Analysis of Diabetes Screening Costs in a County Health Department

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THE DECLINE in communicable disease morbidity and mortality has directed community health efforts to the prevention of chronic diseases. One form of action is the community-supported diabetes screening clinic designed to screen a hyperglycemic group by testing blood or urine specimens. The clinic may include a detection as well as a screening service (*1*).

The followup of hyperglycemic groups defined by screening tests shows that from 0.5 to 1.0 percent of the population screened have previously undiagnosed diabetes. No data are available, however, for evaluating the sensitivity or specificity of these screening techniques (*2*).

The earlier detection of diabetes in these clinics may arrest the progression of diabetes into disability and premature death; it is therefore recognized to be valuable as a secondary prevention which should be included in every organized public health program.

Three hypotheses generally accepted as the basis for operating a diabetes detection service are: (*a*) that diabetes mellitus is frequently unrecognized and asymptomatic; (*b*) that earlier diagnosis and management of diabetes improves prognosis; and (*c*) that untreated diabetics are abnormally hyperglycemic after food intake. A fourth hypothesis which is not generally accepted is that the postprandial hyperglycemic population can be economically and efficiently screened from the general population by a community-operated clinic service.

The Rensselaer County Health Department tested this fourth hypothesis by relating costs to results in its diabetes screening clinic started in September 1954 in Troy, N. Y.

The objective of the diabetes screening clinic is the discovery of a hyperglycemic population that can be referred to physicians for detection of previously unknown diabetes. To demonstrate that this objective is being attained efficiently and economically we offer three indexes of results: number of persons screened, number of hyperglycemic persons discovered, and number of previously unknown diabetics detected.

During the first 4 months of operation in Troy, when methods were still relatively inefficient, 525 persons were screened. Eighteen were found to have capillary blood sugar levels greater than 160 mg. Five of these were diagnosed as previously unknown diabetics.

In 1955, under routine conditions, 1,438 persons participated. Forty-three persons were screened as hyperglycemic, and 13 of this group were diagnosed as previously unknown cases of diabetes (table 1).

Screening Methods

The screening clinics are conducted on a nonappointment basis 4 times a week for 1 hour. The health center is centrally located in Troy, a city of 73,768 persons. Promotion during 1955 was limited to newspaper and word-of-mouth publicity.

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Table 1. Diabetic screening results for 1955, Rensselaer County Health Department, Troy, N. Y.

Age groups	General [1] population	Patients screened	Positive tests [2]		Unknown diabetics detected	
			Number	Percent of patients screened	Number	Percent of patients screened
0–14	19, 425	23				
15–24	11, 220	182	2	1. 1	2	1. 1
25–44	19, 681	606	9	1. 5	1	0. 2
45–64	15, 719	486	23	4. 7	8	1. 6
65 and over	7, 723	141	9	6. 4	2	1. 4
Total	73, 768	1, 438	43	3. 0	13	0. 9

[1] Estimated population distribution by age groups, Troy, July 1, 1955, office of vital statistics, New York State Department of Health.
[2] Capillary blood levels above 160 mg. percent blood sugar content.

A clerk-receptionist registers persons attending the clinic, and determines whether they came for a diabetes test or a chest X-ray. She completes a record card for the desired test and offers the additional screening procedure to the patient. A brief explanation of the procedure and objective of the screening tests is given by the receptionist to induce the patient to participate in both tests. The registration card contains, in addition to the usual identifying information, any family history of diabetes, height, weight, approximate weight 5 years before, time since eating last meal, and the source of referral. The patient is then directed to the X-ray room or the diabetes testing room.

For diabetes screening, the technician copies on the test tube the code number appearing on the registration card which the patient has brought with him. Testing procedure begins with the collection of 0.1125 cc. of capillary blood from the fingertip, which is mixed with 5 cc. of distilled water diluent. The sample is then tested with standardized reagent tablets at a screening level of 160 mg. percent of blood glucose according to the method of Wilkerson-Heftmann (*3*). No urine specimens are taken, and no retesting service provided. At the same session a 4- by 5-inch stereoscopic photofluorographic chest X-ray is taken if the patient has consented to the additional screening procedure. Test results are then recorded on the registration card. Since both tests are performed in a few minutes, the average length of stay in the clinic is from 10 to 15 minutes.

