Continuous Diabetes Screening in a Rural Area

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FOR a chronic disease problem to justify the institution of a public health service program, it must conform to essentially the same criteria as other disease problems: (*a*) there must be available either a means of prevention or an effective treatment, (*b*) the problem must be of such a nature that it (or a significant part of it) cannot be solved by the traditional physician-patient relationship, (*c*) the problem must affect a significant number of people, and (*d*) it must have community significance.

Casefinding in diabetes mellitus conforms to the above criteria. Although no method of primary prevention is known other than control of heredity (which in our present society is not very practicable), early diagnosis and continuous medical supervision can prevent the early complications of diabetes, and some of the late complications can be avoided or postponed (*1a*). Relatively few people have formed the habit of presenting themselves for routine physical checkups, with the result that no opportunity is presented to diagnose an estimated 50 percent of those who have diabetes. The problem is large; it is estimated that there are over 2 million diabetics in the United States (*1b*), half of whom are unknown. Finally, the disease has an important degree of significance to the community, as it causes a considerable amount of disability, premature death, loss of productivity, and increased demands on health and welfare facilities (*2*).

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Diabetes detection programs have been conducted for some years and are an accepted part of the public health scene. There are many types of programs, which vary, in time, from 1-day drives to year-round activities, and in technique, from rapid screening for sugar in the urine to exact, painstaking, and expensive blood determinations.

Justification for the operation of a diabetes detection program is based on the hypotheses that diabetes mellitus is often unrecognized and asymptomatic in the adult; that early diagnosis and treatment of diabetes improves prognosis and reduces complications; and that it is practical to screen postprandial hyperglycemic individuals from the general population by means of a community-operated clinic service (*3*).

One of the best methods of conducting such a screening program is by means of the test developed by Wilkerson and Heftmann (*4*), using the clinitron. This apparatus provides a rapid, inexpensive, and reasonably accurate method of screening large groups of people.

Permanent, year-round diabetes screening programs using the clinitron seem to have been restricted thus far to urban populations. On March 1, 1958, the Glens Falls District Office of the New York State Health Department began a continuous screening program in a rural section of upstate New York, including Saratoga, Warren, and Washington Counties. Data during the first 10 months of operation are presented in the hope that they will contribute toward closing the gap between urban and rural public health practice in diabetes screening.

The population of this tricounty area approximates 177,000, 25 percent of whom live in

three small cities and the rest in rural and semi-rural areas. The median income of the area is above the national average, and its population is well served by the usual number of official and voluntary health agencies. General concern and information about health matters is comparatively good.

Method

The diabetes screening program is conducted in itinerant clinics which everyone 20 years of age or older is eligible to attend. The bureau of chronic diseases and geriatrics of the New York State Health Department supplied a clinitron (on loan from the Public Health Service), a trained technician to conduct the clinics, and sufficient reagents and equipment to start the program. The local tuberculosis and health associations in the three counties donated a total of $325 for the purchase of operating supplies in addition to those supplied initially by the bureau.

The technician carries to each clinic the necessary supplies with which to register and take blood specimens from those attending. A specimen consists of 0.1125 ml. of arterial blood taken from a fingertip, which is mixed immediately with 5 cc. of fluoridated distilled water (approximately 1 grain sodium fluoride per gallon of distilled water). At the end of each clinic the technician returns to the district office, where the clinitron is permanently set up, and runs the specimens through the clinitron. Practically all are processed within 24 hours, and in no instance do they stand more than 48 hours, although by fluoridating the diluent a delay of several days is considered permissible (*4*).

Clinitron testing of 0.1125 ml. specimens, using the appropriate reagent tablet, gives positive results for specimens with blood sugar levels of 160 mg. or more (*4*). For the first 5 months of program operation no attention was paid to the time interval between the last meal and the time when a blood specimen was obtained. However, because some of the local physicians complained that too many of the test results were false positive, from October 1, 1958, to April 1, 1959, no one was tested who had eaten less than 2 hours before clinic time. Since April 1, 1959, all persons have been tested as they presented themselves, regardless of time since eating.

This misunderstanding points up the failure of our attempts at professional education. Before the program was started, several meetings with each of the three county medical societies were held to explain the details of the screening program. At these meetings we tried to establish a standardized procedure for followup by asking the physicians to determine at least one postprandial blood sugar level for each of the patients referred to them with positive screening test results. We emphasized the recommendation of Wilkerson and Heftmann that a blood sample for screening by the clinitron be taken shortly after a meal, and announced that clinic sessions would therefore be scheduled at times when most screenees would be in a postprandial state.

To reinforce these points and the details of the program, a letter was sent to each physician in the district, repeating what had been said at the medical society meetings. However, the educational aspect of these presentations apparently misfired, as the majority of the physicians still believe that fasting specimens are the only proper ones to take.

