

THE GLOBAL BURDEN OF NEUROLOGICAL DISEASE WFN Task Force on Neurological Services

INTRODUCTION

In 1999 the World Federation of Neurology's Strategic Planning Group issued a group of recommendations (1). Strategic goals and directions included that: *the WFN mission be changed to improve human health worldwide by promoting prevention and the care of persons with disorders of the nervous system by fostering the best standards of neurological practice; educational programmes be focused on priority health problems that have been identified; the WFN work to increase its visibility and credibility among international organisations by serving as a data resource, the WFN work with WHO to advance public health aspects of neurology (1).*

Part of this initiative included the formation of the Task Force on Neurological Services, made up of members from different countries and continents, and varying areas of neurological expertise. The first charge of the Task Force was to produce a summary of the global burden and distribution of disorders of the nervous system and to carry out a survey of the distribution of neurospecialists world wide. The purpose of the report was to help identify targets for WFN action and attention, particularly in public health and the prevention of disorders of the nervous system. The goal was to complete the Task Force's report before the WFN Congress in London in 2001.

METHODS

Because of the importance to health planners of the recent and continuing Harvard/WHO/World Bank reports on the Global Burden of Disease, most of the data on disease mortality, prevalence, and impact of disease are drawn from these publications, and from the most recent update for the year 1999 given in the 2000 WHO report (2, 3, 4). All of these influential reports use the same WHO disease definitions and categorisations. The limitations of these data are well recognized, including incomplete reporting from some countries, unreliable and variable diagnostic standards, and unverified statistical assumptions.

The Appendix at the end of this paper provides more discussion of some of the most important neurological disorders. Since 'psychiatric disorders' are also disorders of the brain, data about them are included in the appendix.

To demonstrate the relative importance of various neurological disorders, they are first presented in the context of the most disabling or lethal general health conditions, then tabulated separately. Mortality rates, incidence, prevalence, and DALYs (disability-adjusted life-years) provide different perspectives on the impact of disease, and are all included in the analysis. [The DALY is an assigned value which includes an estimate of the number of years of expected productive life lost due to disease, added to the number of years lived in a disabled state due to disease. The latter is weighted according to the severity of the symptoms or disability (e.g., an incident of Bell palsy has a small weighting, an incident of severe head injury a larger one)].

Since the main data presented are extracted from WHO sources, the current WHO disease groupings are used in many of the tables. “The epidemiological indicators included in the tables are intended to reflect the essential information that health planners . . . might require in order to formulate, implement and evaluate appropriate strategies for the prevention and treatment of disease and injury.” (3, p 36). Problems presented by such groupings are addressed in the Discussion.

At the same time a survey of WFN delegates (5) was carried out to estimate the number of neurospecialists worldwide, including neurologists, neurosurgeons, and psychiatrists. Information about their distribution, specialist and post-graduate education, and practice milieu was also sought.

RESULTS AND DISCUSSION

Global Mortality

Among the top ten causes of death world wide, the only neurological disorder is **cerebrovascular disease**, which is the second most common cause of mortality and the cause of almost one in every 10 deaths (Table 1).

The global mortality rates in Table 1 do not include important differences in regional disease profiles. For example, all but a small number of deaths from TB, measles, and low birth weight occur in developing countries. In addition, almost three quarters of deaths in traffic accidents also occur in developing countries, where malaria is the ninth most common cause of death (2).

Mortality from disorders of the nervous system

About one in nine people dies of a disorder of the nervous system (Table 2). Deaths from **cerebrovascular diseases** outweigh deaths from all other leading neurological disorders combined. **Tetanus**, mainly neonatal, ranked number two in the 1990 data (Table 2), and is currently the target of a global WHO maternal immunization effort. **Congenital malformations** of the nervous system are prominent causes of death: **Anencephaly** kills twice as many people as epilepsy, **spina bifida** twice as many as multiple sclerosis. **Suicide** takes more than four times as many lives as bacterial meningitis.

Global Incidence and prevalence of disorders of the nervous system

Employing data about individual diseases, Tables 3 and 4 list the neurological diseases with the highest incidence and prevalence.

