The Cost–Utility of Telemedicine to Screen for Diabetic Retinopathy in India

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**Purpose:** To assess the cost-effectiveness of a telemedicine diabetic retinopathy (DR) screening program in rural Southern India that conducts 1-off screening camps (i.e., screening offered once) in villages and to assess the incremental cost-effectiveness ratios of different screening intervals.

**Design:** A cost–utility analysis using a Markov model.

**Participants:** A hypothetical cohort of 1000 rural diabetic patients aged 40 years who had not been previously screened for DR and who were followed over a 25-year period in Chennai, India.

**Methods:** We interviewed 249 people with diabetes using the time trade-off method to estimate utility values associated with DR. Patient and provider costs of telemedicine screening and hospital-based DR treatment were estimated through interviews with 100 diabetic patients, sampled when attending screening in rural camps (n = 50) or treatment at the base hospital in Chennai (n = 50), and with program and hospital managers. The sensitivity and specificity of the DR screening test were assessed in comparison with diagnosis using a gold standard method for 346 diabetic patients. Other model parameters were derived from the literature. A Markov model was developed in TreeAge Pro 2009 (TreeAge Software Inc, Williamstown, MA) using these data.

**Main Outcome Measures:** Cost per quality-adjusted life-year (QALY) gained from the current teleophthalmology program of 1-off screening in comparison with no screening program and the cost–utility of this program at different screening intervals.

**Results:** By using the World Health Organization threshold of cost-effectiveness, the current rural teleophthalmology program was cost-effective ($1320 per QALY) compared with no screening from a health provider perspective. Screening intervals of up to a frequency of screening every 2 years also were cost-effective, but annual screening was not (> $3183 per QALY). From a societal perspective, tele-screening up to a frequency of once every 5 years was cost-effective, but not more frequently.

**Conclusions:** From a health provider perspective, a 1-off DR tele-screening program is cost-effective compared with no screening in this rural Indian setting. Increasing the frequency of screening up to 2 years also is cost-effective. The results are dependent on the administrative costs of establishing and maintaining screening at regular intervals and on achieving sufficient coverage.

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The prevalence of diabetes is increasing rapidly worldwide.1 There are approximately 35 million people with diabetes in India, the largest number of diabetic patients in any given country, and this is predicted to increase to 80 million by 2030.2 Increases in the prevalence of diabetes have been observed in both urban and rural settings in India.2,3 Diabetic retinopathy (DR) is a potentially blinding complication of diabetes. The condition progresses through different stages from mild to moderate nonproliferative stages (nonproliferative diabetic retinopathy [NPDR]), which are largely asymptomatic, to severe NPDR and proliferative diabetic retinopathy (PDR), which can lead to blindness if untreated. Vision loss also can be caused by diabetic macular edema, which can occur at any stage of DR. Early detection and timely treatment are effective at reducing the risk of vision loss from DR.4,5 This requires regular retinal examinations to detect the sight-threatening stages of the condition before sight loss occurs.

In India, the majority of the population (72%) live in rural areas.6 However, the majority of ophthalmologists are based in urban centers.6 Ensuring regular diabetic ophthalmic examinations for rural populations therefore poses a considerable challenge.7 To address this gap in access to ophthalmic staff, a rural mobile telemedicine screening program has been established in Tamil Nadu, which aims to provide examination services for populations who may not otherwise have access to such a program. The program uses a digital retinal camera that is linked via satellite to a base hospital in urban Chennai. Ophthalmologists at the base hospital can examine retinal photographs taken in the village and provide DR diagnoses to the patient in real time. Studies in other countries suggest that community-based telemedicine DR screening increases the eye examination rates of diabetic patients.8 Regular screening for DR has been shown to be cost-effective in different high-income settings.9–12 There is also evidence that telemedicine screening for DR is cost-effective.
in some populations, including residents of a remote municipality in Norway and a prison population in the United States. In South India, Rachapelle et al found that the cost per case of DR detected for rural diabetic patients screened through rural teleophthalmology compared with screening of rural patients at an urban hospital was higher from the health provider perspective, but lower once patient costs of attending screening (i.e., travel and income loss) were included. They further commented that because of the large travel distances involved, attendance at hospital screening was likely to be poor, suggesting this may not be a viable option for rural populations. To the best of our knowledge, a comprehensive cost-utility analysis of telemedicine screening programs for DR in rural India or other low-income settings has not been undertaken. In addition, it is unclear what the optimum screening frequency of diabetic persons for DR should be in this setting. Although some studies in high-income countries indicate that annual screening is optimal, Vijn et al suggested that screening every 2 years might be sufficient for the majority of diabetic patients.

