascular and cerebrovascular diseases

TABLE 6: Principal causes of deaths in Singapore

Year	1980	1985	1990	1994
Total No. of Death	12505	13348	13891	14946
% of Total Death				
1. Cancer	20.5	21.7	23.5	25.1
2. IHD & Other Heart Disease	21.4	22.7	23.9	23.9
3. Cerebrovascular Disease	11.6	10.6	12.0	11.3
4. Pneumonia	9.0	9.6	8.6	11.1
5. Injuries	7.2	8.1	7.3	6.4
6. Diabetes Mellitus	2.4	1.9	1.7	2.2
7. Renal Disease	2.4	1.9	1.7	1.4
8. Septicemia	0.5	0.9	0.9	1.2
9. Chronic Liver Disease	1.0	1.1	0.9	1.0
10. Congenital Abnormalities	1.5	1.4	1.4	1.0

TABLE 7: Neurology outpatient clinic attendances at public hospitals, 1980, 1985, 1990, 1992, 1994

Year	Number of Attendance for Neurological Disorders	% of Total Out-Patient Attendance
1980	6493	0.51
1985	6399	0.51
1990	10153	0.69
1992	11393	0.65
1994	24630	1.25

TABLE 8: Survey on the types of neurological disorders seen in out-patient practice

Types of Neurological Disorders	Number (%)
Headache & Facial Pain	353 (24.5)
Cerebrovascular Diseases	249 (17.3)
Seizure Disorders	249 (17.3)
Neuromuscular Disorders	150 (10.4)
Movement Disorders	108 (7.5)
Vertiginous Syndromes	75 (5.2)
Psychiatric Disorders	63 (4.4)
Disease of Spinal Cord	34 (2.4)
Bell's Palsy	24 (1.7)
Others	137 (9.3)
Total	1442 (100)

from the survey, the authors did not attempt to separate new from follow-up cases. Three hundred and fifty three cases were seen for headache & facial pain, of which 210 cases were migraine, 133 cases were tension-type headache and 10 cases were trigeminal neuralgia. None of the other types of headache and facial pain was encountered during the survey. CVD cases included stroke and TIA. Seizure disorders included epilepsy and first seizure. Neuromuscular disorders included sensory and/or motor polyneuropathy (hereditary, idiopathic, inflammatory, and toxic) (41 cases), neuromuscular junction disorders (35 cases), mononeuropathy (e.g. carpal tunnel syndrome) (33 cases), nerve root and/or plexus disorders (20 cases), muscular dystrophy/myopathy (15 cases) and motor neuron disease (6 cases). Movement disorders included Parkinson's disease & secondary Parkinsonism (79 cases), Parkinsonian-plus syndrome and other movement disorders (29 cases). Psychiatric disorders included neurosis, personality disorder and other non-psychotic mental disorders. Spinal disorders included spondylosis, intervertebral disc disorders, and myelopathy. The "Others" category comprised disorders which individually accounted for less than 1% of total cases seen.

DISCUSSIONS

Except for the prospective out-patient survey, most of the information was obtained retrospectively. The reliability of information on neurological admissions depends a great deal on the accuracy of disease coding by hospitals. Similarly, stroke as a cause of death might be

under or over reported where neuroimaging was unavailable or not performed. Nevertheless, information on the types of neurological admissions gives a general indication of the spectrum of neurological diseases in a hospital setting. The data obtained from the out-patient survey had the benefit of categorization of neurological disorders by neurological specialists. This probably accurately reflects the different spectrum of neurological disorders seen in out-patient practice.

Although admissions for neurological diseases accounted for only 2-4% of total hospital admissions in Singapore over the last 15 years, there was an increase in absolute number (by 71.4%) as well as percentage of total neurological admissions (by 0.79% points) during this period. There was also an increase in the number (by 279.3%) as well as proportion of total out-patient attendances at the public sector hospitals during this period.

