Study on Measuring Burden of Disease

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DALY (Disability Adjusted Life Years) was recommended as a new indicator to measure burden of disease (BOD). Although BOD combines information from both morbidity and mortality, it only reflects the burden from the patients themselves because of their illness or death. As a common indicator, BOD should not only include the burden from the patients, but also the burden to the society around the patients, such as the input and support from the society to the ill person, and the losses from the related events. The aim of this study is to explore the scope and the magnitude of the burden to the society using stroke as an example. Results show that the burden due to time lost for caring for patients in hospitals accounts for 2.4% of total BOD (in a narrow sense), which indicates that BOD may be underestimated if the burden to the society is ignored.

INTRODUCTION

Over the last two centuries, many indicators such as incidence, prevalence, mortality, and life expectancy have been developed to measure burden of disease (BOD). Each of the above indicators only reflects one aspect of BOD, and none of them combine the information from both mortality and morbidity. Supported by the World Bank, a new indicator, Disability-adjusted Life Years (DALY) was proposed by a group led by C. Murray in Harvard University in 1993 (Murray, 1994, 1996; Xia, Gong and Gu, 1998). The advantage of DALY lies in the fact that it combines the burden due to the time lost from premature death and disability, which makes it possible to get clearer picture of the disease impacts. But as defined by Murray, DALY in principle reflects the functional limitations due to disability and premature death. In other words, it only reflects the time lost for the patients themselves.

If the objective of designing this indicator is to measure the actual burden of disease, the burden to the society should be included, e.g. the support provided through public services, private incomes, family and friends (Anand and Hanson, 1997; Chen, 1998). Actually great burden would be shared by the society in supporting the patients in different ways, such as resource consumption from medical treatment and caregiving. It is well known that because of the rapid transition of disease patterns, more people are suffering from non-communicable diseases, who need strong support from the family, and as a consequence more resources are consumed. However, very few studies have investigated this issue, so it is important to explore the scope and the magnitude of the burden to society due to diseases.

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METHODS

We measured the burden of disease with the indicator DALY in this study. DALY consists of four measurements: (i) estimating the duration of life lost due to a death at each age; (ii) comparing survival time with a non-fatal health outcome with time lost due to premature mortality; (iii) discounting future health; and (iv) age-weighting.

The general formula for DALY is as follows:

$$\begin{aligned}\text{DALY} &= \int_{x=a}^{x=a+l} D[KCxe^{-\beta x} + (1-k)]e^{-r(x-a)}dx \\ &= \frac{KDCe^{-\beta\alpha}}{(\beta+r)^2}[e^{-(\beta+r)l}(1+(\beta+r)(l+a)) - (1+(\beta+r)a)] \\ &\quad + \frac{D(1-K)}{r}(1-e^{-rl}),\end{aligned}$$

where D is the disability weight, γ is the discount rate, β is the parameter from the age weighting function, K is the age-weighting modulation factor, C is a constant, α is the age at death or the age of onset of the disability and L is the standard expectation of life at age α or the duration of disability. For the standard DALY used in GBD (Global Burden of Disease), γ is 0.03, β is 0.04, K is 1 and C is 0.1658.

In the present study we measure the social burden of disease according to DALY. The time lost for caring for patients are measured in person years, and adjusted by age-weight and time discount.

DATA SOURCE

In this study we used two sets of data. The first set included two data files. The first file was the demographic data by sex, age (in 5-year interval), incidence and mortality due to stroke in the urban area of Tianjin in 1996, provided by the Four Chronic Diseases Management Office, Tianjin Municipal Health Bureau. The second data file included other parameters for calculating DALY, such as disability weight and duration of disability at each age, provided by the GBD Study of the World Bank. The second set of data included a hospital interview survey about the time lost to caring for stroke patients by the families and friends, as well as about the general conditions of the patients, which was conducted in a hospital in Beijing by the authors in 1998. In the first data set, the number of deaths and onset of stroke have been adjusted by the results of the under-reported survey conducted by the surveillance system of the Tianjin Municipal Health Bureau.

Population and Total Incidence and Mortality of Stroke

The total population covered in this study was about 3.7 million, of which 50.2% were males and 49.8% females. The total crude incidence rate in male and female was 490.86 and 349.02 per 100 000, respectively, and the crude mortality rate was 105.91 and 89.53 per 100 000, respectively (Table 1).

Other Parameters for Calculating DALY

The other parameters for calculating DALY such as life expectancy, disability weight, average duration, and average age at onset were cited from the GOD Study of the World Bank (Murray and Lopez, 1996) (Table 2).