This study aimed to assess the cost-effectiveness of the Sankara Nethralaya Medical Research Foundation teleophthalmology program in Southern India. We estimated the provider and societal costs of their rural telemedicine screening and of hospital-based DR treatment, the sensitivity and specificity of the DR examination method used, and the utility values associated with different stages of DR in this setting. This information was used to develop a model to estimate the cost per quality-adjusted life-year (QALY) gained from this screening approach and the incremental cost-utility ratios associated with different screening intervals.

**Materials and Methods**

**Study Setting and Program Description**

The study was undertaken in rural Tamil Nadu, Southern India. A recent survey in rural Tamil Nadu estimated the diabetes prevalence at 7.8% among people aged ≥20 years. The Sankara Nethralaya Medical Research Foundation teleophthalmology program conducts DR screening camps in villages in the rural districts neighboring Chennai. In the current program, 1-off screening (i.e., screening offered once) is conducted in each village rather than diabetic persons being invited for screening repeatedly at regular intervals. People with known diabetes (i.e., those with a doctor diagnosis of diabetes or receiving drug, insulin, or diet control for diabetes) living within a 25-km radius of the screening camp are informed of the screening day via their general practitioners and via door-to-door visits by trained village-level volunteers, local newspapers, and posters. All attendees are enumerated and undergo a visual acuity (VA) examination at a central place (e.g., school or community center). The program uses a customized mobile van with an in-built ophthalmic unit, where the patients are examined by an optometrist using a handheld slit-lamp and have 4 dilated stereoscopic 45-degree fields digital retinal photographs taken (posterior pole covering disc and macula, nasal, superior, and inferior) using a nonmydriatic camera (Orion fundus camera, Nidek Technologies Srl, Albignasego, Padova, Italy). The retinal images are transferred by satellite to the base hospital in urban Chennai in real time where they are reviewed by a vitreo-retinal surgeon and graded using the international DR classification system. Diagnosis and management advice are given directly to the patient by the surgeon via the satellite link-up. All people identified with severe NPDR, PDR, or clinically significant macular edema (grouped as sight-threatening diabetic retinopathy [STDR] for the purposes of this program) are referred to the base hospital, Sankara Nethralaya. Patients with no signs of DR or with mild or moderate nonproliferative retinopathy (non-STDR) are not referred.

At the base hospital, referred patients undergo reexamination by an ophthalmologist using a slit-lamp and indirect ophthalmoscope. Some patients also will undergo further investigations as necessary (e.g., fluorescein angiography). Laser photocoagulation treatment is provided as appropriate.

Eye examination at the screening camps is provided free of charge to the patients. Examination and treatment costs at the hospital are typically paid by a charity for patients referred through this telemedicine program.

**Model Structure**

We used a Markov model to estimate the cost-utility of (1) the current teleophthalmology program, which involves 1-off screening in comparison with no screening program; and (2) the cost-utility of this program at different screening intervals. The model was developed in TreeAge Pro 2009 (TreeAge Software Inc, Williamstown, MA). The model was based on a hypothetical cohort of 1000 rural diabetic patients 40 years of age who had not been previously screened for DR. Each cycle of the model was 1 year, and the simulation costs and outcomes were estimated over a 25-year period on the basis of average life expectancy in India. Simulated patients were classified into 1 of 5 different health states: no DR, non-STDR (includes mild and moderate NPDR), STDR (includes severe NPDR and PDR), clinically significant macula edema, and blind from DR (bilateral best-corrected VA <6/60).

