Diabetes Mellitus at Ages One to Five

Findings at Onset

Howard S. Traisman, M.D., John J. Boehm, M.D., and Alvah L. Newcomb, M.D., Chicago

From 1921 through 1957, 110 infants and children who developed diabetes mellitus after their first and prior to their fifth birthday were seen at the hospitals whence this study originates. It is the purpose of this paper to record our observations of these young diabetic patients.

METHOD OF STUDY

The records of these patients obtained at the time of their first admission to the hospital were reviewed. The following major factors were investigated: sex distribution, age of onset, interval between onset of symptoms and diagnosis, symptoms or presenting complaints, infectious diseases associated with the onset of the diabetes, time of year of onset of symptoms, and hereditary factors involved.

OBSERVATIONS

Sex distribution. Of the 110 patients studied, sixty-five (59.1 per cent) were male and forty-five (40.9 per cent) female.

Age of onset of diabetes mellitus and interval between onset of symptoms and diagnosis. In this series there were none whose onset began in the first year; among thirty-two patients the onset of diabetes was between twelve and twenty-three months of age; for thirty, it was between twenty-four and thirty-five months. In twenty-one, it was discovered between thirty-six and forty-seven months of age, and in twenty-seven, between forty-eight and fifty-nine months of age (table 1).

The average interval between onset of symptoms and diagnosis in twenty-six cases between twelve and twenty-three months was two and one-half weeks with a range of seven days to eight weeks.

Among twenty-nine cases in the twenty-four- to thirty-five-month age group the average interval between onset and diagnosis was three and one-half weeks, with a range of seven days to twelve weeks.

Of the twenty cases in the thirty-six- to forty-seven-month age group the average interval was four weeks, with a range of three days to twelve weeks.

In patients between forty-eight months and five years, the interval was four and one-half weeks, with a range of four days to sixteen weeks.

The average interval for 102 cases in all age groups was three and six-tenths (table 1).

For eight patients in this series the interval between onset of symptoms and diagnosis could not be determined. The reasons for this lack of a clear onset lay in the absence of a history that could be elicited from the parents, or because the patient was admitted after the diagnosis had been established but the duration of the presenting symptoms was not precisely recorded.

Symptoms or presenting complaints. In adults with diabetes mellitus it is well known that polyuria, polydipsia and polyphagia are the most common symptoms. These presenting symptoms are also seen in juvenile diabetes but with different frequency. Table 2 lists in the order of frequency the presenting symptoms of the 110 patients in this study.

1. Polyuria—This symptom was present in 84.5 per cent of the entire series. It should be noted that the incidence is higher in the older age groups than in the twelve- to twenty-three-month age group in which it was only 72 per cent.

2. Polydipsia—Increased thirst was similarly noted in a high percentage of cases (81 per cent). This also was more frequently noted in the older children than in the twelve- to twenty-three-month age group.

3. Weight loss—This was present in 43 per cent of the patients with a slight increase in the incidence as the age of onset increased.

In 88 per cent of the patients either polyuria or polydipsia was present whereas in 91 per cent either polyuria or polydipsia, or weight loss was noted.

4. Polyphagia—Increased appetite was noted in 25 per cent of the series. There was an incidence of 44.5 per cent in the forty-eight-month to five-year group, compared to an incidence of only 12.5 per cent in the

From the Department of Pediatrics, Northwestern University Medical School, The Children's Memorial Hospital, Chicago, Illinois, and The Evanston Hospital, Evanston, Illinois. Address requests for reprints to Dr. Howard S. Traisman, 6354 North Broadway, Chicago 40, Ill.

TABLE 1

(*continued on opposite page*)

Age group (months)	Age at onset (110 patients) M	F	Total	Average interval between onset of symptoms and diagnosis No. of cases	Average interval (weeks)		Patients admitted in acidosis No.	Per cent of age group
12-23	21	11	32	26 (6)*	2.5		13	40.6
24-35	20	10	30	29 (1)*	3.5		7	23.4
36-47	13	8	21	20 (1)*	4.0		10	47.6
48-59	11	16	27	27	4.5		10	37.0
				Average	3.6	All age groups	40	36.4

twelve- to twenty-three-month age group.

