SCREENING FOR DIABETIC RETINOPATHY: A COMPARATIVE STUDY BETWEEN HOSPITAL AND COMMUNITY BASED SCREENING AND BETWEEN PAYING AND NON-PAYING PATIENTS.

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Background: Prevalence of diabetes and diabetic retinopathy varies in the population considering the background and financial status. **Methods:** A total of 79,194 people more than 40 years, were screened for diabetes both in the community and eye hospital setting. Initial screening was carried out by urine dipstick followed by random blood sugar examination. A value ≥ 140 mg/dl of blood sugar was considered positive for diabetes. All the diabetics were then examined for any evidence of diabetic retinopathy through indirect ophthalmoscopy in a dilated pupil by a midlevel ophthalmologist. Health education campaign at public, patient and professional level was also conducted. **Results:** The results of screening were analyzed for three distinct groups; rural population, hospital based free patients and hospital based paying patients. The prevalence of diabetes was found to be 9.12%, 10.34% and 18.57% in rural community, poor hospital and affluent hospital groups respectively. The prevalence of diabetic retinopathy in the total screened population in these three subgroups was 1.92%, 2.52% and 4.42% respectively, while this prevalence in the diabetic population was 21.05%, 24.39% and 23.80% respectively. The cost per person screened was $2.6-3.4, while the cost per diabetic identified was $26-28 and the cost per patient of diabetic retinopathy identified was $ 108-135. **Conclusion**; The prevalence of diabetic retinopathy was two times more in the affluent hospital patients as compared to poor hospital patients or rural population. For each known diabetic, there were four previously undiscovered diabetics in the rural population, and two previously undiscovered diabetics in hospital based population.

Key words: Diabetes Mellitus, Diabetic Retinopathy, Health Education.

INTRODUCTION

The number of people with Diabetes Mellitus (DM) is increasing due to population growth, aging and increasing prevalence of obesity and physical inactivity. This number is expected to rise from that of 171 million in 2000 to 366 million in 2030 [1]. In the United States of America somewhere between one third and one half of these cases remain undiagnosed[2]. The Pakistan National Diabetes Survey,[3] results show that for each known case of DM, there are approximately 2 cases of undiagnosed DM and 3 cases of Impaired Glucose Tolerance (IGT). Undiagnosed diabetes is not a benign condition. At initial clinical presentation, retinopathy is present in 10%-29% of patients, proteinuria is present in 10%-37% and neuropathy is present in 9% [4]. Diabetes accounts for 50% of all nontraumatic amputations, 15% of all blindness, and 35% of all end-stage renal disease [4]. Life expectancy is reduced by one third from the age of diagnosis [5]. Perhaps not surprisingly, health care expenditure on diabetes is enormous with one recent study suggesting that diabetes consumes 15% of health care expenditure (disease prevalence approximately 5%). The total cost of diabetes to the US economy may be as high as $100 billion per year [2,6].

Based on the foregoing findings, it would be reasonable to suggest that recognizing and treating the large number of patients with undiagnosed diabetes earlier would be beneficial, with the aim of intervening earlier and potentially reducing long-term complications. The duration of preclinical disease has been estimated at 10-12 years by extrapolating back from the prevalence of complications at diagnosis [7,8]. In one study [7], the prevalence of retinopathy at diagnosis was estimated to be 20%. Assuming a linear increase in the prevalence of retinopathy over time, the interval between prevalence of no retinopathy and clinical diagnosis was estimated at 4-7 years. Assuming that the time between onset of diabetes and the appearance of retinopathy is 5 years, the time between onset of disease and clinical diagnosis may be as long as 12 years [7]. Clearly, this 12-year window is an interval during which diabetes could potentially be recognized by screening. Similarly glucose intolerance progresses through a number of well-recognized stages prior to the development of diabetes. The initial defect is most commonly postprandial hyperglycemia with fasting hyperglycemia occurring later. In Caucasians with IGT (2-hour glucose on an oral glucose tolerance test of 140-200 mg/dl), the average annual rate of

progression to diabetes is 4.7%, while in patients with impaired fasting glucose (fasting glucose between 110-126 mg/dl), the annual rate of progression to diabetes is between 1% and 2.2% [9,10]. Recognizing diabetes by screening could result in earlier, more aggressive intervention to reduce macrovascular risk with potential long-term benefits. However, to date there is no evidence that screening and recognizing diabetes earlier does alter use of these therapies, and they are extensively underused even in the highest risk groups [11].