These groupings are based on the international classification system and modified to reflect the referral system in the study setting whereby all patients with severe NPDR, PDR, and clinically significant macula edema are considered to have STDR and referred for further examination and treatment. We used the definition of blindness most commonly used in India: VA <6/60. In the model, patients were screened after the teleophthalmology program protocol described earlier. Those identified with STDR were referred to the base hospital for further ophthalmic examination. Patients with confirmed STDR received laser photocoagulation treatment and were subsequently referred for annual examination at the hospital.

**Screening Strategies Evaluated**

We compared 6 different screening interval strategies: no screening, once-in-a-lifetime screening (current approach) and twice-in-a-lifetime screening, screening every 5 years, screening every 3 years, screening every 2 years, and annual screening. Incremental cost-effectiveness ratios (ICERs) were calculated for each successive strategy comparing the most with the next least costly (e.g., comparing annual screening with screening every 2 years). The ICERs were calculated as the difference in cost of the 2 strategies divided by the difference in QALYs gained. The optimal strategy was assessed by comparing ICERs with a threshold for cost-effectiveness. In the absence of an established Indian-recommended threshold, we used the approach recommended by the World Health Organization, which is based on the gross domestic product (GDP) for India ($1061 in 2009) as follows: Interventions less than the GDP (<US $1061 per QALY) are considered very
discount rate of 3%. Equipment was assumed to have a 5-year life span for medical/transport equipment. 10-year life span for computer hardware and digital cameras.

The costs of all inputs were included whether or not they incurred profit margin and are in excess of the actual costs incurred by the hospital in providing the services. To avoid double counting, hospital societal costs were calculated as the sum of household direct and indirect costs minus the provider costs.

Table 1. Health Provider, Household, and Societal Costs Per Person for Diabetic Retinopathy Screening and Treatment in US Dollars

<table>
<thead>
<tr>
<th></th>
<th>Teleophthalmology</th>
<th>Hospital</th>
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<tbody>
<tr>
<td></td>
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<td>Hospital fees</td>
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</tr>
<tr>
<td></td>
<td>Medication</td>
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<td>Income loss</td>
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<td>Societal costs</td>
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cost-effective, interventions between 1 and 3 times the GDP ($1061–$3183 per QALY) are considered cost-effective, and interventions more than 3 times the GDP (>=$3183 per QALY) are considered not cost-effective.

Model Parameters

Primary data were collected on the costs of screening and treatment, utility values associated with different stages of DR (effectiveness), and sensitivity and specificity of the retinal examination method. Other model parameters were derived from the published literature (specified below).4,9,10,20–23

Costs

Health Provider Costs. We estimated the per person provider cost of (1) telemedicine screening and (2) retinal examinations and laser photocoagulation treatment at Sankara Nethralaya hospital, Chennai (Table 1). We used an ingredients costing approach whereby information was collected on the quantities of the different resources used and the value (or prices) of each resource, and the total cost was calculated as the product of quantity and the value. Costs were collected in Indian rupees and converted into US dollars on the basis of the average exchange rate for 2009 of US $ = 46.8 rupees. We used the economic definition of cost whereby the costs of all inputs were included whether or not they incurred a direct financial cost to the program. For example, costs of donated items (e.g., the satellite dish) were included on the basis of the principal of opportunity cost: the value forgone by not using this resource for the next best alternative use. Capital item costs were calculated using the equivalent annual cost method with a discount rate of 3%.24 Equipment was assumed to have a 5-year life span for computer hardware and digital cameras and 10-year life span for medical/transport equipment.