5. Anorexia—Loss of appetite was found in 14.5 per cent of the total cases with a much higher frequency noted in the youngest age group (28 per cent).

6. Lethargy—Although this symptom was present in a relatively large number of cases (13 per cent), there was no striking dissimilarity of incidence among the various age groups.

7. Enuresis—Bed-wetting appearing in 6 per cent of the group.

8. Vomiting—In 4.5 per cent of the patients vomiting accompanied the onset of diabetes.

9. Less common presenting symptoms—Three children were noted to be more irritable just prior to the diagnosis of diabetes. In three patients "craving for sweets" was reported. Of three other patients the mothers noted that the diapers had a "sticky" feel to the touch, while two reported a "strong odor to the urine."

In only two children was diabetes discovered on routine urinalysis. One was a two and one-half-year-old boy whose urine was examined when he was admitted to the hospital for acute appendicitis. The other was a four-and-one-half-year-old girl whose diabetic father tested her urine when she appeared ill. In two patients the onset of diabetes was heralded by a hypoglycemic episode.

Personality change, boils, headache, and abdominal cramps—each occurred once in different subjects as a presenting complaint in the group.

Patients admitted in acidosis or coma. The term diabetic acidosis was used to describe any infant or child whose total serum CO_2 content was 15 mEq./L. or less. In addition, patients who failed to respond or who were unconscious were classified as being in coma.

Forty patients, including six in coma and comprising 36 per cent of the total group, were admitted in acidosis prior to establishing the diagnosis of diabetes. In the group twelve to twenty-three months of age there were thirteen individuals admitted in acidosis. There were seven children in the twenty-four- to thirty-five-

TABLE 2

Symptoms or presenting complaints (110 patients)

	12-23 mo. 32 patients No. and per cent of age group	24-35 mo. 30 patients No. and per cent of age group	36-47 mo. 21 patients No. and per cent of age group	48-59 mo. 27 patients No. and per cent of age group	Total 110 patients No. and per cent of total group
Polyuria	23 (71.9)	26 (86.6)	18 (85.7)	26 (96.4)	93 (84.5)
Polydipsia	19 (59.4)	27 (90.0)	18 (85.7)	25 (92.6)	89 (81.0)
Weight loss	11 (34.4)	12 (40.0)	10 (47.6)	14 (51.9)	47 (42.7)
Polyphagia	4 (12.5)	8 (26.6)	4 (19.0)	12 (44.5)	28 (25.4)
Anorexia	9 (28.1)	4 (13.3)	0 —	3 (11.1)	16 (14.5)
Lethargy	5 (15.6)	2 (6.7)	3 (14.3)	4 (14.8)	14 (12.7)
Enuresis	0 —	2 (6.7)	3 (14.3)	2 (7.4)	7 (6.4)
Vomiting	2 (6.3)	0 —	2 (9.5)	1 (3.7)	5 (4.5)
Irritability	1 (3.1)	1 (3.3)	0 —	1 (3.7)	3 (2.7)
"Craving for sweets"	0 —	0 —	1 (4.8)	2 (7.4)	3 (2.7)
"Sticky diaper"	0 —	3 (10.0)	0 —	0 —	3 (2.7)
"Strong odor to urine"	1 (3.1)	1 (3.3)	0 —	0 —	2 (1.8)
Routine urinalysis	0 —	1 (3.3)	0 —	1 (3.7)	2 (1.8)
Hypoglycemia	1 (3.1)	1 (3.3)	0 —	0 —	2 (1.8)
Personality change	0 —	1 (3.3)	0 —	0 —	1 (0.9)
Boils	0 —	0 —	0 —	1 (3.7)	1 (0.9)
Headache	1 (3.1)	0 —	0 —	0 —	1 (0.9)
Abdominal cramps	0 —	0 —	1 (4.8)	0 —	1 (0.9)

TABLE 1
(continued from opposite page)

Association of infections with diabetes									
Respiratory infections		Exanthems		Pyelitis		Vaginitis		Total infections for age group	
No.	Per cent age group	No.	Per cent age group	No.	Per cent age group	No.	Per cent age group	No.	Per cent
13	40.6	1	3.1	1	3.1	1	3.1	16	50.0
8	26.7	1	3.3	0		0		9	30.0
8	38.0	0		0		0		8	38.0
7	25.9	0		0		0		7	25.9
36	32.8	2	1.8	1	0.9	1	0.9	40	36.4

*For these eight cases no interval could be determined either because no onset history could be elicited from the parents or because the patient was admitted after diagnosis had been established earlier, and duration of presenting symptoms was not accurately recorded.

month age group, and ten children in the thirty-six- to forty-seven-month age group and ten in the group forty-eight to fifty-nine months old (table 1).