Incidence data reveal that **developmental delay due to protein-energy malnutrition** is the most frequently occurring neurological problem in the world. These data also highlight the toll on intellectual function associated with parasitic diseases, and the epidemic of **traumatic injuries** to the nervous system caused by road and work accidents. In some developing countries, the largest part of neurosurgical practice may be devoted to treating traumatic spinal or head injuries. Similarly, prevalence data show that **developmental disabilities** and **cognitive impairment** are the most common neurological disorders (Table 4). The global burden of (largely neurological) sequelae of **perinatal injury or asphyxia**, and that of **neurotrauma** from road accidents, falls, and war is heavy. The neurological complications of diabetes mellitus (**neuropathy** and **amputation**), are a major problem. The most common disorders of the nervous system globally are *preventable*.

(A more complete listing of all of the disorders of the nervous system monitored by the Global Burden of Disease project, along with comments about their global distribution, is provided in Table 5.)

Global Death and Disability from all Causes

Another way of viewing the impact of disorders of the nervous system is provided by the DALYs ascribed to these diseases. Table 6 uses the current WHO categories of disorders, and gives data from both 1990 and 1999, so that trends may be seen. Due to continuing reductions in infectious diseases, over the past decade noncommunicable diseases have overtaken communicable diseases as causes of death and disability.

Of disorders usually considered "neurological" rather than "psychiatric," only **epilepsy, dementia, parkinson disease, and multiple sclerosis** are included in the WHO category of "neuropsychiatric diseases." Data about **cerebrovascular disease** are included under "cardiovascular disease," and data about **infections** of the nervous system, **congenital malformations** and **trauma** affecting the nervous system, and **mental retardation** are scattered throughout other entries of the WHO tables, so that their total impact is not immediately evident from this table.

Global death and disability from disorders of the nervous system

More meaningful are data about individual disorders which primarily affect the nervous system (Table 7). Between 1990 and 1999 some trends can be seen, including the dramatic reduction of **polio** following the WHO global campaign for polio eradication. The largest numbers of DALYs are the consequence of so-called 'perinatal events', a category which includes **cerebral palsy, mental retardation, and epilepsy**, as well as **hearing and visual loss**.

Table 8 arranges the DALYs from neurological disorders in descending order of importance. They currently account for about 8% of DALYs globally. Because communicable diseases remain common in developing countries, disorders of the nervous system make up a higher relative burden of DALYs in industrialized countries (5).

Disorders with common neurological complications

Much of the world's disability and mortality is due not only to primary disorders of the nervous system, but also to neurological complications of other medical disorders, e.g., HIV encephalopathy, cerebral malaria, and diabetic neuropathy. Table 9 lists those health conditions producing the highest number of DALYs from disorders which either primarily or secondarily affect the nervous system.

COMMENTS

This analysis has major limitations.

First, the quality of data regarding the incidence and prevalence of disease varies enormously from region to region, and in some cases is very uncertain. In addition, estimates of the impact of disease on quality of life and remaining years of life are subject to debate. (2, 6)

Second, some aspects of the WHO disease classification system obscure the impact of neurological disorders on the world's health. Cerebrovascular disease is included under the larger category of 'cardiovascular disease,' only first-ever strokes are counted, and no report of etiology or type of stroke is attempted. In addition, the large WHO category 'neuropsychiatric disorders' implies an inclusive grouping of

diseases of the brain, including "psychiatric" disorders, but infectious neurological diseases, cerebral palsy, cognitive disorders, neuro-trauma, and stroke are placed under other categories. Neurological morbidity and mortality due to important infectious diseases such as HIV, tuberculosis, and cysticercosis are not tabulated at all.

Nevertheless, after extracting and re-ordering these data, the authors feel that this summary provides the best available picture of the most important disorders of the nervous system and their effect on the world's populations.