The increase in hospital admissions was due mainly to an increase in the number of admissions for CVD (by 156% between 1980 and 1994). Two thirds of the patients admitted for CVD were 60 years and above (Table 2). The proportion of those 70 years and above steadily increased from 33.6% in 1986 to 40.8% in 1994. This could be explained by the overall aging of Singapore's population over the last 15 years. According to the Government Census, the population of Singapore was 2.282 million in 1980. The estimated population in 1994 was 2.930 million. The average life expectancy at birth increased from 72.5 years in 1980 to 76.5 years in 1994. The number and proportion of

TABLE 9: Stroke admissions, Singapore population, number of neurologists and neuro-imaging facilities between 1980 and 1994

	1980	1994	% Increase
% of total hospital admission for neurological diseases	2.44	3.23	0.79 (% point)
Hospital beds (public & private)	9,570	10,446	9
No. of stroke admissions	2,378	6,086	156
Total population	2.282m*	2.930m*	28
Population >60 yrs	171,150	284,210	66
% of Population >60 yrs	7.5	9.7	2.2 (% point)
Total No. Doctors	1,976	4,146	110
Total No. Consultant Neurologists	6	21	250
Total No. CT scanners in Singapore	1	13	1200
Total No. MRI machines in Singapore	0	5	

* million

population 60 years and above in 1980 were 171,150 and 7.5%, respectively, and in 1994, 284,210 and 9.7%, respectively (an increase of 66% and 2.2 percentage points, respectively). Thus, the aging population partially accounts for the increase in CVD admissions.

For many years in Singapore, patients with neurological disorders had been looked after by internists with an interest in neurology, or primary health care providers such as general practitioners. Over the last 15 years, the number of doctors had increased: 1976 doctors in 1980 and 4146 in 1994. The number of specialists also increased from 706 to 1822 during the same period, constituting 36% and 44% of the total doctor population, respectively⁵. This increase allowed internists to subspecialize in neurology and concentrate their efforts and time on looking after patients with neurological disorders. The first neurological department was established in 1972 in one of the acute hospitals. With this, a training programme for neurologists was started. This contributed to the increase in the number of neurological specialists from 6 in 1980 to 21 in 1994. A second neurology department was established in another acute hospital in 1993. This further increased the number of neurological specialists as well as increased the number of neurology out-patient clinics. The latter contributed to the increase in neurology out-patient attendances (by 379%, Table 7). Such attendances could have been grouped under "General Medicine" attendances in the past.

Neuroimaging has enhanced the diagnosis of neurological disorders, especially CVD. The

number of Computer Tomographic (CT) scanners increased from one in 1980 to 13 in 1994. Magnetic Resonance Imaging (MRI), which is superior to CT scan in diagnosing many intracranial diseases, was not available in the 1980's but became a fairly common investigation in 1990's. Both the increased number of neurologists and the greater availability of the CT scan and MRI were the other two factors contributing to the 156% increase in stroke "admission" from 1980 to 1994, with increased diagnosis of non-fatal stroke cases. An increased awareness of neurological disorders might be another factor leading to more referrals to hospitals for evaluation and treatment. Table 9 summarizes the above contributing factors.

Table 10 shows the number of stroke admissions in relation to stroke deaths. From the table, it appears that stroke mortality was rather high in Singapore in the 1980s with the ratio of stroke deaths to stroke admissions being 1:2. This was also the observation of Bonita et al.⁶ when they compared the mortality trend of stroke in 27 countries. They noted that the mortality rate of stroke was rather high in Singapore comparing to many other developed countries. For example, the age-standardized mortality rate (per 100,000 population) for male in 1985 for some of the countries mentioned are as follows: Hungary (229.4), Singapore (136.0), Japan (106.9), Hong Kong (94.4), England and Wales (70.6), Germany (68.2), France (60.4), Australia (60.3), United States (45.4), Canada (39.1). The other observation from Table 10 was that despite a 156% increase in the number

TABLE 10: Hospital admissions for cerebrovascular diseases, and deaths due to stroke, 1980, 1985, 1990 & 1994

	1980	1985	1990	1994
% of Total Death Due to Stroke	11.6	10.6	12.0	11.3
Total No. of Death Due to Stroke	1147	1418	1666	1691
Total No. of CVD Admissions	2378	3285	3948	6086
Ratio of Stroke Death to CVD Adm.	1:2	1:2.3	1:2.4	1:3.6

of hospital admissions for CVD between 1980 and 1994, stroke as a cause of death during this period remained stable at 10.6-12%. In 1994, the ratio of stroke deaths to CVD admissions has increased to 1:3.6.

