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# Cost-Benefit Analysis of a Community-Based Stroke Prevention Program in Bao Shan District, Shanghai, China

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### Abstract

**Background:** Stroke is a serious problem faced by society. This disease brings not only health problems to individuals suffering from it, but also a serious economic burden to patients and their families. Moreover, it reduces social benefits and the labor force. Therefore, it is important to think about the efficient control and prevention of this disease. It is well known that hypertension is the main cause of stroke. In Bao Shan District, located in Shanghai, China, a community-based prevention program has been in place since 1995. The program is trying to reduce the number of stroke patients and the costs to treat them, mainly by hypertension control and treatment.

**Objectives:** The purpose of this paper is to show the data, describe the results and give a cost-benefit analysis of the program according to data from 1995 to 1997.

Methods: The data is calculated by using the method of cost-benefit analysis.

**Results:** According to the cost-benefit analysis of the program, because the incidence of stroke goes down after the hypertension prevention work is taken, the16 patients will not face economic loss because of stoke after the prevention. This is the biggest benefit of this community-based program. The input of this program is RMB 293,573 and the output is RMB 1,062.204; the ratio of cost and benefit is: cost: benefit=1:3.57 (the official currency of the People's Republic of China; RMB/USD currency exchange rate is 1: 0.1473).

**Conclusion:** The economic burden and the Cost-Benefit Analysis can provide important data to the medical and public health departments in order to make the pertinent prevention policy.

Keywords: Cost-Benefit, Hypertension, Prevention, Stroke

### Background

In recent years, the morbidity and mortality rates of chronic diseases in China have been increasing. Among these chronic diseases, stroke's rates of morbidity and mortality are the highest <sup>1</sup>. Stroke happens suddenly and has very high rates of disability and mortality. Stroke morbidity in China is 89.6 to 314 out of every 100,000 males and 76.7 to 212.2 out of every 100,000 females. The mortality from stroke in urban areas is 127.96 out of every 100,000 people; and in rural areas, it is 115.2 out of every 100,000 people<sup>2</sup>.

Table 1: S	Stroke in	China	2007
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New Patients Annually	Morbidity Rate	Existing Patients	Patients Who Lose the Ability to Work and Cannot Live Independently	Disability Rate	Deaths from Stroke Annually
2,000,000	120/100,000 people	7,000,000	4,500,000	over 75%	1,200,000

This difficult situation has caught the attention of both the health department and the central government.

In Bao Shan District, Shanghai China, the local community spent three years on stroke prevention work, mainly focusing on hypertension control. This had a noticeably positive effect. The purpose of this paper is to provide a cost-benefit analysis of this work.

### Data and Method

Bao Shan District implemented a community-based stroke prevention program in 1995. This paper will show the data, describe the results and give a cost-effectiveness analysis according to data from 1995 to 1997.

The direct hospital inpatient and convalescent costs of total 793 stroke patients are due to expenses of medical therapy in local hospitals, polyclinics and general practitioners in Shanghai.

The indirect costs such as work delays, absence from work, and home nursing were taken from economic statistic data published by the local government  $^3$ .

The costs of community hypertension control mainly include prevention and therapy costs, the salary of various kinds of employees, pharmaceuticals, equipment, and material expenses. The costs of diagnostic tests are not included.

In this paper, data will be compared with those from 1997.

A stroke is caused by the interruption of the blood supply to the brain, usually because a blood vessel bursts or is blocked by a clot <sup>4</sup>. This cuts off the supply of oxygen and nutrients, causing damage to the brain tissue. Diagnostic criteria for stroke include: slurred speech or weakness on one side of the body, brain tumors, brain abscess, migraine headache, bleeding in the brain either spontaneously or from trauma, meningitis or encephalitis, an overdose of certain medications, and an electrolyte imbalance in the body <sup>5</sup>. Transient ischemic attack (TIA) is included.