Trends and the Future

The future will be characterised by a shift to older, age-related mortality, with fewer communicable, maternal, perinatal and nutritional problems, and more HIV-related, cerebrovascular, dementing, and degenerative neurological diseases, especially in developing countries (2, p 387). Although life expectancy is falling in the formerly Socialist economies, it is projected to continue to rise elsewhere, with gains of 10 years or more in sub-Saharan Africa by 2020 (2, p 355). A French community survey of neurological diseases in a relatively elderly population in France in 1986-1987 may offer a profile of the future in developed countries: prevalences of the most common neurological disorders per 100 000 were: **non-migraine headache** (5 059), **migraine** (4 270); **neuropathy** (1 642), **stroke** (1 445), **epilepsy** (788), **transient ischemic attacks** (657), **parkinson disease** (328) and **dementia** (197) [7].

Comparing 1999 data with that from 1990 reveals that **polio and tetanus** are diminishing as a result of WHO targeted inoculation programs; but **cerebrovascular disease, dementia, epilepsy, and meningitis/encephalitis** are increasing. This varies by regions, with rates of **cerebrovascular disease** rising in eastern Europe and in developing countries, and falling in western Europe, the US, and Japan.

The widening **HIV** pandemic is expected to push the disease from 28th in its 1990 contribution to global disease burden into the top 10 by the early 21st century (2, p 284; 4). DALYs due to the WHO group of 'neuropsychiatric conditions' are projected to rise by 50% by 2020 (2, p 374) The increase will be especially marked in India, other Asian countries & islands, Latin American & the Caribbean, and the Middle Eastern crescent (2, p 384).

Prevention and intervention

Much of the global burden of neurological disease is preventable. Communicable disorders such as **polio** and **tetanus** are yielding to world wide inoculation campaigns, and **HIV** vaccines are being tested. **Malaria** is preventable and treatable.

Malnutrition, parasitosis, and perinatal conditions are directly related to remediable economic and social conditions. Risk factors for **cerebrovascular diseases** are well studied, and many such as hypertension can be reduced.

Neurotrauma can be reduced by improvement in roads, driving habits, workplace safety, and safe use of fires for cooking and heat.

Many serious, common disorders of the nervous system go untreated. **Depression** is often unrecognized or undertreated, especially in developing countries. Over 70% of those with **epilepsy** do not receive antiepileptic drugs. **Strokes** receive neither specific treatment nor rehabilitative efforts in most countries. An Estonian study found that hospitalization in special neurological and neurosurgical centers reduced case-fatality rates from near 50% to 30% (8).

Summary:

1. One out of nine people dies from a disorder of the nervous system.
2. The highest incidence and prevalence of disorders of the nervous system are in developing countries, where the number of neurologists is lowest.
3. Because the world's population is ageing and the impact of infectious disease is declining, the relative impact of many disorders of the nervous system, including stroke and dementia, will increase. This is particularly true for developing countries.
4. Stroke outweighs all other neurological disorders combined as a cause of mortality.
5. The neurological disorders with the highest prevalence, however, are developmental disability due to malnutrition, and cognitive dysfunction due to parasitosis. This 'epidemic' of cognitive loss is largely ignored by the neurological community.
6. Because neurological symptoms are the primary manifestation of 7-20% of cases of AIDS, and because 40-70% of those with AIDS or asymptomatic HIV develop neurological complications, the HIV pandemic demands more attention from neurologists.
7. Most of the disorders of the nervous system causing the highest rates of death and disability are preventable.
8. Assessment of the global impact of disorders of the nervous system is difficult to derive from the best available data sources.
9. Disorders of the nervous system have the greatest effect on health in the very regions where neurologists are sparse or absent (5).

Proposals and Recommendations

The WFN can work at three levels in order to attempt to reduce the impact of disorders of the nervous system in developing countries. Disparities in prevention, recognition, treatments available, trained health personnel and essential research are superimposed on scarce resources and inadequate health systems in many countries. These need to be addressed.

1) Efforts directed at the WHO, international funding agencies, and health ministries:

The WFN should use its standing in the international professional community to draw the attention of the public and of health planners to the importance of neurological disorders globally.

The WFN should endorse research priorities in identifying, preventing, and treating the world's most urgent burdens of neurological disorder.