The above observations could be due to an increased diagnosis of CVD (many were probably milder and thus non-fatal), a decrease in stroke mortality, or both, in 1990s. The rapid growth in the number of neurologists from 1980-1994 has led to more neurologists looking after stroke patients. The establishment of specialized stroke units in several major referral hospitals could have accounted for the reduced stroke mortality. At the time of writing, information on the principal causes of death for the year 1995 was published. CVD, for the first time in the last 16 years, has become the 4th commonest cause of death (accounting for 10.9% of all death). Pneumonia has overtaken CVD to become the 3rd commonest cause of death (12.8%). It is possible that some patients who would have died during the acute phase of stroke if managed in a general medical ward are now "surviving" because of the specialized care received during the stay in stroke intensive care units. It is also possible that some patients may survive the acute phase of stroke because of better care provided, only to die later from complications such as pneumonia. We are uncertain as to how much of this "reduced mortality" has translated into increased morbidity, and a need for society to look after more disabled patients. This has important implications for rehabilitation services, nursing homes, and other forms of social support.

Despite an increase in the number of hospital admissions for neurological disorders, the number of admissions for CNS infection remained stable in the last 15 years. Viral or presumed viral meningoencephalitis accounted for slightly more than half of all CNS infection in Singapore with an estimated average annual incidence of 10 cases per 100,000 population.

As mentioned, the diagnosis of viral meningoencephalitis was made mainly based on clinical presentation, cerebrospinal fluid (CSF) microscopic examination, and negative culture for other organism. It is the experience of many neurologists that viral cultures were often negative. Serological diagnosis was also not helpful to identify the type of viral infection as many serological tests required a convalescent CSF specimen. Often we did not send a second specimen of CSF if the patient had already improved clinically (thus repeat lumbar puncture examination was not indicated). When the use of polymerase chain reaction method becoming more routine in Singapore, the identification of specific viruses causing the meningo-encephalitis could be improved in the near future. Tuberculosis continues to be a major health problem globally, with almost 3.8 million cases reported in 1990, of which 49% were in South East Asia⁷. The average tuberculosis rates per 100,000 population for 1989 through to 1991 for South East Asia is 146.2. The incidence of tuberculous meningitis in patients with tuberculosis has been reported to vary from 7-12%⁸. The annual incidence for tuberculous meningitis for Singapore at 0.7 per 100,000 population is thus relatively low.

In contrast to CNS infection, the admissions for the management of Parkinsonism and brain tumour had increased by 305% and 324%, respectively, between 1980 and 1994. This can be explained by an aging population, an increase in the number of neurological specialists and better neuroimaging facilities. Based on the Singapore Cancer Registry's report (the Registry registers all cases of cancer diagnosed in Singapore)⁹, primary neoplasm of brain and other parts of the nervous system is an uncommon cancer locally. This type of cancer is not in the list of the 10 most common cancers in males and females. The 10 most frequent cancers in males between 1988 and 1992 were (in decreasing order of frequency): lung, colo-rectum, stomach,

liver, nasopharynx, prostate, skin, lymphomas, oesophagus and bladder. For the females, the 10 most frequent cancers were (in decreasing order of frequency): breast, colo-rectum, lung cervix, stomach, ovary, skin, nasopharynx, thyroid, and corpus uteri. The age-standardized incidence rates for all three major ethnic groups are also lower than most other parts of the world. Nevertheless, primary neoplasm of the brain and other nervous system were more common than other neurological disorders resulting in hospital admission. There is a rise in the rates of this cancer in both sexes from 1968 to 1992. The majority of cases (45%) had astrocytoma and glioblastoma multiforme as the histological types. Table 4 shows that for every 9-10 cases admitted for primary neoplasm of the nervous system, there was 1 case of metastasis to the nervous system. We suspect that brain and/or spinal cord metastasis was probably under-reported. Some patients might also have systemic metastasis and were coded as having metastasis to other body parts. Even if there was only brain metastasis, the primary neoplasm could have been used for ICD coding, unless the primary neoplasm was unknown. It was also likely that some patients with brain metastasis were not admitted but investigated and treated as out-patients.