For the first 2 months of program operation, the only specimens screened were obtained, in their offices, by about one-third of the private physicians of a single county. The technician for the screening program collected these specimens twice a week. However, the number of specimens supplied by physicians fell off rapidly after the first 6 weeks, and once the community clinics started up, the technician no longer had time to collect them. We found it impossible to recruit volunteers for this purpose, and so, beginning in May 1958, collection of specimens from physicians' offices was abandoned and program efforts were concentrated on local clinics.

Every community in the district was listed and a schedule of clinics set up so that each would have at least one clinic a year. At first, the basis for scheduling more than one clinic a year for certain communities was size of population, which varied from a few hundred to 20,000.

County public health nurses participate in

Table 1. Results of diabetes screening, March 1–December 31, 1958, Glens Falls Health District, N.Y.

Results	Number (3,851)	Percent (100)
Positive test results	183	4.8
Confirmed positive [1]	102	2.7
Previously known	51	1.3
Previously unknown	51	1.3
False positive [1]	76	2.0
Final diagnosis unavailable	5	.1

[1] According to physicians' diagnoses.

the program in two ways. Because of their familiarity with the communities and their experience in recruiting volunteers, county public health nurses were asked to recruit and brief volunteers for the program. At each clinic, volunteers act as registrars, arrange for clinic sites, and help spread the word about the clinics. The nurses also follow up persons whose tests are positive and who do not report to their personal physicians for further testing.

All available mass publicity media are used. Arrangements have been made for frequent radio spot and station break announcements. Before the screening program started and during its early operational stages, local newspapers carried a number of informational articles. They publish clinic schedules and articles urging everyone over the age of 20 to attend a clinic and those with positive tests to obtain more definitive diagnostic services from a private physician. The local public health nurses and the volunteers they have recruited conduct a word-of-mouth publicity campaign for the clinics. In each locality the campaign is stepped up for several weeks before a clinic is scheduled to be held in the area.

Results

During the first 10 months of operation, March 1 through December 31, 1958, a total of 3,851 specimens were tested, with 183, or 4.8 percent, testing positive. Of these 183 positive tests, a final diagnosis is available for 178, with 5 cases lost to followup. Seventy-six of the 178 proved not to have diabetes, 51 were previously known diabetics, and 51 new, previously unknown diabetics were discovered. These 51 previously unknown diabetics constitute 1.3 percent of the total number tested. Table 1 shows these results.

Table 2 gives the number and percent of the total population tested and the number of new cases found among those for whom age was known, by age groups. The highest percentages of total population tested were within the 40- to 70-year age group, the primary target for diabetes screening (*5*). Although this age group represented only 63 percent of those tested, 78 percent of the previously unknown cases of diabetes fell within it.

Table 3 shows the percentage deviation from normal weight for those tested, those who tested positive, and those proved to have diabetes. Of the persons with positive tests, 46.5 percent were overweight by 20 percent or more. This may be compared with 26.0 percent over-

Table 2. Age and sex distribution of confirmed new cases of diabetes in relation to total population and persons tested, March 1–December 31, 1958, Glens Falls Health District, N.Y.

Age (years)	Total population			Number tested [1]			Percent of total population tested [1]			Previously unknown cases		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
All ages	177,636	87,424	90,212	3,735	1,176	2,559	2.1	1.3	2.8	51	17	34
0–19	57,031	28,532	28,499	72	30	42	0.13	0.1	0.15	0	0	0
20–39	50,120	24,536	25,584	1,066	321	745	2.1	1.3	2.9	6	2	4
40–49	22,650	11,235	11,415	889	282	607	3.9	2.5	5.3	10	2	8
50–59	19,758	9,809	9,949	842	244	598	4.3	2.5	6.0	14	5	9
60–69	15,778	7,740	8,038	608	195	413	3.8	2.5	5.1	16	7	9
70 and over	12,299	5,572	6,727	258	104	154	2.1	1.9	2.3	5	1	4

[1] Includes only those for whom age is known.

Table 3. Deviation from normal weight [1] of screenees for whom weight was known, March 1–December 31, 1958, Glens Falls Health District, N.Y.

Test results	Number			Percent overweight						Percent underweight					
				Any amount			20 percent or more			Any amount			20 percent or more		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Total persons tested	3, 703	1, 145	2, 558	73. 5	78	72	26	22	28	26. 5	22	28	1. 6	1. 3	1. 8
Total positive tests	178	75	103	84	84	85	46. 5	36	54	16	16	15	0	0	0
Confirmed positive [2]	102	44	58	83	82	84	48	34	55	17	18	16	0	0	0
Previously unknown	51	17	34	83	85	82	51	46	54	17	15	18	0	0	0
Previously known	51	27	24	84	81	87	45	35	57	16	19	13	0	0	0

[1] According to standard height-weight tables of the Metropolitan Life Insurance Company.
[2] Percentages are expressed in relation to number of positive tests.

weight to the same degree in the total population tested. The difference in percentages is essentially the same in those proved to have diabetes. Conversely, similar comparisons for those who are underweight show consistently lower percentages, while no person 20 percent or more underweight had a positive test. These findings conform to the usually held concepts concerning the relationship between diabetes and obesity.