The WFN should promote the prevention of the world's most widespread neurological disorders. Among the targets should be reduction of risk factors for stroke (especially hypertension), promotion of adequate nutrition, prevention of parasitic and HIV infections, and reduction of head trauma via improved road, home, and job safety measures.

The WFN should promote professional education in the identification, treatment, and especially the prevention, of neurological disorders in developing countries, where these disorders are most prevalent and neurological practitioners are few. Such education should be directed at primary care practitioners, who care for most people with disorders of the nervous system.

2) Collaborate with the other international organizations representing the specialties that care for individuals with nervous system disorders, e.g. International Child Neurology Society, World Psychiatric Association, World Federation of Neurosurgery, and the relevant organizations for rehabilitation, physical therapy, ophthalmology, otolaryngology and nursing.

The WFN should work to ensure that WHO modifies its current disease classification and monitoring system, which tends to obscure the burden of neurological disorders. Specifically, the ‘neuropsychiatric group’ does not capture some of the most common and serious disorders of the nervous system (developmental delay, cognitive dysfunction, neurological complications of common disorders, head trauma). In addition, cerebrovascular disease is concealed under ‘cardiovascular disease,’ brain tumors are not specifically tracked, and suicide is listed under ‘trauma,’ not with neuropsychiatric disorders.

3) Work within the WFN

To supplement WHO reports, the WFN should regularly produce its own analysis of the impact of worldwide neurological disease.

The WFN should provide assistance in certain regions to increase training of neurologists in order to deal with the current high incidence and prevalence of neurological disorders, and to prepare for projected changes in local health problems.

The WFN should expedite continuing medical education in neurology in areas where this is lacking, both for physicians specialising in treating neurological disorders and for generalist physicians.

WFN should aim to enlarge its representation to include not only those among the 107 unrepresented countries which have neurologists, but also those without them, through liaisons with generalist physician or other neurospecialist groups.

Distribution of this report to various WFN working groups is encouraged, including the Membership Committee, the Research Group on Epidemiology, the Research Group on International Affairs, the Research Group on Continuing Medical Education, the Education Committee, and the Research Group on Organisation and Delivery of Neurological Services.

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Table 1. Leading causes of death worldwide, 1990 (2, p 179-180) and 1999 (4), in thousands.

	<u>1990</u>
Deaths from all causes	50 500
1 ischemic heart disease	6 260
2 cerebrovascular disease	4 380
3 lower respiratory infections	4 300
4 diarrheal diseases	2 960
5 perinatal conditions *	2 440
6 COPD	2 210
7 TB	1 960
8 measles	1 060
9 road traffic accidents	1 000
10 lung/ airway cancers	945
	<u>1999</u>
Deaths from all causes	56 000
1 <i>ischemic heart disease</i>	<i>7 090</i>
2 <i>cerebrovascular disease</i>	<i>5 540</i>
3 lower respiratory disease	3 960
4 <i>HIV</i>	<i>2 670</i>
5 <i>COPD</i>	<i>2 660</i>
6 perinatal conditions *	2 360
7 diarrheal diseases	2 210
8 TB	1 670
9 <i>road traffic accidents</i>	<i>1 230</i>
10 <i>cancer trachea, bronchus, lung</i>	<i>1 190</i>

*includes low birth weight and asphyxia; excludes bacterial meningitis

Disproportionate increases in disease-specific mortality from 1990 to 1999 are in italics.

Table 2. Leading neurological causes of death world wide (in thousands) in 1990 (2, p 465ff).

Deaths from all causes:	50 500
Cerebrovascular disease	4 380
Tetanus	542
Other neuropsychiatric	212
Dementia	203
Bacterial meningitis	180
Anencephaly	148
Epilepsy	68
Spina bifida	59
Parkinson disease	58
Down syndrome	57
Polio	27
Multiple sclerosis	25
Japanese encephalitis	5
Leprosy	3
TOTAL	5 960 (11% of total)

Table 3. Neurological diseases with highest global incidence, rate per 100,000 (2)

Protein energy malnutrition, developmental disability	208
Epilepsy	155
First stroke	115
Intracranial injury, road accident, acute	106
Cognitive impairment due to parasitosis*	53
Dementia	49
Cognitive impairment due to iron deficiency anemia	38
Nerve injuries	33
Tetanus	16
Intracranial injury, long-term	13