In considering the potential benefits of early detection and treatment of diabetes it is also important to consider the potential risks associated with screening, particularly the potential physical, social, and psychological harm. Screening may increase worry and reduce health-related quality of life, and a positive test may influence employment and health insurance. Some patients will be incorrectly diagnosed, either being inappropriately labeled as having diabetes or conversely receiving false reassurance, specially while screening asymptomatic persons; in a review of 112 patients being treated for diabetes in a general practice, nine (8%) patients, all without classic symptoms, were found not to have diabetes on further evaluation.[12] The potential impact of these effects on diabetes screening programs has not been extensively studied and clearly may reduce the potential benefits of screening [2].

Overall, evidence for screening for type 2 diabetes is incomplete, particularly with regard to the benefits of early treatment and cost effectiveness [2,13]. However, the need to screen for diabetic retinopathy is uncontroversial. Early detection of sight threatening retinopathy and treatment by laser therapy has been shown to be effective in preventing the onset of visual impairment. With appropriate medical and ophthalmological care blindness may be prevented in at least one eye, by treating both eyes, in 60-70% with macular edema and over 90% with proliferative retinopathy [14-16]. Protection lasts for over 10 years in two thirds of treated patients [17].

This study was conducted to compare prevalence of diabetes and diabetic retinopathy between hospital and community based populations and between paying and free hospital patients

PATIENTS AND METHODS

The study includes a total of 79,194 people screened by Al-Shifa Trust Eye Hospital Rawalpindi, Pakistan, during the period 1997-2001, under a LIONS sponsored project with the aim of prevention of blindness from diabetes. The screening was carried out both at hospital and in the community setting.

The screening in the community was carried out during 475 screening eye camps held in different rural areas of Rawalpindi division. All the patients registered at the rural camp aged 40 years and above were tested for random urine sugar using urine sticks. Those found positive were then investigated further for random blood sugar examination using automated glucometer. Anyone with a reading of 140mg/dl or above was labeled as diabetic. All the diabetics were examined by our medical officer (at least a holder of diploma in ophthalmology) for any evidence of diabetic retinopathy using both direct and indirect ophthalmoscopy in a dilated pupil. All those with any grade of diabetic retinopathy were registered and referred to Al-Shifa Trust Eye Hospital Rawalpindi. All the patients reporting to the camp were also provided with appropriate health education about diabetes and its complications.

The screening in the hospital was carried out using a similar protocol. The out-patient department (OPD)at Al-Shifa is divided into two sections. OPD-I caters for non-paying patients, while OPD-II caters for paying patients. The facilities and professional staff for diagnosis and management are same in both the outpatient departments. All the patients aged 40 years and above reporting to OPD I and II were routinely tested for random urine sugar using urine sticks. Those found positive were then investigated further for random blood sugar examination using automated glucometer. Anyone with a reading of 140mg/dl or above was labeled as diabetic. All the diabetics were examined by our senior residents (minimum of two years post-graduate training at Al-Shifa) for any evidence of diabetic retinopathy using 90 D lens on slit-lamp and indirect ophthalmoscopy in a dilated pupil. All those with any grade of diabetic retinopathy were registered and referred to diabetic clinic of the hospital.

All patients referred with diabetic eye complications were managed accordingly through laser, surgery or medical advice.

RESULTS

The present study is an analysis of results of screening for diabetes and diabetic retinopathy in hospital and community setting. A total of 79,194 people were screened over a period of five years. 25,510 were screened in the hospital while 53,684 were screened in the community. There were 39,842 (50.31%) males and 39,352 (49.69%) females.

The results of screening are available for three distinct groups; rural population, hospital based free patients and hospital based paying patients (Table 1). The prevalence of diabetes ranged from 9% in rural population to almost 19% in paying hospital patients, while the prevalence of diabetes in

free hospital patients was 10%. Thus the prevalence of diabetes in paying hospital patients was almost double than that in rural population and free hospital patients.

Almost 2% of rural population (40 years or above) had some form of diabetic retinopathy, while 4.42% of paying hospital patients had evidence of diabetic retinopathy as compared to that of 2.52% in the free hospital patients. One out of every four or five diabetics had diabetic retinopathy at the time of screening. (21% in rural population to 24% in the rest).