Six patients (5.5 per cent of the total number) were admitted in coma. Two were in the group twelve to twenty-three months old. There was one child in the twenty-four- to thirty-five-month, and one in the thirty-six- to forty-seven-month group. Two children were in the forty-eight- to fifty-nine-month age group. In the twelve- to twenty-three-month group one infant's symptoms were present one-half week prior to admission. Nothing is known of the onset of symptoms in the other infant in this group. The average duration of symptoms in the other three age groups was two weeks (table 3). This emphasizes the fact that the younger the diabetic patient the more rapid is the onset of his ensuing acidosis and coma.

Association of infections with onset of diabetes. With the onset of diabetes there were forty patients (36 per cent) in whom an associated secondary disease was found (table 1). Respiratory infections were by far the most common. These included the common cold, pharyngitis, tonsillitis, otitis media, mastoiditis, bronchitis, and pneumonitis. In 33 per cent of the entire group there was an associated respiratory infection at the time of onset with little difference in frequency among the various age groups. One patient had rubella and another rubeola associated with the onset of their diabetes mellitus. One child had pyelitis and another vaginitis.

TABLE 3
Patients admitted in coma

Age group (months)	Number	Per cent of each age group admitted in coma
12-23	2	6.2
24-35	1	3.3
36-47	1	4.8
48-59	2	7.4
All age groups	6	5.5

TABLE 4
Time of year of onset of diabetes

Age group (months)	Spring (March-May)	Summer (June-Aug.)	Autumn (Sept.-Nov.)	Winter (Dec.-Feb.)
12-23	3	9	11	9
24-35	5	6	10	9
36-47	7	3	3	8
48-59	4	6	6	11
Total	19	24	30	37
Per cent	17.3	21.8	27.3	33.6

Time of year in relation to onset of diabetes. It is not known whether or not the season of the year has any relationship to the onset of diabetes. In this series of 110 patients nineteen (17 per cent) were discovered in the spring, twenty-four patients (22 per cent) in the summer, thirty (27 per cent) in the autumn, and thirty-seven patients (34 per cent) in the winter months. Thus, 39 per cent of cases occurred in the spring and summer compared to 61 per cent in the autumn and winter (table 4). There was no apparent correlation with infection.

Family history of diabetes. For study of the incidence of diabetes in the families of the 110 juvenile diabetics, two groupings were made to include those patients with a proximate family history (diabetes in parents, grandparents, aunts, or uncles) and those with a remote family history (great-grandparents, great-aunts, great-uncles, or first cousins). Twenty-seven (25 per cent of the entire group) had a proximate family history of diabetes, and four (4 per cent) had a remote family history, making a total of thirty-one patients (28 per cent) with a family history of diabetes at the time of onset of their disease (table 5).

DISCUSSION

The predominance of male patients in the age group that we are reporting is in striking contrast to adult diabetics in whom the females outnumber the males.[1] However, it is consistent with other studies of juvenile diabetes in which the sex ratio approximates

TABLE 5

Family history of diabetes (110 patients)

Age group (months)	Proximate*	Remote†	Total
12-23	5	2	7
24-35	12	0	12
26-47	4	2	6
48-59	6	0	6
Total	27	4	31
Per cent	24.6	3.6	28.2

*Parents, grandparents, aunts, uncles.
†Great-grandparents, great-aunts, great-uncles, cousins.

unity.[2-4] We have noted an increased number of female patients in the older age groups under our care.

The diagnosis of diabetes mellitus in infants is rare. The diagnosis is seldom made because of the infrequency of the disease, its sudden onset, and the fact that accompanying symptoms of anorexia and vomiting are so characteristic of many other ills of infants.