*ascariasis, tricuriasis, ancylostomiasis, necatoriasis

Table 4. Neurological diseases with highest prevalence, rate per 100,000 (2)

Protein-energy malnutrition, developmental disability	6834
Cognitive impairment, parasitosis*	1806
Cognitive impairment, iron deficiency anemia	1340
First stroke	586
Epilepsy	548
Diabetic neuropathy	459
Intracranial injury, chronic, road accident	426
Birth asphyxia/trauma, all sequelae	421
Dementia	357
Intracranial injury, longterm, other injuries	206
Polio sequelae	203
Nerve injuries, war	184
Intracranial injury, acute, road accident	156
Spinal cord injury, falls	137
Diabetic amputation	121

*ascariasis, tricuriasis, ancylostomiasis, necatoriasis

Table 5. Comprehensive 1990 incidence / prevalence rates of neurological diseases, per 100,000 (3)

Grouping or disorder	Incidence	Prevalence	Comment
Communicable, maternal, perinatal & nutritional disorders:			
Infectious and parasitic			
Congenital syphilis	4.9	145	most in SSA
Neurosyphilis	2.1	15.9	most in DC
Polio sequelae	4.1	203	nearly all in DC
Diphtheria, neuro. compl.	0.4	0.1	nearly all in DC
Tetanus	15.6	0.6	most in India
Bacterial meningitis	11.7	0.9	least in EME
Epilepsy	0.7	25	least in EME
Motor deficit	0.7	23	least in EME
Retardation	0.9	30	least in EME
Malaria, neurological seq.	3.0	57	almost all in SSA
Leprosy	9.9	46.2	almost all in DC
Disabling	1.5	39	almost all in DC
Japanese encephalitis	1.1	0.5	most in China
Cognitive impairm.	0.3	13.3	all in China/Asia
Neurol.sequelae	0.4	17.9	all in China/Asia
Ascariasis, contemp.			
cognitive defic.	277	277	all in DC
Cognitive impair.	27	1000	all in DC
Trichuriasis, contemp			
cognitive deficit	--	347	all in DC
cognitive impair	20 2	763	all in DC
Ancylostomiasis & necatoriasis			
cognitive impair	5.6	182	all in DC
Perinatal			
Hypertensive disorders of pregnancy, neuro. sequelaa	0.1	3.5	more in DC
Birth asphyxia / trauma, all sequelae	--	979	most in India
Nutritional deficiencies			
Protein-energy malnutrition, developmental disability	208	6834	more in DC
Iodine deficiency			
mild. devel. disabil	0.9	31	more in DC
cretinism	0.3	10.3	middle east/China/India
Iron-deficiency anemia, cognitive impair	38	1340	less in EME, FSE
Noncommunicable disorders			
Malignant neoplasms			
[Brain tumors are not tracked]			

Endocrinopathies			
Diabetic foot	112	19	more in EME, FSE
Diabetic neuropathy	--	459	most in EME
Diabetic amputation	8.9	121	most in EME
Neuropsychiatric disorders [sic]			
Epilepsy	155	548	everywhere
Dementia	49	357	most in EME & FSE
Parkinson disease	5.8	71	most in EME
MS	2.0	48	more in EME & FSE
Cardiovascular disease			
CVA, first	115	586	most in FSE then EME
Birth defects, genetic			
Down syndrome	3.7	98	everywhere
Anencephaly	2.8	0	most in India
Spina bifida	2.7	56	most in Asia, India
Injuries			
Unintentional			
Road accidents			
fractured skull 'long term'	0.8	25	least in China & mideast
spinal cord injury	4.7	96	most EME, FSE, LA
intracranial, short	106	7.1	least in China
intracranial, long	5.4	156	least in China & mideast
Falls			
fractured skull, long	2.9	94	most in India & Asia
spinal cord	7.2	137	most in Asia, FSE
intracranial injury, longterm	13	426	most in India
Fires spinal cord	0	0.6	biggest in India, less SSA
Drownings paraplegia	0.8	21	most in China, Asia, SSA
Other injuries,			
spinal cord	3.7	56	most in SSA India, FSE
intracranial, long	7.2	206	most SSA India
injured nerves	33	816	most in SSA
Intentional			
Suicide	86	--	highest x2 in China
Violence, skull fracture	0.5	12	highest in SSA
spinal cord	0.2	4.6	most in LA by far
intracran. long	2.2	59	least in mideast
injured nerves	0.9	23	most in SSA
War			
intracranial long	3.8	92	most mideast, SSA, FSE
injured nerves	7.6	184	most in SSA, mideast