Telescreening costs included the personnel time (for screening camp staff and the vitreoretinal surgeon at the base hospital); advertising the camp, mobile van, and fuel; equipment for ophthalmic examination and satellite connection; consumables; and the community building. Detailed information on the resources used and their associated quantity and value were estimated from interviews with the program manager, as well as screening camp log books and payroll records. We derived per patient cost using the average number of people screened collected from program records over the past 2 years.

Information on hospital retinal examination and treatment costs was provided by Sankara Nethralaya Hospital Chennai and included personnel, equipment, consumables, and buildings. Average staff time required per patient for retinal examination and treatment was estimated through interviews.

Household Costs. To estimate costs to the household, we interviewed 25 consecutive people attending 2 different rural screening camps (total of 50 interviews) and 50 consecutive patients attending the base hospital in Chennai City for laser photocoagulation.

Patients were interviewed using structured questionnaires about direct costs (travel, food, accommodation, hospital fees, and medicines) and indirect costs (income lost) incurred by the patient and his or her carer(s) as a result of attending screening/treatment. Indirect costs included paid work only. Treatment costs included expenses associated with the retinal examination at the hospital and the first laser photocoagulation treatment.

“Societal” costs for telescreening were calculated as the sum of the health provider and household costs. For hospital costs, this approach would introduce double counting because hospital fees charged to patients (or the charity covering the fees) include a profit margin and are in excess of the actual costs incurred by the hospital in providing the services. To avoid double counting, hospital societal costs were calculated as the sum of household direct and indirect costs minus the provider costs.

Effectiveness

We estimated utility values associated with different stages of DR. The methodology and results will be presented in detail in a future publication. Briefly, 249 people with diabetes aged ≥40 years from urban Chennai were recruited from an ongoing DR epidemiology study and a laser clinic at Sankara Nethralaya hospital. Of the 249 participants, 30 had no DR, 73 had NPDR, 114 had STDR, and 32 were blind from DR. Utility values were elicited during face-to-face interviews in Tamil using the time trade-off method, whereby the maximum number of years a patient was willing to trade for perfect vision was elicited using a series of choice-based questions.25

Accuracy of Diagnostic Tool for Diabetic Retinopathy

We assessed the sensitivity and specificity of the screening test used in the teleophthalmology program by comparing it with a gold standard of dilated 7 stereoscopic 45-degree field retinal images taken using a Carl Zeiss fundus mydriatic camera (Visucam-lite, Jena, Germany). For this evaluation, 346 participants were recruited from a diabetic clinic in Chennai using quota sampling so that there were at least 50 people in each group: no DR, mild NPDR, moderate NPDR, severe NPDR, and PDR. Retinal photographs taken using the 2 different cameras were graded by separate ophthalmologists. These data were used to estimate the sensitivity and specificity of teleophthalmology screening tool and the proportion of patients in whom the stage of DR was misdiagnosed using this method.
Other Model Parameters

The baseline distribution of the population among the different health states was estimated from a population-based survey of DR among people aged ≥40 years in Chennai. We applied the prevalence estimates for the survey participants aged 40 to 50 years. Annual progression rates between the different DR stages were estimated from previous studies, with calibration to DR prevalence estimates derived from the recent population-based survey in Chennai. The effectiveness of photocoagulation treatment on reducing the rate of progression to blindness was estimated from the results of the Early Treatment Diabetic Retinopathy Study trials. Estimates of the mortality rates were taken from Indian life tables, with a mortality multiplier for blindness and diabetes based on observational studies.22,23 The proportion of patients identified as having STDR at telescreening who actually attended their referral to the hospital was estimated to be 50% according to telescreening records.

We made the following assumptions in the model:

- All patients with confirmed STDR at the base hospital would undergo the recommended laser photocoagulation treatment.
- Three laser treatments were given to patients with PDR and 1 treatment was given to patients with macular edema, as is typical practice in this setting.
- After treatment, patients would be examined annually at the base hospital and would no longer be included in the telescreening program.

