

## RESEARCH ARTICLE

# Health Economics Evaluation of a Gastric Cancer Early Detection and Treatment Program in China

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### Abstract

**Objective:** To use health economics methodology to assess the screening program on gastric cancer in Zhuanghe, China, so as to provide the basis for health decision on expanding the program of early detection and treatment. **Materials and Methods:** The expense of an early detection and treatment program for gastric cancer in patients found by screening, and also costs of traditional treatment in a hospital of Zhuanghe were assessed. Three major techniques of medical economics, namely cost-effective analysis (CEA), cost-benefit analysis (CBA) and cost-utility analysis (CUA), were used to assess the screening program. **Results:** Results from CEA showed that investing every 25, 235 Yuan on screening program in Zhuanghe area, one gastric cancer patient could be saved. Data from CUA showed that it was cost 1, 370 Yuan per QALY saved. Results from CBA showed that: the total cost was 1,945,206 Yuan with a benefit as 8,669,709 Yuan and an CBR of 4.46. **Conclusions:** The early detection and treatment program of gastric cancer appears economic and society-beneficial. We suggest that it should be carry out in more high risk areas for gastric cancer.

**Keywords:** Gastric cancer - early detection and early treatment - health economics - China

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### Introduction

Gastric cancer is one of the most common cancers in the world. According to estimates of the worldwide incidence and mortality from 27 cancers in 2008 have been prepared for 182 countries, it was predicted that, in 2008, there were 73.8 thousand patients died of gastric cancer around the world, accounted for 9.7% of all cancer deaths (Ferlay et al., 2008). Most gastric cancer patients were Present in the middle age and was Particularly Prevalent in the 40-60 age group, the average age was about 50 years old. Only 5% of patients were under 30 years old. In China, gastric cancer is one of the most common malignant tumor, according to the third National Mortality Retrospective Sampling Survey in 2007, the Chinese mortality of gastric cancer was 24.71/105 ranked third in mortality, 320 thousand patients died of gastric cancer (Chen, 2008).

In China, gastric cancer mortality exist obvious difference among regions, high incidence exist in rural areas with a large populations in China's South-East coastal, North China, Northeast China. From 1980s, some tumor research institutions set up many high risk areas of gastric cancer in Zhuanghe, Liaoning province, Linqi, Shandong province, and changle, Fujian province, carried out etiology and epidemiology study for high risk population in high risk areas. Early detection and treatment is one of the most important strategies of Cancer prevention and control (Yuan et al., 2001). Zhuanghe

was the first demonstration base of early detection and treatment of gastric cancer in China (Wen et al., 2009). In 2008 the cost of early detection and treatment program in rural areas included in the central government subsidies; Zhuanghe became one of the benefited areas.

Zhuanghe, Liaoning province is located in central of liaodong peninsula, there are 365 villages and towns, 6 subdistrict offices, total population about 920000. Epidemiological survey data show that in the 1980s, the mortality of gastric cancer in male was 49.55/100000, while in female was 22.23/100000, above the national average (Xiao et al., 2005). The latest research (Jing et al., 2012) shows that gastric cancer mortality in Zhuanghe declined (male 23.71/100000, female 10.78/100000) although it is still higher than the national average (Li et al., 2009). The epidemiology effect of early detection and treatment in gastric cancer has been confirmed, this article using the health economics methodology to assess the screening program on gastric cancer in Zhuanghe, China to provide the basis for health decision in expand the program of early detection and treatment.

### Materials and Methods

#### *Participants*

The screening enrolled 7818 residents aged 40-69 in Zhuanghe from 2008-2012. Eligible participants were between 40 and 69 years of age who has a history of

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stomach problems, or family history of gastric cancer.

*Screening and Intervention methods*

Using epidemiological survey, health education, serum pepsinogen detection, gastroscopes and gastric mucosa biopsy methods diagnose early gastric cancer and treatment timely.

