COST-EFFECTIVENESS OF ELDERLY HEALTH EXAMINATION PROGRAM: THE EXAMPLE OF HYPERTENSION SCREENING

Bing-Hwa Deng,1 Hong-Wen Liu,2 Pi-Chen Pan,3,4 Lih-Wen Mau,5 and Herng-Chia Chiu5

1Management Office, Kaohsiung Municipal Hsiao-Kang Hospital, 2Department of Family Medicine, Kaohsiung Medical University Hospital, 3Office of Technology Cooperation, Yuh-Ing Junior College of Health Care and Management, 4Faculty of Public Health, and 5Graduate Institute of Healthcare Administration, Kaohsiung Medical University, Kaohsiung, Taiwan.

The National Health Insurance (NHI) and social welfare agencies have implemented the Elderly Health Examination Program (EHEP) for years. No study has ever attempted to evaluate whether this program is cost-effective. The purposes of this study were, firstly, to understand the prevalence and incidence rates of hypertension and, secondly, to estimate the cost and effectiveness of the EHEP, focusing on hypertension screening. The data sources were: (1) hypertension and clinical information derived from the 1996 and 1997 EHEP, which was used to generate prevalence and incidence rates of hypertension; and (2) claim data of the NHI that included treatment costs of stroke patients (in- and outpatients). Hypothetical models were used to evaluate the cost-effectiveness of the hypertension screening program in various conditions. Sensitivity analysis was also employed to evaluate the effect of each estimation indicator on the cost and effectiveness of the hypertension screening program. A total of 28.3% of the elderly population in Kaohsiung (25,174 of 88,812) participated in the 1996 EHEP; 14,915 of them participated in the following 1997 EHEP, with a retention rate of 59.3%. Criteria from the Sixth Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI) (systolic blood pressure/diastolic blood pressure ≥ 160/95 mmHg or taking antihypertensive drugs) were used; we found that prevalence and incidence rates of hypertension were 24.6% and 6.6%, respectively. Hypertension rates are increasing in the aging process as shown in both prevalence and incidence models. In comparison with non-participants, the prevalence model indicates that each hypertension patient who had attended the EHEP not only saved NT$34,570–34,890 in medical and associated costs, but also increased their lifespan by 128 days. The present findings suggest that the EHEP is a cost-effective program with health and social welfare policy implications. With the relatively low participation rate of the EHEP, health and social agencies need to put more effort into the promotion of this free health examination program to attract potential participants. In doing so, the population at risk for hypertension would be identified for early treatment, and the probability of having stroke could be decreased. Consequently, health care expenditures for treatment and caregiving of stroke patients would be minimized. Finally, it should be noted that the sensitivity and values of selected parameters can modify the results of cost-effectiveness analysis. Interpretations of the effects of prevention services on costs and effectiveness need to be treated with caution.

Key Words: cost, effectiveness, elderly, hypertension, stroke

it can cause other diseases such as heart and renal diseases that result in long-term morbidity and disability [4–7]. The provision of a screening service can detect the disease at early stages and help to prevent stroke and other related diseases.

Although hypertension screening is widely recognized to be an important part of public health policy, early prevention provides direct savings on medical costs through reducing health care utilization and eliminating social and family burden for caregiving [8]. Studies on the prevalence of hypertension in the elderly are limited by a smaller sample size [9], or are sampled in the general population [10–12]. Information on the incidence of hypertension in elderly persons in Taiwan is scarce. This paper intends to answer the following scientific enquiries: (1) to understand the prevalence and incidence rates of hypertension in elderly persons; (2) to explore the relationship between aging and change in hypertension rates; and (3) to estimate the cost-effectiveness of the Elderly Health Examination Program (EHEP), a public sponsored massive health screening program in Taiwan.

**METHODS**

The EHEP and the study population

The EHEP is jointly supported by the Kaohsiung City Health Department and the Bureau of National Health Insurance (BNHI), which offer free health examinations to Taiwanese senior citizens. The program provides a relatively comprehensive health examination, including medical history, physical examination, laboratory tests, chest X-ray, electrocardiogram, and laboratory tests [13]. Blood pressure is one of the physiologic measures of the screening service. Elderly voluntary participants of the EHEP in 1996 and 1997 were included in this study.