The onset in infants is abrupt in contrast to the gradual onset in children and adults. To aid in the diagnosis of this young group the following symptoms are noted: fever, pulmonary signs and symptoms, anorexia, vomiting, restlessness, polyuria, weight loss and glycosuria. Additional important symptoms in the infant include recurrent enuresis and sticky diapers.

In older children the classical symptoms of polyuria, polyphagia, polydipsia, weight loss and glycosuria are usually present. Severe abdominal pain often accompanies approaching ketosis and simulates acute abdominal disease. The diffuse abdominal pain of diabetic acidosis recedes with the administration of insulin and parenteral fluids, while the pain of appendicitis or other abdominal disease persists. It is noted that the interval between onset of symptoms and diagnosis gradually increased in this study as the age of the patients increased. The average interval of three and six-tenths weeks in our study differs considerably from that of Danowski's series.[4] Danowski included 405 juvenile diabetics of all ages in whom the average interval between onset of the disease and diagnosis was eleven and seven-tenths weeks. This may be even more sharply contrasted to the longer interval of months or years before a diagnosis of diabetes mellitus is made in adults.[5]

The more common symptoms of polyuria, polydipsia, polyphagia and weight loss were less frequent in the twelve- to twenty-three-month age group. However, anorexia was more frequent in this youngest group. Discovery of diabetes was usually made by the routine diagnostic tests in an attempt to find a cause for the individual's loss of appetite, irritability, or during a severe infection.

Enuresis occurred in 6 per cent of our patients. We considered bed-wetting a symptom only in those infants and children who had been toilet-trained previously. This is in contrast to Danowski's series[4] in which this symptom was present in almost 40 per cent of 513 juvenile diabetics of all ages. In only two of our children was diabetes discovered on routine urinalysis. This low incidence is in notable contrast to the 32 per cent of patients discovered on routine urinalysis by other investigators.[4] The relation of hypoglycemia to the onset of diabetes mellitus in adults has been well reviewed and reported by Seltzer and associates.[6] However, this association has not been emphasized with regard to the juvenile diabetic. We observed two children whose onset of diabetes was diagnosed because of a hypoglycemic episode.

The incidence of acidosis in our series is considerably higher than the 10 to 18 per cent noted by others.[4,7] This can possibly be explained by the fact that many of the patients at the Children's Memorial Hospital are referred undiagnosed by other hospitals and nonstaff physicians. They enter because of severe vomiting, dehydration, or infection.

In forty patients (36 per cent) we found associated diseases. Thirty-three per cent of the entire group had an associated respiratory infection. Two patients had an exanthematous disease; one child had pyelitis, and another vaginitis. These figures are similar to those of other authors.[3,4]

It must be emphasized that diabetes mellitus in the twelve- to twenty-three-month age group may masquerade as pneumonia, gastritis with dehydration, and even meningitis. A routine urinalysis and blood sugar should be done whenever the possibility of diagnosing diabetes is entertained. While the onset of this disease is frequently associated with various infectious processes, they play no role in the etiology of our juvenile diabetics.

Situations of stress such as trauma, emotional problems, infections, obesity, and endocrine disturbances were not seen in our group. However, we are of the opinion that these aforementioned conditions do not precipitate diabetes mellitus, or necessarily precede it.

There is no definite relationship between the time of the year in relation to the onset of diabetes. Though most of our cases occurred in the fall and winter which is similar to some series,[4,8] it differs from others[9,10] in which a higher onset is noted in the spring and summer. Diabetes mellitus cannot be regarded as seasonal.

There was a family history of diabetes in 28 per cent of our patients. This figure is somewhat lower than that quoted by others.[3,4,11] The low incidence can be explained by the fact that our patients are quite young, and that there is a trend to increased familial incidence of diabetes as the juvenile patient grows older. This is attributable to the appearance of diabetes in distant relatives and siblings with the increasing age of the juvenile diabetic.

It is noteworthy that there was not a single case of a sibling with diabetes in this series.

Once the young diabetic is diagnosed and treated, he usually does well. The initial diabetic acidosis is treated with regular insulin and parenteral fluids. Antibiotics are prescribed for any co-existing infection. Oral feedings are gradually introduced, and when able the patient receives a specific weighed diet. At this time Lente insulin is usually administered.