The patient is advised both verbally and by a brochure that reports of both procedures, accompanied by one-half of the 4- by 5-inch stereoscopic X-ray film, will be sent to the family physician. Patients with positive tests are referred to their physicians for diagnostic study. The physician is then requested to report his diabetes diagnostic findings to the clinic on an enclosed self-addressed coded postcard when the diabetes test is positive. If the diabetes test is positive or if there are abnormal X-ray findings, the individual is sent a letter advising him to consult his physician. In general, the agency follows up with nursing service all cases with positive screening tests until a diagnosis is established or excluded.

Problems in Operation

On intake in the clinic, 637 persons had not eaten within 2 hours. One hundred sixty-five persons attended 4 to 6 hours after eating regardless of the timing of the clinics. Only 812 had eaten within 2 hours. To meet this problem we are now exploring the specificity and sensitivity of screening at two different levels: 160 mg. if the specimen is postprandial or 130 mg. if it has been more than 2 hours since the last meal.

Acceptance of both screening procedures is greatly influenced by the attitude and interest of the registration clerk. When the same clerk served at each clinic the participation improved. We do not recommend the use of a public health nurse for registration because of the greater cost and the fact that the nurse's time is better spent in promotional and educational activity in the field.

The only bottleneck encountered during the tests was in developing enough skill to draw 0.1125 cc. of blood without undue "milking" of the finger. This problem was overcome after a few sessions. For rapid testing, a clinitron is used (*4*).

During 1955, only 50 percent of the followup

reports were made voluntarily by the physicians. The other half were obtained by public health nurses. Diagnostic criteria used by physicians for establishing or excluding diabetes were quite variable. Among 27 suspects definitely diagnosed as diabetic or nondiabetic by family physicians, 13 diagnoses were made on the basis of 1 fasting blood sugar, 2 on the basis of negative urines, and 1 on the basis of a glucose tolerance test; 11 indicated that no glucose tolerance test was performed but did not indicate what criteria were used. The followup results taken at face value indicate the need for the inclusion of a detection service in the clinic with referrals for treatment on the basis of uniform diagnostic criteria.

Program Costs

The collection of cost data was a byproduct of a departmentwide performance budgeting system installed by the New York State Temporary Commission on Fiscal Affairs of State Government in 1954 (*4*). Two basic types of cost are identified, fixed and variable. Variable costs are incurred in direct proportion to patient participation. Fixed costs occur in setting up and being ready to start; they are costs which are not appreciably affected by patient volume. For example, the cost of the testing equipment is fixed and the cost of testing supplies is a variable cost. The sum of fixed and variable costs is the operating cost.

In calculating a cost per unit of result, it is important to have the distinctions between fixed, variable, and operating costs clearly in mind. For example, if a new program is planned on a 5- to 10-year operating basis, the operating cost is the most significant figure. On the other hand, if the program is being abandoned for economy reasons, the variable cost looms important since it is the only cost which will be saved.

Our operating cost was determined first by depreciating the equipment on a 10-year straight-line basis and the other fixed costs on a 5-year replacement basis. These figures were then added to the sum of all variable costs. The operating cost did not include the cost of services in the basic health department. These service costs could not be eliminated if the program were abandoned nor did they need augmenting when the program started. They included clinic space and public health nurse followup service.

The sum of $1,908.71 was spent in the 4

Table 2. Expenditures for setting up the diabetes screening service, Rensselaer County Health Department, Troy, N. Y.[1]

Expenditure	Fixed cost	Variable cost
Technician fees		$156.25
Intake clerk		40.00
Finger lancets		40.00
Reagent tablets		137.90
Pipettes	$424.56	
Test tubes	110.00	
Testing apparatus	1,000.00	
Total	$1,534.56	$374.15

[1] During September through December 1954, when 525 persons were screened.