### Analysis and Results

It took three years to complete the intervention of 793 hypertension patients out of a total 16,415 patients in the community hypertension prevention center. Hypertension morbidity in that area was, before the intervention, 157 out of every 100,000 people. After the three-year-intervention, the rate was 61 out of every 100,000 people. Moreover, the stroke onset age was postponed by about 10 years, and there were 16 fewer stroke patients out of every 100,000 people.

The economic loss of stroke patients and their families without the community-based prevention work is significant:

According to the report, the rate of stroke events in China that causes disability is very high, at about 80%. The recurrence rate is about 41%. The average life expectancy of a post-stroke patient is only 7.5 years after the stroke  $^{6}$ . In this paper, all of these influential factors were considered.

The hospital therapy expenses for each stroke patient are RMB (the official currency of the People's Republic of China; RMB/USD currency exchange rate is 1: 0.1473) 7,500<sup>7</sup>. Diagnostic tests, inpatient care and medication are included. After a recrudescence, the medical treatment cost will be RMB 7,500×41% (recrudescence rate), for a total of RMB 3,075. Every stroke patient requires a hospital stay of approximately two months for convalescent treatment. The total cost of these two months is RMB 6,000.

INPUT	QUANTITY	UNIT COST	TOTAL COST
In-Hospital Treatment Following Stroke	1	RMB 7,500	RMB 7,500
In-Hospital Treatment During Recrudescence	1*41% (Recurrence Rate)	RMB 7,500	RMB 3,075
2 Months In-Hospital Convalescent Treatment	1	RMB 6,000	RMB 6,000
Total In-Hospital Treatment	RMB 16,575		

### Table 2: In-Hospital Cost of Each Patient

The family-based convalescent treatment costs, after release from hospital, will be about RMB 350 per month" for nursing costs (if hiring a nurse). According to the average post-stroke lifespan of 7.5 years, the total cost for each family will be: RMB  $350 \times 12 \text{ month} \times 7.5 \text{ years} \times 80\%$  disability rate= RMB 25,200.

Table 3:	At-Home	Cost/	Patient
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INPUT	UNIT COST	MONTH	YEAR	DISABILITY RATE	TOTAL COST
At home convalescent treatment (e.g. hiring a nurse)	RMB 350	12	7.5	80%	RMB 25,200

The stroke patient and his family also need to pay about RMB 200 per month for the additional convalescent treatment by themselves. Therefore, the total cost over 7.5 years will be: RMB  $200 \times 12$  months  $\times 7.5$  years  $\times 80$  disability rate= RMB 14,400.

INPUT	UNIT COST	MONTH	YEAR	DISABILITY RATE	TOTAL COST
At home convalescent treatment by themselves	RMB 200	12	7.5	80%	RMB 14,400

It is certain that stroke patients face a significant decrease in income. We use the standard income rate of RMB 4534 individually per year and a 30% annual reduction. Over the course of 7.5 years, the total decrease in income for each stroke patient will be: RMB  $4,534 \times 30\% \times 7.5$  years= RMB 10,201.5.

### Table 4: Income Loss of Each Patient

STANDARD INCOME PER YEAR	RATE OF DECREASE	YEARS	TOTAL LOSS
RMB 4,535	30%	7.5	RMB 10,201.5

In summary, every stroke event in our sample has an economic loss of: (RMB) 7,500+3,075+6,000+25,200+14,400+10,201.5=RMB 66,376.5

### Table 5: Total Economic Impact on Each Patient

Inpatient Hospital Treatment Cost	Outpatient Treatment Cost	Income Loss	Total Economic Loss
	RMB 25,200		
RMB 16,575	RMB 14,400	RMB 10,201.5	RMB 66,376.5

In this community, the prevention work successfully reduces the number of patients by 16 for every 100,000 people. The total economic impact on these 16 patients would be: RMB  $66,376.5 \times 16$  patients=RMB 1,062,024

### Table 6: Total Economic Loss of 16 Patients

Economic Losing of Each Patient	Number of Patients	Total Economic Loss of All Patients
RMB 66,376.5	16	RMB 1,062.204

Some other expenses such as transportation, nutrition, work delay and the industrial and agriculture production value reduced due to the disease have not been taken into account in these calculations.