Estimation of prevalence and incidence rates of hypertension

Blood pressure was measured by nurses at the four Kaohsiung City hospitals. Hypertension was defined according to the criteria of the Sixth Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI criteria). A patient was confirmed to have hypertension if systolic blood pressure (SBP) was ≥160 mmHg or diastolic blood pressure (DBP) was ≥95 mmHg. Elderly persons who had a medical history of hypertension or who had taken antihypertensive medication were also grouped as hypertension cases. To categorize borderline hypertension, the JNC VI criteria (SBP/DBP ≥140/90 mmHg or taking antihypertensive drugs) were used; for the prevalence rate, the 1996 database was used. As for the incidence rate, a closed cohort design was used, i.e. elders who attended both the 1996 and 1997 EHEP were included. The normotensive elderly in 1996 were used to calculate the incidence rate of hypertension; in other words, subjects with normal blood pressure in 1996 but who were identified to have hypertension in 1997 were treated as new cases of hypertension.

Cost-effectiveness and weighted variables

Cost was measured by the average total costs of a stroke case. The direct costs associated with stroke were mainly derived from the claims data, including hypertension outpatient treatment costs before stroke (hospital and clinic visits), hospitalization expenses of having stroke, and subacute care costs (home care and/or nursing home expenses) after discharge from hospital. The hypertension screening cost was estimated based on the EHEP cost, which was the payment for the workload of each blood pressure measurement.

Effectiveness was measured by average loss of active life days due to the stroke. The measurement adopted Weinstein and Stason’s findings [14], i.e. 1.5 quality adjusted life year (QALY) loss after stroke. Essentially, we aimed to identify how many days of active life would be saved for those who attended the health screening services compared to those who did not.

The values of parameters important to the modeling were mainly derived from anecdotal evidence from Taiwan population studies [15–17]. For those variables without any anecdotal evidence from the nation, international scientific findings were used [6,14,18–21]. Examples are rates of having had stroke for hypertensive patients with or without hypertension treatment, medication compliance rate, and others. Table 1 lists the values and sources of the parameters used in this study.

Modeling the decision process

Two prediction models were used to estimate the economic and life impact of the EHEP. One is based
on the prevalence model that uses hypertension prevalence rate as the basis of estimation and the other is based on the incidence prediction model, which adopts the incidence rate as the basis of prediction. The Figure illustrates the conceptual model of the study assumption. Kaohsiung city’s elderly population was divided into two categories: the EHEP and the non-EHEP groups. The EHEP group was further categorized into two groups, the same as the non-EHEP group. Those attending the screening services were identified as either hypertensive or non-hypertensive. Fifty percent of the identified cases might seek care for hypertension and take medication as prescribed by their doctors. However, half of them may not take any health care actions at all.

For the non-EHEP group, previous evidence suggested that 43% might go to other institutions for health screening [17]. Once they have been identified as hypertensive cases, they seek medical attention just as those of the EHEP group did. However, about 57% of elders may never get a chance to be identified as a hypertensive case earlier and receive treatment as compared to their counterparts.

The probability of suffering a stroke is different under various conditions. Many assumptions were made to estimate the costs and life days saved. Assumption 1 is that EHEP elders who either actively seek hypertension treatment or not both still have the probability of suffering a stroke. Assumption 2, the percentage of being identified as hypertensive for the
non-EHEP group is the same as for the EHEP group. Assumption 3, those who have not been screened for hypertension might not know their blood pressure; consequently, they would not have benefited from medical attention. The study framework could be applied to both the prevalence and incidence models.

**Sensitivity analysis**

Sensitivity analyses were conducted to select appropriate values for each parameter used to generate the cost and effectiveness. Several measurements indicated that a relatively higher sensitivity was carefully selected. In general, a medium value was adopted to avoid bias in the study. Examples are stroke rate with or without hypertension treatment, mortality rates for stroke, cost of nursing home and home care, and so on.