Table 1 - Results of Screening for diabetes and diabetic retinopathy

Parameters	Community Screening (1)	Hospital-based screening			Grand Total (1+2)
		Paying	Free	Total (2)	
Total population screened	53,684	8,418	17,092	25,510	79,194
Number of diabetics identified	4,897	1,563	1,767	3,330	8,227
Prevalence of Diabetes	9.12 %	18.57%	10.34%	13.05%	10.38%
Number identified with diabetic retinop	1,031	372	431	803	1,834
Prevalence of diabetic retinopathy in the screened population	1.92%	4.42%	2.52%	3.14%	2.31%
Prevalence of diabetic retinopathy amongst diabetic population	21.05%	23.80%	24.39%	24.11%	22.29%
No. of known diabetic	967	527	485	1,012	1,979
Prevalence of known diabetics in the screened population	1.80%	6.26%	2.83%	3.96%	2.49%
Prevalence of known diabetics amongst diabetic population	19.74%	33.71%	27.44%	30.39%	24.05%

Table 2 - Gender differences in the prevalence of diabetes

	Male	Female
Prevalence of diabetes amongst paying hospital patients	18.88%	18.24%
Prevalence of diabetes amongst free hospital patients	11.21%	9.48%
Overall prevalence of diabetes amongst hospital patients	13.79%	12.28%
Prevalence of diabetes amongst the patients screened in the community	9.20%	9.03%

Table 3 - Cost Analysis of Screening for Diabetic Retinopathy (US $)

	Community Based ▪ *53,684 screened* ▪ *4,897 cases of diabetes* ▪ *1,031 cases of retinopathy*	**Hospital Based** ▪ *25,510 screened* ▪ *3,330 cases of diabetes and* ▪ *803 cases of retinopathy*
Fixed Cost	0.48	0.42
Variable Cost - non-consumables	1.50	2.55
Variable Cost – consumables	0.62	0.45
Cost per person screened	**2.60 (Rs. 150)**	**3.42 (Rs. 200)**
Cost per diabetic identified	**28.50 (Rs. 1,700)**	**26.19 (Rs. 1,572)**
Cost per case of diabetic retinopathy detected	**135 (Rs. 8,000)**	**108 (Rs. 6,500)**

Table 4 - Prevalence of Diabetes in Pakistanis

Year	Ref.	No. of diabetics	Area	Prevalence of diabetes (%)		
				M	F	Total
2002	32	2,032	Rural Lasbella, Baluchistan	10.1	4.3	6.3
2001	20	1,318	Inner City Manchester	-	-	33
1999	33	1,035	Rural NWFP	9.2	11.6	11.1
1999	34	834	Urban Baluchistan	11.1	10.6	10.8
			Rural Baluchistan	10.3	4.8	6.5
1995	35	967	Shikarpur city, Sindh	16.2	11.7	13.54
1995	36	4,232	Karachi, Poor	-	-	1.8
			Karachi, Affluent	-	-	4.5
	37	4,395	Pak Muslims in Oxford, UK	9.1	10.3	9.5
2005	Current Study	79,194	Rural	9.20	9.03	9.12
			Urban, poor	11.21	9.48	10.34
			Urban, affluent	18.88	18.24	18.57

The prevalence of already known diabetics amongst the total screened population was 2%, 6% and 3% in the rural population, paying and free hospital patients respectively. This prevalence in the diabetic population ranged from 20-34%. Thus for each known diabetic, there were four previously undiscovered diabetics in the rural population, and two previously undiscovered diabetics in urban/hospital based population. (Table 1)

The gender difference was not marked with slight male preponderance. (Table 2)

The cost-analysis of this screening program shows that the unit cost of the screening depends on the volume of population screened as well as on the prevalence of diabetes and diabetic retinopathy in the screened population. The cost per person screened in the community is Rs. 150 as compared to Rs. 200 in the hospital based due to high volume of the population screened in the community. On the other hand the cost of detecting diabetes or diabetic retinopathy is lesser in the hospital based due to high detection rate for the pathology (Table 3).

DISCUSSION

In South Asia, including Pakistan, social and environmental changes are occurring rapidly, with increasing urbanization, changing lifestyles, higher energy density of diets, and reduced physical activity. Studies have shown that diabetes is much more common in Asian Indians and Afro-Caribbean's [18]. In a Newcastle study, [19] 18% of South Asians aged 25-74 years were found to have established diabetes, with a further 18.7% having impaired glucose tolerance, which implies a 30-50% higher risk of the development of diabetes in 5-10 years. A study comparing the prevalence of type 2 diabetes in white Europeans and individuals of African-Caribbean and Pakistani descent has shown the newly detected diabetes was 20% in Europeans, 22% in African-Caribbean's, and 33% in Pakistanis[20]. One important factor contributing to this increased prevalence in Asians (Pakistani, Indian and Bangladeshi) is excessive insulin resistance[21].