Table 4 shows the relationship between those with positive tests and those with positive tests confirmed, according to the interval between the last meal and the time of test. It will be seen that both the case rate and the percentage of false positives fall off after 1 hour, indicating that the test becomes less sensitive but more specific with the longer intervals after eating.

The source of referral to screening clinics for those patients who indicated a source was as follows:

Referral source	*Patients*
Private physician	400
Public health nurse	99
Newspaper	2, 283
Radio	110
Family	30
Friend	219
Health agency	23
Other	528
Total	3, 692

The newspaper has been the most effective source of publicity so far. However, it is likely

Table 4. Results of diabetes screening tests, according to time between last meal and taking of blood specimen for screenees on whom time interval was known, March 1–December 31, 1958, Glens Falls Health District, N.Y.

Time interval between last meal and test (hours)	Total tests	Positive test results			Case rate (percent confirmed positive of total tests)	Percent true positives of total positives
		Number	Percent of total tests	Number confirmed		
Total	3, 690	136	3. 7	74	2. 0	54. 4
Less than 1	898	58	6. 5	26	2. 9	44. 8
1–2	1, 515	46	3. 0	25	1. 7	55. 3
2–3	911	24	2. 6	17	1. 9	70. 8
3 or more	366	8	2. 2	6	1. 6	75. 0

that many were motivated to attend clinics by local word-of-mouth publicity and were merely reminded of the time and place through the newspapers.

Costs

Table 5 gives the actual cost of the program for the first 10 months, so far as can be determined. No charge has been made for such items as light, heat, stationery, and office space, as it is impossible to determine these with any degree of accuracy. The item for stenographic services is somewhat arbitrary and has been taken as 25 percent of one stenographer's total time. This figure is derived from the actual stenographic time spent on the program during a 10-week interval.

Tables 5 and 6 separate expenses into fixed and variable types, because such a method provides additional information of value in predicting the future cost of the program as it expands. The fixed cost per test performed in the first 10 months of operation was $1.07 and the variable cost was 32 cents, a total of $1.39. Similarly, the costs per new case found were $80.55, $23.99, and $104.54, respectively.

These costs are approximately 50 percent higher than those reported for programs in urban areas (*3,6*). The excess is almost entirely accounted for by two facts: our program is itinerant in nature and therefore involves a considerable amount of travel expense, and it is conducted as an independent unit. Other programs in this general area of New York State are usually conducted in conjunction with chest X-ray clinics, which makes it possible to divide certain costs between the two programs.

A word of caution is in order here. Comparison of costs in this program with the others mentioned is improper except in the very broadest sense. No uniform method of accounting has been used in the various programs, and therefore comparison between specific items is impossible. Only very large differences in costs can be indicated with the figures available.

Table 6. Relationship of diabetes screening costs to results, March 1–December 31, 1958, Glens Falls Health District, N.Y.

Type of cost	Cost per person screened (N=3,851)	Cost per new case (N=51)	Total expense
Fixed cost	$1. 07	$80. 55	$4, 107. 85
Variable cost	. 32	23. 99	1, 223. 61
Total	1. 39	104. 54	5, 331. 46

Administrative Problems

Of the four operational problems encountered, the first was in deciding where clinics should be held. As this was a new program to the local staff, there was no way of telling how large a community was necessary to make it worthwhile to hold a clinic, nor was there any way of predicting local response. Therefore, every concentration of population of more than

Table 5. Operating costs of diabetes screening program, March 1–December 31, 1958, Glens Falls Health District, N.Y.

Expense	Fixed cost	Variable cost	Total cost
Technician's salary ($2,990 per year)	$2, 491. 67		
Stenographer's salary ($3,610×¼ for ⅔ of a year)		$601. 67	
Technician's expenses:			
General (meals, etc.)	378. 75		
Auto (16,600 miles @ 5 cents a mile)	830. 00		
Depreciation ($300 per year)	250. 00		
Equipment [1]	157. 43		
Supplies [2]		421. 94	
Postage		200. 00	
Total	4, 107. 85	1, 223. 61	5, 331. 46

[1] Includes depreciation on glassware, clinitron, refrigerator, and miscellaneous equipment.
[2] Includes reagents, cleaning materials, finger lancets, cotton balls, alcohol. Excludes cost of stationery.

a few houses was assigned at least one clinic, with the thought that after a full circuit, those found unprofitable could be dropped from the schedule. This was a fortunate decision, for our experience indicates the size of the community in no way determines the public response. Some of our largest clinics have been held in areas that were sparsely populated.