The basic principle underlying the treatment of infants and children is thorough education of their parents. The parents should know the uses of the different insulins; diet prescriptions; how to perform urinalysis; how to recognize and prevent complications; and how to preserve the mental health of the child. Details of our routine management have been reported elsewhere.[12,13] The great majority of this age group of juvenile diabetics do exceptionally well, and are cooperative. They rarely require hospitalization for the usual childhood infections and contagious diseases. Activity is unrestricted, and they compete on an equal footing with their nondiabetic contemporaries.

SUMMARY

The records of 110 infants and children with onset of diabetes mellitus between one and five years of age were reviewed.

Sex distribution, average interval between onset of symptoms and diagnosis, presenting complaints, associated diseases, seasonal incidence, and family history were examined.

The diagnosis of diabetes mellitus in infants is rare. The diagnosis is seldom made because of the infrequency of the disease, its sudden onset, and because the accompanying symptoms of anorexia and vomiting are so characteristic of many other ills of infants. The onset in infants is abrupt in contrast to the gradual onset in children and adults. In older children the classical symptoms of polyuria, polyphagia, polydipsia, weight loss and glycosuria are usually present.

The basic principle underlying the home care and treatment of infants and children with diabetes mellitus is thorough education of their parents.

SUMMARIO IN INTERLINGUA

Diabete Mellite A Etates De Inter Un E Cinque Annos: Constatationes Al Tempore Del Declaration Del Morbo

Es presentate un revista del dossiers de 110 infantes e juveniles con diabete mellite a declaration a etates de inter un e cinque annos. Es discutite le distribution secundo le sexos, le intervallo medie inter le declaration del symptomas e le diagnose, le gravamines de presentation, le morbos associate, le incidentia saisonal, e le historias familial.

Le diagnose de diabete mellite in infantes es rar proque (1) le morbo mesme es rar, (2) su declaration es subite, e (3) le symptomas que accompania lo—i.e. anorexia e vomito—es characteristic de multe altere morbos de infantia. Le abruptitate del declaration del morbo in infantes contrasta con le declaration gradual in juveniles e adultos. In juveniles de etate plus avantiate, le symptomas classic de polyuria, polyphagia, polydipsia, perdita de peso, e glycosuria es usualmente presente.

Le base del custodia e del tractamento domiciliari de infantes e juveniles con diabete mellite es le education del parentes.

REFERENCES

[1] Spiegelman, M., and Marks, H. H.: Age and sex variation in the prevalence and onset of diabetes mellitus. Am. J. Pub. Health *36*:1, 1946.

[2] Joslin, E. P., and Wilson, J. L.: Lessons for future treatment from 472 fatalities in diabetic children. Brit. M. J. *4692*: 1923, 1950.

[3] John, H. J.: Diabetes mellitus in children. Review of 500 cases. J. Pediat. *35*:723, 1949.

[4] Danowski, T. S.: Diabetes Mellitus, with Emphasis on Children and Young Adults. Baltimore, The Williams and Wilkins Co., 1957, Ch. 7, pp. 121-39.

[5] Beaser, S. B.: The clinical characteristics of early diabetes mellitus. New England J. Med. *239*:765, 1948.

[6] Seltzer, H. S., Fajans, S. S., Conn, J. W.: Spontaneous hypoglycemia as an early manifestation of diabetes mellitus. Diabetes *5*:437, 1956.

[7] Avant, J. A., Jr.: Diabetes in childhood. New Orleans Med. and Surg. J. *104*:662, 1952.

[8] Adams, S. F.: The seasonal variation in the onset of acute diabetes. Arch. Int. Med. *37*:861, 1926.

[9] Baker, T. W.: A clinical survey of one hundred and eight consecutive cases of diabetic coma. Arch. Int. Med. *58*:373, 1936.

[10] Spencer, H.: Diabetes mellitus in children: studies of height and weight of forty-five patients. Am. J. Dis. Child. *36*:502, 1928.

[11] White, P.: Diabetes in youth. New England J. Med. *224*: 586, 1941.

[12] Lussky, R. A., Newcomb, A. L., Traisman, H. S.: Lente insulin in diabetic children. Diabetes *5*:124, 1956.

[13] Newcomb, A. L.: Diagnosing and treating diabetes mellitus in infancy and childhood. Miss. Valley Med. J. *76*:25, July 1954.