*Evaluation of health economics*

Three major techniques of medical economics namely cost-effective analysis (CEA), cost-benefit analysis (CBA) and cost-utility analysis (CUA) were used to assess the screening program (Haddix et al., 1996). Measure and evaluate the cost of LYS (life year saved), QALY (quality adjusted life year) and BCR (cost-effectiveness ratio)

Early detection and treatment of gastric cancer including screening in high risk group and treatment should be taken to patients those found by this screening. Expense of this program involved cost of screening and treatment.

Gastric cancer patients found in ordinary way whose treatment involved surgery, chemotherapy or integrated application of these two methods. Cost including Hospitalization and outpatient expenses. Databases are from finance dept in the local hospital.

This Screening lasts for a certain period of time, and value of money is different with the change of years, so we need to convert the cost and efficiency to the same point in time for a scientific comparison and evaluation. This research computes costs and benefits in the discount, the discount to 2008 levels. The formula of discount rate

$$A = \sum_{t=0}^{t=n} \frac{C_t}{(1+r)^t}$$

A: The number of currency after the discount (CNY, yuan)

C: the number of the original currency r: discount rate t: years

The different studies of health economics use the different discount rates, the world bank commend to choose the discount rate of 3% ~ 5%, the U.S. department of health research group recommended in health economics evaluation comes to health and medicine using the discount rate of 3%. In conclusion, this research adopt the discount rate of 3%.

Sensitivity analysis is mainly judge stability of the Conclusion when the estimate of variable within a certain range changes. This study will do the single factor sensitivity analysis carried out on the discount rate.

**Table 1. Screening Cost in Zhuanghe from 2008-2012**

year	PG		Gastroscope		Pathology		Cost of	Total
	No. of screening	Total cost	No. of screening	Total cost	No. of screening	Total cost	Training survey	
2008	1531	76550	1230	123000	1230	123000	70000	392550
2009	1544	77200	977	97700	977	97700	70000	342600
2010	1522	76100	1411	141100	1411	141100	70000	428300
2011	1679	83950	866	86600	866	86600	70000	327150
2012	1529	76450	721	72100	721	72100	70000	290650
summation	7805	390250	5205	520500	5205	520500	350000	1781250

**Results**

*Screening results*

In the program, 7818 (male: 3074, 39.32%, female: 4744, 60.68%) participants were screened among the eligible population in Zhuanghe between 2008-2012, and 38 (male:23 female:15) patients were diagnosed with gastric cancer. 31 (male: 19 female: 12) patients with early gastric cancer, with accounted for 81.58% of the total. The number of cases of different kinds of gastric cancer was as follows: 2 cases of cardia gastric cancer, 6 cases of angle of stomach gastric cancer, 5 cases of stomach body gastric cancer, and the nidi of the other two cases were uncertain.

*Health Economics Evaluation*

Cost-effectiveness analysis. The cost of early detection and treatment: Screening costs included investigation, Pepsinogen detection, gastroscopes, mucosa pathological biopsy cost, all of above is 1781250 Yuan (Table 1). 38 patients with gastric cancer were detected from 2008 to 2012. Treatment costs (involve The registration fee, inspecting fee, treatment, operation, nurse, etc) is 274170 Yuan, after the discount of the total cost is 1945206 Yuan (Table 2).

The cost of gastric cancer patients with normal treatment: If the 38 cases of gastric cancer did not participate in the screening, the average cost of diagnosis and treatment for one gastric cancer patient in Zhuanghe (the data provided by Zhuanghe hospital) is 27508 Yuan, total of 38 patients is 1045304 Yuan, after the discount is 986297 Yuan.

The cost of screening and treatment of 38 patients is 1945206 Yuan (Table 2). Screening spent extra 958927 Yuan, and 25235 Yuan had been spent for reducing a death of gastric cancer.