The Cost of Community-based Hypertension Control Work in 10 communities over 3 years:

The Bao Shan Stroke and Hypertension Prevention Center has a budget of about RMB 9,676.6 each year; the total budget for 3 years is RMB 29,030. Annual costs include the treatment and prevention fee (RMB 80,000), the special project fee (RMB 150,000), and employee salaries (RMB 70,000). There is RMB 90, 0000 in 3 years. The Bao Shan district is comprised of 310 communities; each community receives RMB 2,903.

The annual salary of staff in the community prevention center is RMB 13,327 so the total cost of each person over the course of three years is RMB  $13,327\times3$  years=RMB 39,981 (This calculation does not include the salaries of part-time staff).

Each physician in every community prevention center has an annual salary of RMB 7,189. The average number of physicians in each community center is 6, so the annual salary for 6 physicians is RMB 7,189×6 physicians=RMB 43,134 and the total salary for 6 physicians in 3 years is: RMB 43,134×3 years=RMB 129,402.

The annual pharmacy costs for each hypertensive patient, in order to control blood pressure, are RMB 40. The medications usually prescribed are Hydrochlorothiazide and Nitrendipine. Therefore, the total pharmacy costs in the Bao Shan district for all 793 patients over the course of 3 years is: RMB 40×793 patients×3 years=RMB 95,160. Nitrendipine is taken twice daily, so the annual cost for this medication for each patient is RMB 58.5; Hydrochlorothiazide is taken three times daily, making its annual cost RMB 33.

The total cost of the community-based hypertension prevention in Bao Shan district is: RMB 29,030+39,981+129,402+95,160=RMB 293,573

INPUT	UNIT COST	QUANTITY	TOTAL COST
Budget	RMB 9,676.6	3 years	RMB 29,030
Total Staff Salary	RMB 13,327	3 years	RMB 39,981
Physician Salary (6 physicians)	RMB 43,134	3 years	RMB 129,402
Pharmacy Expenses for 793 Patients	RMB 31,720	3 years	RMB 95,160
Total Cost over 3 Years	RMB 293,573		

Table 7: Total C	Cost of Commun	ity-based Hype	ertension Con	trol Work
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### DALY of Patients in Bao Shan District

DALY (disability-adjusted life year) =YLL (Years of Life Lost) +YLD (Years Lived with Disability)

YLL=N×L (N = number of deaths; L = standard life expectancy at age of death in years)

 $YLD=I \times DW \times L$  (I = number of incident cases; DW = disability weight; L = average duration of the case until remission or death)

The DALY of stroke patients in Bao Shan District is 12.5 for every 1,000 people (Guo, 2007).

QALY (quality-adjusted life year) of Patients in Bao Shan District

NUMBER	ITEM	MALE	FEMALE	TOTAL
1	Residents of Bao Shan Expected Life Years	12.35	12.93	25.28
2	Stroke Patients quality adjusted life years	4.83	5.63	10.46
3	QALY	0.71	0.68	1.39
4	Patients' QALY	3.43	3.83	7.26
5	QALY When Prevent Each Case	8.92	9.1	18.02
6	Number of Prevented Case	9	7	16
7	QALY of Total Prevented Case	80.28	63.7	143.98
8	Increased Discount Year of Life When Prevent Every Case	7.52	7.3	14.82
9	Total Increased Discount Year of Life	67.68	51.1	118.78

Table 8: QALY of Apoplexy Patients in Bao Shan District (1997)

(Item 4=Item 2×Item 3; Item5=Item 1- Item 4; Item7=Item 5×Item 6; Item8=Item 1-Item 2; Item 9= Item 6×Item 8) According to the analysis above, because the incidence of stroke goes down after the hypertension prevention work is taken, these 16 patients will not face economic loss because of stoke after the prevention. This is the biggest benefit of this community-based work. The input of this kind of work is RMB 293,573 and the output is RMB 1,062.204; the ratio of cost and benefit is: cost: benefit=1:3.57