Table 3. Monthly variable costs incurred in the operation of a routine diabetes screening service classified by object, Rensselaer County Health Department, 1955

Month and item	Cost
January: 10–100 adhesive bandages	$7.70
January: Technician fees	25.00
February: Reagent tablets	54.00
February: 1 case cotton balls	15.30
February: 1 case alcohol	10.74
February: Technician fees	35.00
March: Technician fees	35.00
April: Technician fees	35.00
April: Shipping clinitron	9.01
May: Technician fees	40.00
June: 10–100 adhesive bandages	11.00
June: Technician fees	45.00
July: Technician fees	37.50
July: Finger lancets	20.00
July: 1 case facial tissues	13.17
August: Technician fees	12.50
August: 1 case gauze pads 3 by 3	38.00
September: Technician fees	17.00
October: Finger lancets	20.00
October: Test reagents	79.20
October: Technician fees	23.25
November: Technician fees	95.00
November: Test reagents	183.00
December: Finger lancets	40.00
Jan.–Dec.: Intake clerk	120.00
Total variable cost	$1,021.37
Fixed costs [1]	206.91
Operating cost for 1955	$1,228.28

[1] Equipment depreciation and replacement cost determined in 1954.

Table 4. Relationship of diabetes screening costs to result, Rensselaer County Health Department, 1955

Type of cost	Total expense	Cost per person screened (1,438)	Cost per suspect (43)	Cost per new case detected (13)
Fixed cost (depreciation and replacement) [1]	$206.91	$0.14	$4.80	$15.90
Variable costs	1,021.37	.71	23.75	78.56
Operating cost	$1,228.28	$0.85	$28.00	$92.50

[1] Gross fixed costs for 1954 were $1,534.56.

months it took to establish the clinic on a routine basis. Table 2 shows how this cost was distributed as fixed or variable.

Relationship of Cost to Result

The operating cost for diabetes screening during the 4 months of operation in 1954 was $581.06. Five previously undiagnosed diabetics were detected at an operating cost of $116.21 each.

Only variable costs were incurred during 1955. They are listed in table 3 exactly as the obligations were incurred. This time sequence should give the reader an insight into the development of the operation.

In 1954 there were no expenditures for certain supplies, such as cotton and alcohol, which were drawn from existing stocks. Such items are included in the 1955 expenses and an inventory was left at the end of that year. No adjustment was made since the inventories were small and a cost adjustment would not significantly alter the analysis.

In using these data we find that the operating cost (including the annual fixed replacement and depreciation cost determined in 1954) for diabetes screening in 1955 was $1,228.28. How the various component costs contained within the operating cost relate to the results is shown in table 4. Most significant is the fact that the cost of detecting a case of diabetes is $92.50 under present patient volume. This should approach the variable cost of $78.56 per new case as better promotion of the program is attained. In the first 4 months of operation in 1954 a similar variable cost of $74.00 was obtained.

Summary

Diabetes screening procedures for promotion of earlier detection are a recognized form of secondary prevention of disease. In a community-operated screening clinic, a postprandial hyperglycemic population can be delineated from the general population by capillary blood sugar determination at a cost of approximately 85 cents per person screened. One year's experience has shown that the cost of detecting one previously unknown case of diabetes should approach a cost of $75 per new case found.

REFERENCES

(1) Levin, M. L.: Screening for symptomatic disease: Principles and background. J. Chron. Dis. 2: 367–374, October 1955.

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(3) Wilkerson, H. L. C., and Heftmann, E.: Screening method for blood glucose. J. Lab. & Clin. Med. 33: 236–238, February 1948.

(4) New York State Temporary Commission on Fiscal Affairs of State Government: A program for continued progress in fiscal management. Albany, N. Y., 1955, vol. 2, pp. 217–242.

EQUIPMENT REFERENCE

(A) Clinitron, Lessells and Associates, Inc., Boston, Mass.