SSA = Sub-Saharan Africa, DC = developing countries, EME = established market economies, FSE = former socialist economies, LA = Latin America

Table 6. Most common causes of DALYs from all causes, in thousands (2, 4,)

From all causes: 1990 1 379 000
 1999 1 440 000

	<u>1990</u>	<u>1999</u>
<i>I. Communicable, maternal, perinatal and nutritional (totals)</i>	606 000	615 000
A. Infectious & parasitic	316 000	354 000
Diarrhoeal diseases	100 000	72 000
Childhood cluster	71 000	54 600
Respiratory infections	117 000	101 000
HIV	11 200 **	89 800
B. Perinatal conditions*	92 000	89 500
C. Nutritional deficiencies	51 000	44 500
 <i>II. Noncommunicable diseases (totals)</i>	 565 000	 622 000
A. Malignant neoplasms	71 000	84 500
B. Neuropsychiatric disorders	145 000	159 000
C. Cardiovascular disease	133 000	157 000
D. Respiratory (COPD, asth)	60 000	70 000
 <i>III. Injuries (total)</i>	 209 000	 201 000
A. Unintentional injuries	152 000	152 000
B. Intentional injuries	56 000	48 800

*excludes bacterial meningitis; includes low birth weight & asphyxia.

**added for comparison with 1999; not one of the most common in 1990.

Table 7. DALYs due to disorders primarily affecting the nervous system (2, p 573ff, and 4)

	1990	1999
<i>I. Communicable, maternal, perinatal & nutritional conditions</i>		
A. Infectious & parasitic diseases		
Childhood cluster		
Poliomyelitis	3 370	1 720
Tetanus	17 500	12 000
Bacterial meningitis	6 200	9 820
Leprosy	384	476
Japanese encephalitis	744	1 050
B. Perinatal conditions *	92 300	89 500
C. Nutritional deficiencies		
Protein-energy malnutrition	21 000	13 600
 <i>II. Non-communicable diseases</i>		
A. Neuro-psychiatric conditions		
Epilepsy	5 350	7 630
Alcohol dependence	16 700	18 700
Alzheimer/Dementias	8 500	10 000
Parkinson disease	1 050	1 590
Multiple sclerosis	1 420	1 570
B. Cardiovascular disease		
Cerebrovascular disease	38 500	49 900

* Sequelae include cerebral palsy, mental retardation, hearing or visual loss, & epilepsy (3, p 867)

Table 8. 1990 and 1999 DALYs due to disorders of the nervous system, in thousands (2, p 573ff, and 4)

	1990	1999	
All cause	1 380 000	1 438 000	
Cerebrovascular disease	38 500	49 900	
Tetanus	17 500	12 000	
Dementia	8 500	10 000	
Bacterial meningitis	6 240	9 820	
Epilepsy	5 350	7 630	
Anencephaly	4 990	N/A*	
Down syndrome	4 750	N/A*	
Spina bifida	4 120	N/A*	
Polio	3 370	1 720	
Multiple sclerosis	1 420	1 570	
Parkinson disease	1 050	1 590	
Japanese encephalitis	744	1 050	
Leprosy	384	476	
total	96 900	110 000**	
	7.0%	7.6%	of all DALYs;

*not available

* assuming same DALYs as 1990 for anencephaly, Down syndrome, & spina bifida

Table 9. DALYs lost from disorders primarily or secondarily affecting the nervous system., in thousands (2, p 573ff, and 4)

