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Cost-Effectiveness Analysis of Tele-ophthalmology for Screening for Diabetic Retinopathy in Remote Communities

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Abstract

Application of tele-ophthalmology to community-based screening for diabetic retinopathy with one-stage or two-stage design in remote area has been hardly addressed. Digital image data underpinning this architecture were transferred for sending images to a retinal specialist for diagnosis. The clinical burden of diagnosis and confirmatory should be taken into account even though applying the tele-ophthalmology screening in rural area. In this circumstance, one needs to screen general population on the basis of predictive model to ascertain high-risk subjects that in turn receive confirmatory diagnosis at second stage. The balance between cost and effectiveness for different screen regimes was worthy of being investigated. A Monte Carlo computer simulation approach has been employed to simulate the disease natural history of diabetic retinopathy for a hypothetical population. The model generates a hypothetical population with the make-up of demographic features identical to that of Matsu population in 2004. Economic evaluation of different screening regimes was performed by TreeAge. All strategies dominated over no screening according to incremental cost-utility ratios. The incremental C/U ratio for two-stage design versus no screening (US 218) was not substantially different from that for tele-ophthalmology (US 220). The optimal inter-screening interval was two years for tele-ophthalmology and two-stage design.Time-dependent predictive model was developed for two-stage design with tele-ophthalmology. Economic evaluation found biennial screen regime dominates over other screening regimes because it elicits less cost but more benefit.

Keyword:

tele-ophthalmology, retinopathy screening, cost-effectiveness analysis

Introduction

The application of teleophthalmology to population-based screening for eye-related diseases in remote areas with scare ophthalmologists has been developed through a population-based multiple disease screening for ocular diseases among residents aged 40 years or older in Tungyin, one of townships in Matsu, Taiwan. Digital image data underpinning this architecture were transferred to a conventional personal computer via the Internet[1].

Data from clinical trials have shown that timely intervention with retinal photocoagulation prevents vision loss due to diabetic retinopathy. Because the condition is often asymptomatic in its early phase, regular evaluation is critical to clinical management of diabetic retinopathy. Numerous studies have demonstrated an overall cost effectiveness of retinopathy detection for type 2 diabetic patients. Although tele-ophthalmology has been recognized as a tool in providing health care for rural community[1], the clinical effectiveness and economic value of telemedicine has been poorly understood. From the viewpoint of evidence-based medicine, decision on whether such a diabetic retinopathy screening is worthwhile is dependent on a series of factors, including screen tools, disease natural history, cost, effectiveness of screening and inter-screening, interval. The balance between cost and effectiveness was worthy of being investigated. The aim of this study is to perform economic evaluation for the assessment of tele-ophthalmology and screening regime for diabetic retinopathy.

Methods

Participants would then be consecutively imaged using a store-and-forward telemedicine system. Digital 350 color fundus images were obtained with the non-mydriatic digital fundus camera. Two-field dilated digital images would be taken per eye. As screening for DR with direct method and fundus image check in general population may be costly two-stage design was therefore proposal to identify high-risk group for further referral to undergo examinations. To ascertain high-risk group, one may require predictive model on the basis of inexpensive and routine biochemical variables, time-dependent Cox regression model was proposed to build up adequate predictive model.

The five-state Markov model was used to model the disease natural history of diabetic retinopathy following the proliferative pathway to blindness was delineated follows NDR->BDR->PPDR->PDR->blindness. Through screening, asymptomatic stages were detected and received intervention in order to reduce blindness. Markov decision

tree was applied as the basis of the decision on policy of screening for diabetic retinopathy regarding tele-ophthalmology.

The base-case parameters estimated including probability of disease progress, sensitivity, specificity, attendant rate, utilization value and discount rate. The costs for tele-ophthalmology include direct costs for devices, training, and overhead expenses. The cost without tele-ophthalmology for screening and treatment were based on current health insurance programme for an ophthalmology visit with a dilated eye examination. A Monte Carlo computer simulation approach has been applied to simulating the disease natural history of colorectal cancer for a hypothetical population with the make-up of demographic features identical to that of Matsu population. Micro-simulation using Tree-Age software was performed to calculate cost in dollars, effectiveness expressed by the remaining vision after 50 years of follow-up of subjects who are screened from 30 years of age

Results

Average baseline values were also used to derive average QALYs for each strategy. Base-case analyses resulted in 18.39 of average QALYs with the tele-ophthalmology strategy , 18.35 of average QALYs using two-stage design and 18.28 of average QALYs with no screening strategy. The average cost effectiveness ratio was US 220 per QALY for the tele-ophthalmology , US 218 for two-stage design, and NTD 262 for no screening strategy. Again, all strategies dominate over no screening. The incremental C/E ratio for two-stage design was not substantially different from that for tele-ophthalmology. Incremental cost for reducing one unit of QALY was UD 1,595 for tele-ophthalmology against two-stage design. The optimal inter-screening interval was two years for tele-ophthalmology and two-stage design for sensitivity-analysis.

Discussion

Two screening decisions, including tele-ophthalmology, and tele-ophthalmology with two-stage design, opposed to no screening were considered in the current study. It is very interesting to note that tele-ophthalmology elicits more cost but also more effectiveness in reducing blindness. On the other hand, two-stage tele-ophthalmology may reduce cost but lead to smaller benefit because of false negative cases compared to tele-ophthalmology. This suggests that one may make use of two-stage design with the application rather than the administration of tele-ophthalmology to the entire population. As far as inter-screening interval, biennial screen regime dominates over other screening regimes.

In conclusion, tele-ophthalmology with or without two-stage design was demonstrated to be feasible in community-based screening for DR in remote area. Economic evaluation found two-stage tele-ophthalmology with time-dependent model almost as cost-effective as the application of tele-ophthalmology to the whole population.

Reference

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