## RATIO = <u>COST (INPUT)</u> = <u>RMB 293,573</u> = 1: 3.57

### BENEFIT (OUTPUT) RMB 1,062.204

### Discussions

It is very efficient to reduce the prevalence of stroke, prolong patients' lives and improve the quality of life via a community-based hypertension program. The heavy social and economic costs caused by the stroke have already caught the attention of professionals in fields related to medicine, public health, and insurance. In United States, the stroke treatment expense is 2.6% of the entire health care expense. In Sweden, each stroke patient incurs costs of \$73,333 over the course of his life<sup>8</sup>. In this paper, we have accounted that each stroke patient in Bao Shan district has a total economic loss of RMB 66,376.5 (over 7.5 years). It is clear that the community-based prevention work is effective. This prevention program has the direct cost and benefits result 1:3.57; note that the population in Bao Shan district is 780,000. According to the ratio we have calculated, the absolute benefit in Bao Shan District over the 3 years will be over RMB 70,000,000.

The major limitation of this paper is the validity of DALY. Disability adjusted life years (DALYs) have been launched by the World Bank and backed by the World Health Organization as a measure of the global burden of disease <sup>9</sup>. DALYs combine information about morbidity and mortality in numbers of healthy years lost. In the DALY approach, each state of health is assigned a disability weighting on a scale from zero (perfect health) to one (death) by an expert panel <sup>9</sup>. Though the idea of expressing burden of disease in a single index is tempting, any attempt to summarize information about quality of life and length of life in one number is bound to run into conceptual and methodological problems <sup>10</sup>. DALY approach has been criticized in valuing life as a function of health status. The application in cost effectiveness analyses of DALY seems to be that the healthier the person, the more valuable their life is to themselves and to society and the greater their claim on restricted healthcare resources to have their life extended. This makes sense only if the value of life is not seen as a dimension distinct from health, but rather as a direct positive function of health <sup>10</sup>. Future revision of DALY should deal with the use disability weightings in the valuation of gained life years.

### Conclusion

The economic burden and the Cost-Benefit Analysis can provide important data to the medical and public health departments in order to make the pertinent prevention policy. Innovations such as health insurance and community health service are currently being implemented in China. The policy and the methods are very important for further success. During the implementation process, the funds invested should be dispersed according to the authentic cost-benefit analysis, in order to improve the quality of individuals' health and to minimize the social and economic burdens.

## Appendix

RMB: The official currency of the People's Republic of China.

DALY: Disability-Adjusted Life Year.

QALY: Quality-Adjusted Life Year.

USD: The official currency of the United States of America.

YLL: Years of Life Lost.

YLD: Years Lived with Disability.

TIA: Transient ischemic attack.

### References

[1] Jun Y. The Economic Burden of Chronic Disease in China. *Chronic Disease Prevention and Control.* 1998; 6:49-60.

[2] Guo F. The Death Rate of Apoplexy is rising. *Health Daily*. 2007; 9:10-11.

[3] Bao Shan District Year Book. *Community-based apoplexy prevention work*. Shanghai: Chinese Stat Publishing Company; 1999.

[4] World Health organization. Stroke, Cerebrovascular accident. Available at http://www.who.int/topics/cerebrovascular\_accident/en/. Accessed September 2, 2010.

[5] Donnan GA, Fisher M, Macleod M, Davis SM. Stroke. *Lancet.* 2008; 371:1612–1623.

[6] Kun ND. Convalescence Medicine. Beijing: Renming Publishing Company; 1996.

[7] Wang GQ. Shanghai Apoplexy Research. *Shanghai Medicine Magazine*.1999; 11:8-14.

[8] Li DW. Economic Burden of Apoplexy. *Chinese Healthcare Management*.1999; 15:243-255.

[9] World Bank. *World development report 1993: investing in health.* New York: Oxford University Press, 1993.

[10] Arnesen T. Nord E. The value of DALY life: problems with ethics and validity of disability adjusted life years. *BMJ*. 1999; 319:1423-1425.