Cost-utility analysis. Total cost of the screening program is treatment cost of 38 cases, 1945206 Yuan. Utility for this program is gain the extra QALYs (quality adjusted life years) from reduce gastric cancer death. First estimates the utility value: use the WHOQOL-BREF devised by world health organization to estimate the life quality of gastric patients, is used to estimate the utility value. On this survey of 100 patients (male50 female50), Each score by the positive, the standardized processing, HRQOL standard scores are obtained, and Calculate the average by gender classification. HRQOL standard scores expressed by percent, so  $u = \text{HRQOL} / 100$ .  $u$  from 0 to 1,  $u_1 = 0.68$  (male)  $u_2 = 0.66$  (female).  $CUR = \Delta C / \Delta U$ , means the increased cost of this program so as to gain each unit

**Table 2. Total Cost of Early Detection and Treatment in Zhuanghe from 2008-2012**

Year	Cost screening	No. of cases found by screening	Treatment cost	Total cost	Discounted combined
2008	392550	10	72150	464700	464700
2009	342600	5	36075	378675	367646
2010	428300	7	50505	478805	451320
2011	327150	7	50505	377655	345608
2012	290650	9	64935	355585	315933
summation	1781250	38	274170	2055420	1945206

**Table 3. Increasing of QALYs while screening program in Zhuanghe, 2008-2012**

Item	Cases of gastric cancer		Summation
	Male	Female	
Adjusted life expectancy of healthy residents (summation)	418.33	353.63	
Adjusted life expectancy of gastric cancer patients (summation)	76.68	57.65	
QALYs utility value of healthy residents	1	1	
QALYs utility value of gastric cancer patients	0.68	0.66	
QALYs of healthy residents	418.33	353.63	
QALYs of gastric cancer patients	52.14	38.05	
Increasing QALYs to avoid one patient death	15.92	21.04	17.94
Avoid death cases No. of gastric cancer	23	15	38
Total number of increasing QALYs due to avoid Gastric cancer patients' death	366.19	315.58	681.77

**Table 4. Cost-benefit Analysis of Gastric Cancer Screening Program**

Item	No. of gastric cancer cases		Summation
	Male	Female	
Avoid the number of cases	23	15	38
Get QALYs of less gastric cancer patients	366.19	315.58	681.77
Number of benefit people	7	8	15
The proportion of people with benefits (%)	30.43	53.33	
The increase in QALYs by benefit people	111.45	168.31	279.76
The increase in economic benefits (Yuan)	3453786	5215923	8669709

QALYs,  $\Delta C$  denotes net cost,  $\Delta U=A*Q$ , in formula,  $\Delta U$  means net utility, A means cases found by screening denotes the increasing of QALYs while one case was found.

Due to gastric cancer screening program, found early gastric cancer cases, total avoid 38 patients died, total increased by 681.77 QALYs, increased by 17.94 QALYs to avoiding each death, CUR is 1370 Yuan ( $933904/681.77=1370$ )

**Cost-benefit analysis.** Cost-benefit in gastric cancer from 2008-2012 refer to Table 4, the screening program avoid 38 cases from death, thus added 681.77 QALYs, among them, 279.76 QALY increased by cases older than 60, multiply by 30990 ( Per Capita GDP in Zhuanghe, 2008). Get the benefits of the program is 8669709 Yuan, and divided by 1945206 (the number of program cost)is the benefit cost ratio of this program, is 4.46, indicate that invested 1 Yuan to reduce the gastric cancer death while the economic benefit is 4.46 Yuan.

**Sensitivity analysis.** According to the 5% discount rate for sensitivity analysis, to reduce death in a patient with gastric cancer in high-risk groups in Zhuanghe need to invest 24576 Yuan, by Cost-effectiveness analysis. Cost utility results show that save a QALY cost 1413 Yuan. Cost-benefit analysis shows that total cost of gastric cancer screening is 1878406 Yuan, produce benefit of 8421965 Yuan, benefit cost ratio of 4.48.