Sensitivity Analysis

We undertook a 1-way sensitivity analysis in which the parameter values were varied one at a time using the estimate ranges shown in Table 2. The minimum and maximum values were from 95% confidence intervals (CIs) for the prevalence estimates, utility values, diagnosis accuracy, and mortality multiplier. For costs, a range of ±30% was applied. Hospital attendance after referral was estimated to range from 30% to 80% according to hospital records and discussion with program managers.

We also carried out a probabilistic sensitivity analysis that enables uncertainty across all the variables to be varied simultaneously. This approach takes repeated (10,000) samples from across the ranges of all the parameters. Cost-effectiveness acceptability curves were used to summarize the uncertainty on cost-effectiveness estimates at different willingness to pay thresholds.

Ethical Considerations

Ethical approval for this study was obtained from the ethics committees of the London School of Hygiene & Tropical Medicine and Vision Research Foundation Chennai, India. Written informed consent was obtained from all participants in the interviews and the assessment of the accuracy of the diagnosis methods. The research adhered to the tenets of the Declaration of Helsinki.

Results

Model Parameters

Table 1 shows the per-person costs of telescreening, hospital retinal examinations, and laser photocoagulation treatment from the health provider and societal perspective. The health provider costs of telescreening were $7.36 per person screened, and the societal costs (i.e., including direct and indirect household costs) were $9.38. Costs for retinal examination and a single laser photocoagulation treatment at the hospital were $5.84 and $7.51 per person, respectively, from the health provider perspective. From the societal perspective, these costs increased to $14.72 per person for retinal examination and $45.19 for laser photocoagulation. Hospital fees were the largest cost incurred by the household (85% of the total cost).

Table 2 shows the other Markov model parameter estimates. Mean utility values worsened with increasing severity of DR, and the utility value for bilateral blindness from DR was 0.55 (95% CI, 0.46–0.64). The proportion of patients misdiagnosed by teleophthalmology examination according to the sensitivity and specificity analysis was generally low. The mortality rate was approximately double for diabetic or blind people.

Cost-effectiveness

Table 3 shows the costs, QALYs, and ICERs for each strategy. The incremental QALYs gained from increased frequency of screening are relatively small, which concurs with the relatively small proportion of people who progress to blindness over the model duration.
The cheapest though least-effective strategy is once in a lifetime screening. From a health provider perspective and compared with no screening, once-in-a-lifetime screening has a cost–utility ratio of $1320 per QALY gained, which is within the range considered “cost-effective” in this setting ($1061–3183). Increasing the frequency of screening to twice in a lifetime and every 5, 3, or 2 years, respectively, increases the costs but also increases the QALYs gained. The ICER of all these strategies were within the cost-effective range ($1061–$3183/QALY). Increasing to annual screening doubled the QALYs gained, but the additional cost placed the ICER ($4029/QALY) outside of the range considered cost-effective in this setting.

If the societal perspective is considered, screening once in a lifetime, twice in a lifetime, and every 5 years is cost-effective (12.7195/QALY), whereas the ICER for screening strategies of every 3 to 1 years is no longer below the cost-effective threshold.

Sensitivity Analysis

The most influential parameters in determining the ICERS were utility values, transition probabilities, and costs of teleconsulting. By considering the health provider perspective, if the utility value for blindness is reduced to 0.46 (lower CI), the ICERs for once- and twice-in-a-lifetime screening seems to be highly cost-effective (<$1048/QALY) and the ICER for annual screening improves to $2639 (i.e., within the threshold of cost-effectiveness). If the utility value for blindness is increased to 0.64 (upper CI), the ICERs are >$3144/QALY for all screening frequencies greater than every 5 years. A 30% reduction in the cost of teleconsulting moved the ICER for annual screening into the cost-effective range ($2905). Finally, applying the highest of the range estimates for progression rates from no DR to NPDR and from NPDR to STDR increases the cost-effectiveness for all ICERS and moved annual screening to within the range considered cost-effective. Applying the lower end of these estimates reduces the ICERS so that any strategy more frequent than every 5 years would not be considered cost-effective.