TABLE 1

Population, Rates of Incidence and Mortality of Stroke in Urban Areas of Tianjin (1996)

Sex	Population (thousand)	Incidence (per 100 000)	Mortality (per 100 000)
Male	1853.5	490.86	105.91
Female	1839.7	349.02	89.53
Total	3693.2	420.20	97.75

TABLE 2

Some Parameters of Calculating DALY (1993, the World Bank)

Age (years)	Avg. Age at Onset (years)	Disability Weight	Life Expectancy (years)		Average Duration (years)	
			Female	Male	Female	Male
<15	10	0.224	72.99	70.40	–	–
15–	20	0.224	63.08	60.44	18.1	19.0
25–	30	0.224	53.27	50.51	18.1	19.0
35–	40	0.224	43.53	40.64	18.1	19.0
45–	50	0.258	33.99	30.99	7.5	7.4
55–	60	0.258	24.83	21.81	7.5	7.4
65–	70	0.258	16.20	13.58	3.0	2.0
75–	80	0.258	8.90	7.45	3.0	2.0

RESULT

The Burden of Disease Due to Stroke Measured by DALY

The total DALY of stroke in males and females was 11.70 and 9.38 per 1000, respectively. The DALY was slightly higher in males than in females, which is similar to results obtained using other indicators of disease burden, such as incidence and mortality. This revealed the consistency between DALY and the old single indicators. When the data was grouped by age, the same trends were also found in each age group. The results also show the age trend in population. As age increased, the burden of disease measured by DALY also increased (Table 3).

Condition of Caring for Stroke Patients in Hospitals

102 patients who had suffered a stroke were surveyed in respect with the time loss to caring for them by others and the general conditions of the patients as well. All patients were diagnosed by symptoms, signs and CT findings. There were 72 males

and 30 females. Their average age was 61.9 years. The total average duration of hospitalization was 22.0 days. The prognosis was as follows: 21 cases completely recovered, 64 cases were recuperating, 6 remained without improvement, and 11 died. There is no statistically significant difference in the average duration of hospitalization between sex, age group, and type of stroke ($P>0.05$) (Table 4).

TABLE 3

DALY of Stroke by Age and Sex (Urban Areas of Tianjin, 1996) (per Thousand Population)

Age(years)	Male	Female
<35	0.31	0.24
35–	5.11	2.53
45–	13.31	9.16
55–	38.26	30.32
65–	49.04	37.65
75–	62.85	47.94
Total	11.70	9.38

TABLE 4

Average Duration of Hospitalization of 102 Stroke Patients

Group	*n*	Average Duration (days)	Test	*P*-Value
Sex				
Male	72	21.5±10.6	$t=0.95$	>0.05
Female	30	22.8±10.7		
Type of Stroke				
Ischemic	73	22.0±8.6	$t=0.02$	>0.05
Hemorrhagic	29	21.9±13.7		
Age (years)				
<45	9	17.1±8.9	$F=1.93$	>0.05
45–	17	24.2±5.2		
55–	25	21.6±8.2		
65–	40	23.4±13.1		
75–	11	20.7±12.0		

Because there was close correlation between the time of patient care and the duration of hospitalization, the total time lost to caring for patients in hospitals was calculated. Three types of people who cared for the patients are defined in our study: spouse of the patient, offspring or relatives of the patient, and employed caregivers. A total of 299 people took care of the 102 patients during the study period and 2087 person-days were spent on care. The average age of the caregivers was 40.3 years old (Table 5). Therefore, the average of the caring time per hospitalized patient was 20.

9 person-days. That is to say, if a stroke patient was hospitalized for one day, the time lost to caring for him by others was 0.95 person-day.

Comparing Social Burden of Disease With the Burden of Illness Itself

As reported, most of the stroke patients were treated in hospitals. Chen (1994) reported that the national hospitalization rate due to stroke was over 80%, and it was higher in urban areas than in rural areas. In this study, we used the average caring time from our own survey (20.9 days) and the national average hospitalization rate (80%) to calculate the total time loss to caring for stroke patients in urban areas of Tianjin City in 1996. The result showed that the total caring time for stroke patients by others, adjusted by age-weight and time discount, was 951 person years in this population of 3.7 million in one year. By comparing the caring time per thousand with the DALY of stroke in the same population, we found that the time lost to caring for stroke patients by families, relatives and other people accounted for 2.4% of the DALY for stroke (Table 6).

TABLE 5

Condition of Caring for the 102 Stroke Patients

Type of Caring Person	*n*	Average Age (years)	Time of Caring (person-days)
Spouse	46	55.0±11.5	449
Offspring or Relatives	243	37.7±6.7	1436
Other employed caregivers	10	35.5±5.5	202
Total	299	40.3±7.6	2087

TABLE 6

Comparing Social Burden of Disease With the Burden of Illness Itself

Sex	Burden of Illness Itself (DALY/1000)	Time Lost for Caring (person-years/1000)	Time Lost for Caring Compared With DALY (%)
Male	11.70	0.26	2.2
Female	9.38	0.26	2.8
Total	10.54	0.26	2.4

DISCUSSION

When we evaluate the burden of disease, the social burden of disease should not be ignored. In this study, burden due to the time lost to caring for stroke patients in hospitals accounts for 2.4% of DALY. Stroke is a disease with frequent relapse, and the stroke patients were often confined to bed again, and the patients usually suffer more in the relapse than at the onset of the disease. Moreover, the stroke patients of-

ten need care for a very long time, even after hospital discharge. As a consequence, the total social burden of stroke should be more than 2.4% of DALY, possibly over 10% of the estimated DALY.

The people caring for patients are commonly almost in middle age (in the present study the average age was 40.3 years old), and these people tend to be the main labor force in the society. Caring for patients in hospitals will disturb their normal regular work and life. The social burden of disease should therefore be granted more attention.

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