Whether screening for and treating patients with screen-detected diabetes is cost effective, is largely unknown as very little work has been carried out in this area. Perhaps the most widely quoted study used a Monte Carlo simulation model. The estimated cost per QALY for diabetic screening in this study is less than that for breast screening with annual mammography for women aged 50-65 but is more than cervical screening with four yearly smears for women aged 20-75 [22].

In the current study, diabetic screening was carried out in people over 40 years of age in both community and health care setting. A study conducted to screen general population over 45 years found the prevalence of diabetes to be 0.2% when age was the sole risk factor, while in patients where age was associated with one or more other risk factors like hypertension, obesity or a positive family history the prevalence shot to 2.8% [23] (14 times increase in the yield). Secondly, screening outside of clinical setting will have low compliance with treatment recommendations and a very uncertain impact on long-term health. Therefore to be cost-effective, screening for diabetes should be in a health care setting and targeted against high-risk individuals. However the cost of early diabetes diagnosis must also be considered in clinical economic context. Patients with diabetes have health care costs about 250% higher than age-and gender- matched patients without diabetes [24], while it increases to about 400% in diabetic patients with heart disease as compared to diabetics without heart disease [25].

Double screening tests for diabetics were used in the current study - Urine dipstick followed by random blood sugar testing. A variety of different tests have been proposed for screening for type 2 diabetes [26]. The fasting plasma glucose (FPG) has the advantage of reproducibility from day to day but has the disadvantage that patients must be in the fasting state. A cut point between 99 mg/dl and 108 mg/dl seems to offer the optimal sensitivity and specificity for recognizing diabetes in studies where all patients have oral glucose tolerance tests to diagnose diabetes[27,28]. Measurement of a random blood glucose has the advantage that it can be undertaken opportunistically; however, it is less reproducible than FPG and not standardized. A random (i.e., non-fasting) plasma glucose greater than 140 mg/dl has a sensitivity of 45% and a specificity of 86%.[29] Although some authors favor urine glucose testing (fasting, random or 1 hr post-prandial) for screening for diabetes [30] the general consensus is its sensitivity is too low for this purpose [2, 26]. In population-based screening using semi quantitative urine dipstick, a "trace positive" dipstick result or greater has a reported sensitivity of 23-64% and specificity of 98- 99% [27,31]. However, in a high-risk population, quantitative assays of urine glucose achieved high sensitivity (81%) with high specificity (98%), comparable to both fasting plasma glucose and glycosylated protein assays.[27] The FPG>126mg/dl is currently favored in ADA guidelines for screening for type 2 diabetes [3], although it is acknowledged that on occasion other tests may be appropriate, including random glucose in the US guidelines, a postprandial urine test in the diabetes United Kingdom guidelines and possible use of the OGTT as a screening test in both [26]. Both the screening tests used in our protocol have comparatively low sensitivity (the ability to detect a positive case), so it might be argued that there is an underestimation of diabetes in the current study.

The prevalence of diabetes in the current study ranged from 9.12% in rural population to 18.57% in paying hospital patients, while it was 10.34% in free hospital patients. This is consistent with most of the studies conducted in Pakistan [32-36] (Table 4). All three published reports of Pakistan National Diabetes Survey [33-35] show considerable increase in prevalence rates with increasing age, the single most important determinant of risk. The current study has the highest prevalence rate of 18.57% in the paying hospital patients. The urbanization of the population and adoption of increasingly sedentary lifestyle and westernized diets contribute to these increasing rates noted. The marked contrast in the disease prevalence between poor and paying hospital patients in the current study is a strong testimony to this.