## Discussion

Although the incidence of gastric cancer declined in recent 30 years, it's still the second leading cause of cancer death around the world. East Asia is the region of the highest mortality rate of gastric cancer, including Japan, South Korea and China. Despite the continued presence of the burden in gastric disease, only Japan and South Korea implemented a program of nationwide screening in gastric cancer (Leung et al., 2008). The screening program for the detection of serum PG, gastroscopy and mucosal biopsy, this study uses three methods commonly used in health economics to comprehensive analysis and evaluation this program, in the cost-effectiveness analysis, to reduce death in a patient with gastric cancer in high-risk groups need to invest 25235 Yuan in Zhuanghe. Cost utility analysis results show that save a QALY cost 1370 Yuan. Cost-benefit analysis shows in 2008-2012 gastric cancer screening has cost 1945206 Yuan, resulting in benefits 8669709 Yuan, benefit-cost ratio of 4.46, indicating that the screening program is feasible and profitable in economics. Meanwhile sensitivity analysis showed little change in benefit-cost ratio, the analysis results are reliable and stable. This study was designed to evaluate the program of gastric cancer screening in Zhuanghe, by using the health economics methodology, provide accurate data (select the optimal gastric cancer screening programs) to compare different screening programs in different regions, but also provide theoretical support for the further

promotion of gastric cancer screening programs.

At present, the health economics evaluation data of the large-scale gastric cancer screening program is insufficient. Some researchers in China carried one-time screening helicobacter pylori (Hp) infection of 30-40 years old crowd and the treatment for helicobacter pylori positive cases was to prevent the occurrence of gastric cancer, the cost of reducing one case of gastric cancer is 10405 Yuan, lower than the cost of this study (Wang et al., 2003). However Hp infection may not happen gastric cancer, and lower cost for the treatment of Hp infection. Therefore, from the accuracy of the gastric cancer diagnosis and the validity of the treatment, the cost of this study is reasonable. Ding applied endoscopic and pathological biopsy in 1987 as the ultimate means of sequential gastric cancer screening method, the results of health economics is spend more than 8951 Yuan to reduce the death of a patient with gastric cancer (Ding et al., 2000). Although its cost is lower than this study, for its study is more than 20 years ago, economic development level, the treatment of gastric cancer and cost have some differences, both expenditures do not have comparability. Singapore (Dan et al., 2006) started endoscopic check for 50-70 - year - old Chinese men every 2 years, the cost to get a QALY is \$26836; the cost to avoid death of a patient with gastric cancer is \$247600. Korea also started digestive tract X-ray barium meal examination and gastroscopy of the population aged over 40. The cost of the digestive tract X-ray barium meal examination to avoid death in a patient with gastric cancer is \$239155 - \$341002. The cost of the gastroscope to avoid death in a patient with gastric cancer screening is \$109466-164246, increasing cost of get a life year is \$8104-8966 (Cho et al., 2013). The two countries' gastric cancer screening program cost is higher, is not suitable for China. The study was conducted to evaluate cost-effectiveness outcomes of the national cancer screening program (NCSP) for gastric cancer in South Korea. With regard to sensitivity analyses varying based on the upper age limit, endoscopy NCSP was dominant for both males and females. ICER estimates for LYS indicate that the gastric cancer screening program in Korea is cost-effective (Cho et al., 2013). According to comprehensive evaluation the gastric cancer screening program at home and abroad, the sensitivity and specificity of the study is high (Yuan et al., 2012), easy, cost effective and reasonable, and also participants compliance is good. Therefore, This gastric cancer screening program is a kind of optimization scheme which accords with the situation of our country current.

At the same time, this study also has certain limitation, such as no screening interval was discussed. Studies of gastric cancer screening time interval, Korea research (Kim et al., 2000) proposals for 1-5 years, the optimal time interval should be less than 3 years; Singapore (Dan et al., 2006) recommends every two years for a screening for gastric cancer; Japanese people aged 60-69 is recommended once every 2 to 3 years, and 50 to 59, once every four years, less than 50, but once every five years or more (Kobayashi et al., 2012). No gastric cancer screening interval research of our country, it can be used as our further research.

According to the domestic and foreign present situation and development trend of gastric cancer screening and early detection and early treatment, in the future we should try our best on how to determine the scope of the screening, screening object, screening methods, screening time interval, intervention and treatment aspects for further study, in order to obtain the biggest effect of prevention and cure of cancer of the stomach.

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