**RESULTS**

**EHEP participation rate and retention rate**

There were 25,174 and 24,157 of the city’s elderly residents who participated in the 1996 and 1997 EHEP, representing 28.3% and 26.5% of the total elderly population, respectively. Among the 25,174 participants in 1996, 14,915 elders participated in the EHEP in the following year (1997), with a retention rate of 59.3%.

**Prevalence rate of hypertension**

Table 2 indicates three groups—normotension, borderline hypertension, and hypertension—by age cohort. In 1996, of 24,266 valid samples, 5,981 or 24.6% were categorized as having hypertension, 11,730 or 48.3% of them were normotensive, and 6,555 or 27.0% had borderline hypertension. For the hypertension group, the percentage increased with age. For the 65–69 cohort, only 23.8% were classified as hypertensive; the percentage increased to 26.4% for the age group 75–79, 27.6% for the age group 80–84, and then jumped to 32.8% for those aged ≥85 years. The same trend could be seen in the borderline group as well, although there was a relatively lower increase rate (range, 25.7–29.2%).

**Incidence rate of hypertension**

For the elders (14,915) with a repeated measure in 1997, 6,942 (46.5%) had been classified as normotensive in 1996. Of 6,942 elders, 461 were identified as new hypertensive cases, with an incidence rate of 6.6% (Table 3). More than 20.6% of normotensive patients were classified into the borderline group. As for the prevalence group, the incidence rate of hypertension increased with age. For the age group of 65–69, only 6.1% were identified, then up to 7.9% for the age group 75–80, and 10.0% for those aged ≥85 years. The increasing rate was also shown in the borderline hypertension group (range, 18.7–22.5%).

**Cost-effectiveness of EHEP**

The estimated total average cost for the treatment of EHEP hypertension cases was estimated to be NT$144,154 for the prevalence model, while for non-EHEP cases, it was NT$179,044. The EHEP group saved NT$34,890 compared to the non-EHEP group.
The effectiveness measure indicated that EHEP hypertensive elders might have a loss of 168 active days of life compared to 296 days for the non-EHEP group. In other words, elderly persons who participated in the program might live 128 days longer compared to their counterparts. The results indicated that participating in the EHEP can not only save medical and associated costs (NT$34,890), but also save 128 active days of life.

DISCUSSION

This study finds that preventive health care is cost-effective. Urban elders who participated in public
health screening services not only lived longer, but also spent less on medical services, subacute care, and home care associated with their medical condition.

The prevalence rate of hypertension, identified from this study, is relatively lower than that of Tseng et al [22] and Lu et al [9], but is similar to other studies [18,23]. The relatively lower prevalence of hypertension could partially be explained by the demographic characteristics of EHEP participants. Older adults who participate in health screening programs usually tend to be healthier or have relatively higher degrees of education as compared to the general elderly population. Empirical evidence has shown that education is positively associated with the elderly’s health status and information resources [24].

This study was based on a large sample size of the urban elderly population in southern Taiwan to generate the incidence of hypertension for Taiwanese elderly persons. The incidence of hypertension as found in our study sample is similar to findings generated by other studies [25,26]. However, there is no similar study based on a nationwide elderly population for comparison. The present findings provide benchmark information about the incidence of hypertension in the elderly population, as well as leading further study on this subject.

Another important finding of this study was the revealing of an aging effect on the prevalence and incidence of hypertension. For both prevalence and incidence models, the older the participants were, the higher the prevalence and incidence of hypertension associated with them. This finding also corresponds to the results of Yeh et al [11].

The average cost per person and days of life saved were related to the measures of the cost and effectiveness, respectively. Both prevalence and incidence models demonstrated that the preventive screening program is cost-effective. The magnitude of cost and days of life saved are similar to previous findings reported by Johannesson et al [20]. However, the magnitudes are relatively lower than findings reported by Littenberg et al [19]. The difference might be explained by the difference in derived parameters, time the study was conducted, and the differences in culture.