Second, not all physicians use the same tests to verify a tentative diagnosis of diabetes. In this part of New York State, methods of diagnosing diabetes vary from examining random urine specimens to postprandial blood sugar tests.

At the beginning of the program, physicians were requested to determine at least one postprandial blood sugar for patients referred to them with positive tests. In practice, only a few have used this test. The great majority have used a single fasting blood sugar determination. Two or three of the more thorough physicians use glucose tolerance tests, while two perform only random office urinalyses in spite of the fact that they have been advised that the clinitron test is a more sensitive indicator of diabetes.

A third difficulty has been to obtain reports from physicians of final diagnoses for patients with positive screening results. In well over half the cases, two letters have been necessary, and in many instances a further reminder by telephone has been required. No physician has objected to supplying this information, but the general professional distaste for paperwork and its growing volume have increased the time spent in followup.

Finally, although considerable publicity through mass media has been maintained, it has been difficult for the district health officer to find adequate time for this very important aspect of the program. We feel that only the least possible amount of publicity consistent with results has been provided, and that, if more time were available for this purpose, response to the program could be significantly increased.

Discussion

The major purpose of the diabetes screening program was to provide a local casefinding program for one more of the serious chronic diseases, with the long-range goal of testing 10 percent of the population over the age of 20 each year. A secondary purpose was to increase knowledge by designing a successful rural application for a program which has heretofore been restricted to urban areas.

Much needs to be done in adapting programs for dispersed populations. Costs, local relationships, local participation, and many other administrative factors which determine the success or failure of a program vary in urban and rural settings. It is felt that in this program a good start has been made toward solving these problems.

It must be freely admitted that taking specimens 2 hours or more after the last meal is undesirable from a casefinding point of view, since it leaves undiscovered cases among those screened. Because of local unwillingness to accept the proportion of false positive results which occurs at high levels of test sensitivity, it was necessary to reduce the sensitivity of the test in order to increase its specificity. At present, there are signs that the program is gaining in acceptance. We hope that after the second year of operation the program will have proved of sufficient worth that specimens can be taken in accordance with the recommendations of Wilkerson and Heftmann.

The failure of most physicians to test individuals with positive screening results by determining a minimum of one postprandial blood sugar is a definite drawback and almost certainly causes a significant number of mild or latent diabetics to be overlooked. We can only hope these people will return for retesting at subsequent clinics, when some, at least, will present a more advanced and more easily diagnosed stage of the disease. We hope, also, that this will happen before too many of the adverse effects of diabetes have had a chance to assert themselves.

I have mentioned that the size of clinic attendance often bears no relationship to the size of the local population where clinics are held. The most successful responses seem to be related to the effectiveness of the word-of-mouth publicity by local volunteers and public health nurses. One of our current objectives is to identify the factors involved and apply them more universally.

A serious objection to the program at the present time is the high cost per test performed and per new case of diabetes found. Although $104, the cost of finding a new case, compares favorably with that of finding a new case of syphilis or of tuberculosis, the situation is not exactly comparable. Though an unknown case of diabetes does not create new cases, it represents cost to the community in the form of disability, loss of productivity, premature death, increased welfare costs, and increased load on health facilities. Nevertheless, we feel that, compared with the cost of casefinding in urban settings, this figure is not excessive, but it is still too high (*3,6*).

Costs are expected to come down. By far the greater portion of these costs are fixed. Therefore, for every additional increase in the number tested, there will be a much greater proportional decrease in the cost per test and the cost per case found. It is expected that for at least the next several years the number of people tested will increase, thus automatically lowering both costs. However, unless some way is found for absolute reduction of the fixed cost, there is no hope of approaching the cost level in urban programs.

The number of new, previously unknown, diabetes cases found represents 1.3 percent of those tested. This is greater than both the usual estimates and the actual experience of similar programs. No explanation is immediately available.

Summary

A year-round diabetes detection program was established in March 1958 in a tricounty rural section of upstate New York (Saratoga, Warren, and Washington Counties). The program's objectives are to offer a casefinding service in a serious chronic disease and to provide answers for some of the unsolved administrative problems in rural public health practice. Evaluation procedures were built into the original program design to permit periodic analysis.

Of the 3,851 persons tested during the first 10 months of operation, 1.3 percent proved to have previously unknown diabetes. This figure is undoubtedly low because of (*a*) the time interval between the last meal and the test and (*b*) the general non-use of postprandial blood testing by private physicians making final diagnoses of screenees with positive tests. This inadequate followup testing of positive screenees poses a problem for which no effective corrective action has as yet been devised.

Among the unsolved administrative problems the factor of cost looms large. It is felt that with expansion of the program as time goes on this difficulty will be reduced. The long-range goal is to test 10 percent of the population over the age of 20 each year.

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