	1990	1999
<i>I. Communicable, maternal, perinatal & nutritional conditions</i>		
A. Infectious & parasitic diseases		
Childhood cluster		
Measles *	36 500	29 900
Tetanus	11 500	12 000
Malaria	31 700	45 000
Tuberculosis	38 400	33 300
HIV	11 200	89 800
B. Perinatal conditions	92 300	89 500
C. Nutritional deficiencies		
Protein-energy malnutrition	21 000	13 600
Anemias	24 600	26 300
<i>II. Non-communicable diseases</i>		
A. Diabetes mellitus	11 100	15 000
B. Neuropsychiatric		
Alcohol dependence	16 700	18 700
Alzheimer/dementias	5 960	10 000
C. Cardiovascular		
Ischaemic heart disease	46 700	59 000
Cerebrovascular disease	38 500	49 900
Inflammatory heart disease	10 300	8 890
D. Congenital abnormalities	2 700	36 600
<i>III. Injuries</i>		
A. Unintentional injuries		
Road traffic accidents	34 300	39 600
Falls	26 700	31 000
B. Intentional injuries		
Self-inflicted	19 000	25 100
Homicide/Violence	17 500	15 300
War	20 000	8 440

** Encephalitis occurs in 1 in 2000 cases of measles. Subacute sclerosing encephalitis (SSPE) follows measles in up to 1 in 1000, especially in developing countries where more susceptible young children acquire the infection (9)

APPENDIX

Cerebrovascular disease. Data for death rates from stroke in certain areas are very unreliable, but regional differences appear to be extremely significant. For example, stroke is the leading cause of all 'cardiovascular' deaths in China and sub-Saharan Africa, causing about half of them. In addition, although mortality data from sub-Saharan Africa are generally sparse and unreliable, a careful study from Tanzania from 1992 to 1995 attributed 55% of deaths to cerebrovascular disease. ("Yearly age-adjusted rates per 100 000 in the 15-64 year age group for the 3 project areas (urban, fairly prosperous rural, and poor rural, respectively) were 65, 44, and 35 for men, and 88, 33, and 27 for women, as compared with the England and Wales 1993 rates of 10.8 for men and 8.6 for women.") The most significant postulated risk factor was hypertension (10), but aggressive, successful marketing of cigarettes in developing countries will make an increasing contribution. As the population in such areas ages, more strokes are to be expected.

One of the highest worldwide rates of stroke was reported from Novosibirsk, Russia, 232 per 100,000 for all ages, (ischemic stroke 87.7%, intracerebral hemorrhage 8.5%, subarachnoid hemorrhage 3.8%), and 1 554 per 100 000 for those over 75 years of age. Hypertension, angina, and cigarette smoking were the most frequent risk factors (9).

The incidence of significant **neurological trauma** from accidents, falls, violence, and war surpasses the occurrence of first-ever stroke [Table 4]. Studies from Norway to Malawi identify the major causes of head injury as road accidents and falls (10,11). For road accidents and other unintentional injuries, intracranial injury is the most common cause of emergency room visits or hospitalisations (24-44%, depending on age) [2, p 284]. Head injury is one of the most common causes of death in fatal accidents (12).

The prevalence of **epilepsy** in developed countries is about 0.5%, rising to 1% or more in developing countries. Up to 70% of people with epilepsy in some developing countries do not receive treatment (13). A study of patients in a 'bush hospital' in Zambia found that 44% of all neurologic admissions were for seizures. Only 31% of those with epilepsy had ever received AEDs, and 90% of those treated were underdosed. Underdiagnosis was also common (13).

The causes of epilepsy vary widely. The most common CT scan abnormalities found in Latin America and India are lesions suggestive of neurocysticercosis. Malaria is commonly associated with seizures in sub-Saharan Africa.

CNS infections:

Malaria is often a neurological disease (3, p 326). In the the region of highest incidence, sub-Saharan Africa, neurological complications occur in 30/100 000 cases, or 155 000 people in 1990. Other estimates of **cerebral malaria** range up to 10% of hospitalized cases, with case fatality rates of 10-50%. It is particularly common in children (14).

Tuberculomas make up 15-20% of intracranial masses seen in some developing countries (15).