Varying other parameters (i.e., costs of hospital examination and treatment, sensitivity and specificity of diagnostic test for DR, hospital attendance rate) had negligible influence on the ICER estimates.

The results of the probabilistic sensitivity analysis are shown in Figure 1. This suggests that within the ranges considered cost-effective on the basis of the GDP, there is considerable uncertainty as to the optimal strategy. Considering the cost-effective threshold of 3 times the GDP ($3144), screening every 2 years has the highest probability of being cost-effective (28% simulations). If the threshold is increased to >$3144, annual screening has the highest probability of being most cost-effective.

Discussion

Our cost–utility model suggests that from a health provider perspective, the current Sankara Nethralaya rural teleophthalmology screening program is cost-effective compared with no DR screening for rural diabetic patients if the World Health Organization–suggested threshold (1–3 times the Indian GDP) is used to define cost-effectiveness. Increasing the screening frequency to provide screening at regular intervals would increase the costs of the program; however, the increased QALYs gained (because of reduction in progression to sight loss among treated patients) would suggest that screening up to a frequency of once every 2 years would also be considered cost-effective in this setting. Annual screening fell outside of the cost-effective range. If household costs are included to provide estimates from a societal perspective, the program becomes more expensive, although the majority (85%) of the additional cost is from the hospital fees charged to patients rather than travel costs or productivity losses. From the societal perspective, screening once or twice per lifetime remains cost-effective, but systematic screening at intervals of 5 years or more is no longer within the cost-effectiveness range.

There are few studies from low- and middle-income patients with which to compare our findings. Further, caution on comparison with other studies is warranted because of variation in cost-effectiveness analysis methods used. Our findings concur with previous studies in the United
Kingdom that show that systematic screening compared with opportunistic screening for DR was cost-effective. Studies in Norway (remote populations) and the United States (prison populations) also concluded that telemedicine was a cost-effective screening strategy. In terms of screening interval, annual screening is recommended in many countries, and a study in the United Kingdom has found evidence for the cost-effectiveness of this approach. In contrast, a cost–utility analysis of DR screening in the United States indicated that for the majority of diabetic patients, screening every 2 years was sufficient and that annual screening added considerable extra costs for marginal benefit when compared with screening every other year. The authors recommended that screening frequency could be adapted according to patient risk factors (e.g., age and glycemic control) so that those at greater risk were examined more frequently. These risk factors were not included in our model because it is not considered feasible to implement different screening protocols for different patients in this setting.

Our sensitivity analysis showed that the cost of screening influenced the cost-effectiveness of the program. Reducing per person costs by 30% resulted in improved incremental cost-effectiveness of all strategies and moved the ICER for annual screening to within 1 to 3 times the GDP. Given that equipment contributes one of the largest costs, it may be possible to reduce per person screening costs by increasing the number of people screened (i.e., by increasing number of screening camps per year). Retinal examinations undertaken at the camp through ophthalmoscopy instead of retinal photographs sent via satellite to the hospital also may reduce costs. However, this would be dependent on the availability and willingness of trained ophthalmic staff to attend the screening camps. In accordance with other DR screening economic evaluations, our model was sensitive to the utility value used for blindness. The lower utility value parameter estimate (0.46) that increased the effectiveness and ICERs of all screening strategies is similar to that used in a previous US study that found DR screening to be highly cost-effective. In contrast, applying the higher estimate (0.64) increased the ICERs of screening frequencies greater than every 5 years to >$3144/QALY. This value is similar to that applied by Vijan et al, who suggest that for the majority of diabetic patients in the United States, annual screening may not be warranted on the basis of cost-effectiveness. A strength of our study was that we derived our utility value (0.55) from a sample of diabetic patients from the program area. Transition probabilities among no DR, NPDR, and STDR also were important determinants of cost-effectiveness. In the absence of data on rates of transition for the Indian population, we relied on estimates from previous studies in non-Asian populations calibrated to reflect the distribution of DR states in the recent population-based survey in Chennai. Calibration led to slightly lower estimates of transition between no DR to NPDR and STDR than in some previous economic evaluation studies. Accordingly, population-based surveys of DR in India report a lower prevalence of DR and STDR than in some previous economic evaluation studies. Epidemiologic data on rates of DR progression in India are needed to further inform screening program evaluation. The results of the probabilistic sensitivity analysis suggest that there is a great deal of uncertainty about the optimal strategy. It suggests that no screening would be the best option at the threshold for interventions to be cost-effective. However, at