The spectrum of neurological illness seen in out-patient practice was different from that of in-patient setting. This was not unexpected as many neurological illnesses such as headache & facial pain, seizure disorders, transient ischaemic attack, movement disorders, vertiginous syndrome and neuromuscular disorders usually do not require hospitalized care. The 5 most common neurological disorders seen in the out-patient practice in Singapore were: headache and facial pain (24.5%), CVD (17.3%), seizure disorders (17.3%), neuromuscular disorders (10.4%) and movement disorders (7.5%). In contrast, the 5 most common neurological disorders in the study by Boongird et al in Thailand¹⁰ (including both in-patients and out-patients) were: CVD (38.4%), headache (9.8%), epilepsy (9.5%), polyneuropathy (4.7%), and Parkinson's disease (4.2%). In a similar study by Jusoh in Malaysia¹¹ (including both in-patients and out-patients), the 5 most common neurological disorders were: epilepsy (19.4%), headache and migraine (13.6%), CVD (9.1%), peripheral neuropathy (8.2%), and Parkinson's disease (5.4%). These differences should not be interpreted as real differences in the disease prevalence in these countries. As stated, our

study separates the in-patients' from out-patients' disease patterns. Other possible factors for the differences include the different roles for a neurologist in the communities, different referral pattern, as well as cultural influences in seeking medical treatment in a hospital.

Our data suggest an increase in the incidence of neurological diseases in Singapore. This has important implications for the planning & provision of neurological care, and training of neurological specialists in Singapore.

ACKNOWLEDGEMENTS

We would like to thank the Ministry of Health, Singapore, for allowing us to publish the information on neurological admissions in Singapore. We would also like to thank the following members of the Clinical Neuroscience Society for their valuable contributions in the out-patient survey: Drs Chang Hui Meng, Ho King Hee, Lee Sze Haur, Lo Yew Long, Loh Ngai Kun, Loong Si Chin, Low Poh Sim, Puvanendran K, Pavanni R, N.V. Ramani, Tan Chai Beng, Helen Tjia, Wong Meng Cheong, and Yeow Yew Kim (first author also took part in the survey).

REFERENCES

1. Health Facts Singapore, produced by the Research and Epidemiology Department, Ministry of Health, Singapore.
2. International Classification of Diseases 9th Edition (ICD-9), 1977.
3. Report on Registration of Births and Deaths, 1980, 1985, 1990 & 1994.
4. Ministry of Health Annual Reports, 1990, 1991, 1992, 1993 & 1994.
5. Singapore Medical Council Annual Reports, 1980 & 1994.
6. Bonita R, Stewart A, Beaglehole R. International trends in mortality 1970-1985. *Stroke* 1990; 21: 989-92.
7. Raviglione MC, Snider DE, Kochi A. Global epidemiology of tuberculosis. *JAMA* 1995; 273: 220-6.
8. Tandon PN. Tuberculous meningitis (cranial and spinal). In: Vinken PJ, Bruyn GW, Klawans HL (eds) *Handbook of clinical neurology Vol 33, Infections of the nervous system Part I*. North-Holland Pub Co, 1978: 195-262.
9. Chia KS, Lee A, Seow A, Shanmugaratnam K. Trends in cancer incidence in Singapore, 1968-1992. *Singapore Cancer Registry Report No. 4*, 1996.
10. Boongird P, Soranastaporn S, Menken M, Vejjajiva A. The practice of neurology in Thailand, a different type of medical specialist. *Arch Neurol* 1993; 50: 311-2.
11. Jusoh R. Profile of neurological practice in Malaysia. *Neurol J Southeast Asia* 1996; 1: 15-7