Neurological symptoms are the primary manifestation of 7-20% of cases of AIDS, and 40-70% of those with AIDS or asymptomatic **HIV** develop neurological complications. HIV deserves more attention as an important contributor to neurological pathology and disability (16).

With the decline of leprosy, **diabetic neuropathy** is the most common peripheral neuropathy world wide, occurring in 10-62% of those with diabetes mellitus, with the most commonly reported prevalence around 50% (17). Almost 1% have a 'diabetic foot,' the result of vascular and neuropathic disease (3, p588-594).

Chronic neurological conditions result in a huge worldwide burden of disability. This is especially severe for children. Protein-energy malnutrition, developmental disability, birth asphyxia/trauma, spinal bifida, and Down's Syndrome are remarkably frequent, and although presenting at birth, these conditions are lifelong. Spinal cord and other Injuries affect individuals of all ages, and the sequellae are often lifelong. Other conditions that are amendable to neuro-rehabilitative approaches include polio, disabling leprosy, Japanese encephalitis, diabetic amputation, and multiple sclerosis, the need for **rehabilitation** services for neurological disorders is staggering.

Comprehensive, organized rehabilitation programs are clearly beneficial for reducing mortality and disability for stroke and spinal cord injury, but are available only in industrialized countries. In developing countries, even rudimentary rehabilitation services that reduce disability such as bracing, adaptive equipment and wheelchairs, are lacking. Millions of persons with a variety of physical disabilities due to neurologic disorders, are therefore unable to reach their maximum potential. Although the most important method to reduce disability is prevention of chronic neurological conditions, there is also a tremendous need for resources to minimize disability and maximize the social integration of persons who have already developed chronic neurological conditions.

Appendix Table A. Disorders of the nervous system with highest global incidence, rate per 100,000

Major depression	2079
Alcoholism	723
Obsessive compulsive disorder	714
Panic disorder	546
Cognitive deficit due to ascariasis	277
Bipolar disorder	254
Protein energy malnutrition developmental disability	208
Epilepsy	155
Post traumatic stress	116
Stroke, first	115
Intracranial injury, road accident acute	106
Suicide	86
Dementia	49
Cognitive impairment due to iron deficiency anemia	38
Nerve injuries	33
Cognitive impairment, trichuriasis	20.2
Tetanus	15.6
Intracranial injury, longterm	13

Appendix Table B. Disorders of the nervous system with highest prevalence, rate per 1000. Includes psychiatric conditions.

Protein-energy malnutrition, developmental disability	6834
Cognitive impairment, iron deficiency anemia	1340
Major depression	1270
Alcoholism	1180
Obsessive compulsive disorder	1110
Cognitive impairment, ascariasis	1000
Nerve injuries, other causes	816
Cognitive impairment, trichuriasis	763
First stroke	586
Epilepsy	548
Diabetic neuropathy	459
Intracranial injury, chronic, road accident	426
Birth asphyxia / trauma, all sequelae	421
Panic disorder	406
Dementia	357
Cognitive deficit, trichuriasis	347
Bipolar disorder	338
Post-traumatic stress disorder	278
Cognitive deficit, ascariasis	277
Intracranial injury, longterm, other injuries	206
Polio sequelae	203
Nerve injuries, war	184
Cognitive impairment, ancylostomiasis & necatoriasis	182
Intracranial injury, acute, road accident	156
Spinal cord injury, falls	137
Diabetic amputation	121

Appendix Table C. Most common causes of DALYs, from all causes, in thousands (2, 4)

All causes:	1990 1 379 000	1999 1 440 000
Injuries (accidental)	151 000	152 000
Respiratory infections	117 000	101 000
HIV	11 200	89 800
Perinatal conditions**	92 000	89 500
Malignant neoplasms	61 000	84 500
Diarrhoeal disease	100 000	72 000
Ischemic heart disease	46 700	59 000
Unipolar depression	58 000	59 000
Childhood exanthems	71 000	54 600
Cerebrovascular disease	38 500	50 000

*All but bacterial meningitis; includes low birth weight & asphyxia.

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