It should be noted that the sensitivity and values of selected parameters can modify the results of cost-effectiveness analysis. Interpretations of the effects of prevention services on costs and effectiveness need to be cautiously made. As with the example of hypertensive patients, the incidence rates of having stroke with and without treatment were two sensitive parameters to costs and effectiveness [19]. On the other hand, adjusted quality of life and discount rate had a very low influence on costs and effectiveness. Accordingly, the sensitivity of selected parameters should be taken into consideration for the evaluation of program cost-effectiveness.

Furthermore, the values of selected parameters are also important to the magnitude of program effect on costs and effectiveness. In order to minimize the bias of extreme values of parameters, the medium value of each parameter was used for estimation; however, the application of the medium might over- or underestimate costs for different natures of study samples. For example, the range for annual costs of hypertensive treatment was NT$2,500–7,500 according to BNHI data. A medium value of annual costs might be a good representative of an urban population as in the present study; however, it might overestimate the annual costs of hypertension treatment for rural populations. For future research, the costs may need to be adjusted for the degree of urbanization in response to the socioeconomic status of study samples.

Limitations of the study should be noted. First, all the participants were volunteers; therefore, the sample might not be representative of the urban elderly population. Second, several weighting factors were derived from studies conducted in other countries. These weightings might not be appropriate for Taiwan. This reminds us that there is a dearth of valuable information in studies of this area. Lastly, since the EHEP is a massive screening program and hypertension screening is only one of the many items, the one-time measure of blood pressure may not be reliable enough.

The study has health policy-making and clinical implications. Only 28.3% and 26.5% of the elderly population in Kaohsiung participated in the 1996 and 1997 EHEP, respectively, with a retention rate of 59.3%. These figures could have two implications, up to 70% of the urban population did not take up the opportunity for free health screening. Since the program has proved to be cost-effective, the government should identify those who failed to participate in the program and encourage them to participate in health screening. Only those aged ≥65 years qualify for free screening services. As with the cost-effectiveness evidence of the EHEP, health policy makers may consider extending
the eligibility of the EHEP program to younger elderly group(s).

Based on the prevalence and incidence rates, our estimates indicate that both hypertension and borderline hypertension rates increase with age. The definition or threshold of hypertension needs to be adjusted for age in clinical practice. If blood pressure is a normal aging process, the cut-off point for determining hypertension should be redefined. Our findings provide a clinical basis for such preventive services.

ACKNOWLEDGMENTS

The research presented in this article was supported by a grant from the National Health Research Institutes (NHRI-EX90-8903P), Taiwan.

REFERENCES

老人健康檢查之成本效果：
以高血壓檢查為例

鄭丙華 1 刘宏文 2 陈碧珍 3、4  毛莉雯 5  邱象嘉 5

高雄市立小港醫院  (委託高雄醫學大學經營)  1管理室
高雄醫學大學附設醫院  2家庭醫學科
  3育英醫護管理專科學校  技術合作處
高雄醫學大學  4公共衛生學系  5醫務管理學研究所

老人健檢施行多年，鮮少有研究嘗試評估其成本效益。本研究之目的在於探討，接受健檢老人高血壓的盛行率與發生率，藉此評估老人健檢計畫中高血壓篩檢的成本與效益。本研究以 25,174 名參與 1996 年健檢計畫、居住於高雄的老年人為研究對象，依據 JNC VI 為標準；採用 1996 及 1997 年的健檢臨床資料，發現血壓的盛行率及發生率分別為 24.6% 與 6.6%。研究亦呈現罹患高血壓的機率會隨著年紀而顯著增加。相對於未參與健檢計畫者，本研究發現參與計畫的高血壓患者不僅可省下 NT$34,570 至 NT$34,890 的醫療相關成本，且可提升約 128 天的存活期。本研究除了顯示老人健檢計畫具有的成本效益外，並建議高血壓患者危險群應及早接受治療，以降低中風的可能性。最後特別值得注意的是，成本效益分析會因納入評估之指標敏感度與數值不同，而有所差異；故研究結果之詮釋應特別謹慎。

關鍵詞：成本，效益，老人，高血壓，中風
(高雄醫誌 2007;23:17－24)