The ultimate aim of screening for DM is to prevent or delay serious complications. Retinopathy is the commonest complication of DM. It is the biggest single cause of registered blindness in the United Kingdom (UK) amongst working age group [37]. The current consensus of opinion from Europe and the United States is that screening for diabetic retinopathy by suitably trained and experienced practitioners is cost effective and results in reduced morbidity due to blindness [38,39]. Various methods for screening of diabetic retinopathy are currently available [39,40]. These include slit-lamp biomicroscopy, digital imaging, retinal photography, direct and indirect ophthalmoscopy, Hiedelberg Retinal Tomography[40] etc. However, seven-field stereo retinal photography is both 100% sensitive and specific for diagnosing diabetic retinopathy and is the standard for evaluating the severity of retinopathy both for clinical and epidemiological studies [41]. Optometrists, opticians, general physicians, diabetologists and ophthalmologists can be employed in different screening programs. It is noteworthy that trained opticians and optometrists have been found to be better at detecting retinopathy than general practitioners[42]. In the current study diabetics were screened for diabetic retinopathy through indirect ophthalmoscopy in a dilated pupil by a midlevel ophthalmologist. Almost similar screening protocol has been used in a South Indian Study conducted in 2001-2002 [43]. We tend to agree with the conclusion of that study that screening high-risk groups for sight-threatening retinopathy using indirect ophthalmoscopy may be a useful short-term alternative in our set-up until retinal photography (or digital imaging) becomes affordable. However evidence indicates that direct ophthalmoscopy using a hand-held ophthalmoscope does not give adequate specificity and sensitivity and should be abandoned as a systemic screening technique[44]. Indirect ophthalmoscopy is sensitive and specific enough to be viable, but the method requires considerable skill[45].

The prevalence of retinopathy amongst the diabetic population in some of the earlier published studies from Pakistan is 11% [45] and 26% [46] while it ranges from 20-40% in studies from India [43], Sri Lanka[47], UK[48] and USA[49]. The prevalence in the current study ranges from 21% in rural population to 24% in hospital population. Few studies have shown the prevalence of diabetic retinopathy in general population to be around 3.5% [49,50]. In the current study 1.92% of the rural population and 4.42% of paying hospital patients had diabetic retinopathy at the time of screening.

Screening for diabetic retinopathy saves vision at a relatively low cost which is many times less than the disability payments made to people who go blind in the absence of a screening program. However screening without service leads to frustration and casts a negative shadow on such screening programs. Such programs must ensure that these reach the majority of population at risk and those identified must have access to an effective treatment like photocoagulation. The compliance with treatment recommendations in our rural population was less than 60%, while it was over 90% in hospital based population. Studies have shown that younger age, shorter duration of diabetes[51], male gender, low education, and rural background were factors adversely affecting compliance[52]. Availability of functioning lasers in health care facilities and the proportion of ophthalmologists adequately trained in applying laser are also important issues at national level.

All such screening programs must be accompanied by appropriate health education at patient, public and professional level. Studies to assess public awareness about diabetes in some of major urban centers like Karachi[53], Quetta[54] & Rawalpindi [55] have shown that 60-70% of the patients have very poor knowledge about their disease. Similar conclusions have been drawn about Pakistani diabetics living in UK[56]. Results [57] suggest that screening modified health beliefs but had limited effect on behavioral intentions, with patients of longer disease duration being more reluctant to change their self-management. Opportunities during retinal screening for advice on self-management could be more effectively exploited. A study[58] to assess the knowledge of physicians treating diabetes in Pakistan has found out that overall 62% answers to the interview were correct, with the physicians from Sindh having the highest score of 66% and Federal Capital Area of Islamabad with the lowest 54%. Data[59] also suggest that education may significantly improve the ability of non-ophthalmologists to detect and to appropriately refer patients who are at risk for vision loss.

CONCLUSIONS

Diabetes has emerged as a major public health problem in Pakistan and has the potential to become the third most important cause of blindness in Pakistan.

Screening for diabetes should be carried out in health care setting. In the community setting, the screening must be part of general screening eye camps. Screening should be conducted in people over 40 years of age while targeting the high risk population.

Although FPG is considered the most sensitive screening test, yet in our set-up while planning a wide-scale population screening, random blood sugar is more appropriate with 140 mg/dl to be cut-off point.

Screening for retinopathy may be conducted by indirect ophthalmoscopy till retinal photography becomes a viable option. However it may be more appropriate to improve test performance by continuing training of examiners and audit than to abandon indirect ophthalmoscopy for retinal photography.

Screening for diabetic retinopathy using this protocol, is recommended in every patient over 40 years of age, reporting for any type of eye examination at secondary and tertiary level of health care. Health education and training must be an integral part of all such screening programs. Short training courses for ophthalmologists in laser application and for general physicians in retinal examination should become a regular feature at our teaching hospitals. Training programs and posts for laser technicians and biomedical engineer are mandatory at major teaching hospitals.

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