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**Figure 1.** Cost-effectiveness acceptability curve generated through probabilistic sensitivity analysis: probability that screening interval is cost-effective given willingness to pay.
the higher threshold for cost-effective screening, screening every 2 years was the best option.

An important strength of this study is that we collected primary data on costs, effectiveness, and diagnostic tool accuracy from the program setting rather than relying on published studies undertaken in other countries (mainly in the United Kingdom and United States). In addition, data on baseline DR prevalence were estimated from a recent population-based study conducted in Chennai. We also undertook a probabilistic sensitivity analysis that allowed exploration of uncertainty around the cost and effectiveness.

Study Limitations
This study had a number of limitations. Our model assumed 100% attendance of the initial cohort at each subsequent DR screening. Although there is evidence that DR screening in rural communities may increase compliance compared with hospital-based screening, complete attendance may not be realistic. Compliance influences cost-effectiveness when comparing screening intervals. Davies et al found that lower compliance necessitates more frequent screening in their analysis of DR screening in the United Kingdom. Compliance rates in this setting need further study to inform decisions about implementing systematic telescreening programs. We did not include the costs of establishing and maintaining an administrative system for regular (i.e., every 1 to 5 years) screening (e.g., setting up screening databases, contacting screening participants, monitoring attendance) because empirical data on these costs are not available. However, from the model, we calculated that if implementing such a system increased the telescreening costs to more than $12.40 per person, then screening at any of the regular screening intervals (i.e., every 5 years and more) would no longer be within the cost-effective range. Assessment of the cost and logistic feasibility of regular screening is needed. We did not include potential societal cost-savings of averting costs associated with blindness, such as productivity gains, and this may underestimate cost-effectiveness. In addition, we applied a single average utility value for blindness (defined as VA <6/60) rather than different estimates for progressively lower levels of vision loss. The estimated prevalence of DR among diabetic patients was obtained from an urban Chennai sample, and if the prevalence of DR is lower in the rural population, then this may reduce the cost-effectiveness of telediagnosis.

Our analysis has highlighted the need for further research into areas that are likely to influence estimates of costs and effectiveness of DR screening programs. First, further data are needed on diabetes and DR epidemiology in rural India, and in particular on DR progression rates. Second, investigation into the costs and logistic feasibility of setting up and maintaining systematic rural telescreening programs is needed, as well as data on compliance of diabetic patients in such programs. Finally, a clear definition of cost-effectiveness for India would be of value for facilitating interpretation of economic evaluations.

In conclusion, diabetic populations in rural communities in India typically have limited access to ophthalmic care. A recent study in rural Tamil Nadu found that the majority of people with diabetes (63%) had not previously had a retinal examination. Our analysis suggests that a 1-off telescreening program for DR is cost-effective compared with no screening in this rural Indian setting from a health provider perspective. Increasing the frequency of screening up to 2 years also is cost-effective, although this is dependent on the administrative costs of establishing and maintaining screening at regular intervals and on achieving sufficient coverage.

References


Footnotes and Financial Disclosures

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