

Glycemic Control in Children With Type 1 Diabetes in Wales

Influence of the pediatric diabetes specialist nurse

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OBJECTIVE — To determine whether glycemic control is improving in diabetic children in Wales and to identify factors associated with improvement.

RESEARCH DESIGN AND METHODS — Data were collected in 2001 and 2006.

RESULTS — Over time A1C was reduced from 9.08 ± 1.66 to $8.88 \pm 1.63\%$ ($P = 0.012$). There were differences among centers ($P < 0.001$) and differential changes over time (interaction $P < 0.001$). Since 2001 five centers had appointed a pediatric diabetes specialist nurse (PDSN). A1C improved in these centers from 9.59 ± 1.88 to $8.72 \pm 1.61\%$ ($P < 0.001$). Glycemic control was worse in children aged >10 years compared with younger patients ($P < 0.001$). Improvement occurred in those aged >10 years. Age ($P = 0.003$) and insulin dose ($P < 0.001$) were positively and independently associated with A1C. Thus, any influence of PDSNs was not achieved through increased insulin prescription.

CONCLUSIONS — Improvement in glycemic control has occurred. Worse control is associated with greater prescribed insulin dose in older children. Appointment of PDSNs was associated with improved glycemic control among adolescents.

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Whether glycemic control in children with type 1 diabetes is improving with modern management is controversial. We aimed to determine whether control has improved in Wales and to identify factors related to improvement. Between 2001 and 2006 five centers appointed a pediatric diabetes specialist nurse (PDSN), allowing examination of changes associated with this service development. We assessed glycemic control over time by center, age-group, insulin regimen, and sex.

RESEARCH DESIGN AND METHODS

Twelve of 14 pediatric diabetes units in Wales supplied data collected at routine clinic visits within 3 months of November 2001 and November 2006. Patients were $>99\%$ white aged

up to 18 years. Age-standardized weight measurements are from U.K. national growth standards (1). Five centers appointed PDSNs after 2001, having not had one previously. The remaining seven centers, except for the smallest, already had PDSNs. Ascertainment calculation denominator data came from the Brecon Group register, an all-Wales register of diabetic children.

The influence of center, age-group, and appointment of a PDSN on A1C over time was analyzed in separate ANOVA models (Tukey honestly significant difference post hoc test). In comparison of centers, A1C data were adjusted for age, sex, and body weight. Multilinear regression (backwards stepwise) was used to assess the influence of age, sex, PDSN, insulin dose (units per kilogram per day) and

number of daily doses on A1C. Because the last of these parameters was only available for the 2006 dataset, the initial analysis was undertaken using 2006 data only ($n = 795$) and then a second analysis without number of daily doses was performed with 2001 and 2006 data ($n = 1,689$). Data are reported as means \pm SD.

RESULTS — The proportion of Welsh diabetic children included was 80% in 2001 and 88% in 2006. In 2006 patients were heavier, but A1C was lower (Table 1). Diabetic children were 0.60 SD above mean weight for age in 2001, increasing to 0.72 SD in 2006. Insulin dose increased in proportion to weight. A1C was not different by sex (boys $8.96 \pm 1.63\%$ and girls $9.05 \pm 1.67\%$, $P = 0.21$).

Adjusted A1C from the 12 centers varied from 8.45 ± 1.57 to $10.33 \pm 1.57\%$ in 2001 and from 8.10 ± 1.56 to $9.30 \pm 1.58\%$ in 2006. ANOVA demonstrated differences among centers ($P < 0.001$) and over time ($P = 0.001$) and differential change among centers over time (interaction $P < 0.001$). Four centers showed improvement, one was borderline ($P = 0.053$), five showed no change, and in two A1C deteriorated.

Glycemic control was worse in children aged >10 years compared with those aged 5–9 years ($P < 0.001$) and <5 years ($P < 0.001$) (Table 1). In a three-way ANOVA (year, new PDSN, and age $<$ or >10 years), there was interaction between year and age-group ($F = 3.96$, $P = 0.047$), indicating that children aged >10 years showed improvement in 2006 compared with 2001.

In centers appointing a PDSN, A1C improved versus that in those with no staffing change (center vs. time interaction $P = 0.001$). Centers that appointed a PDSN were those with the highest mean A1C, raising the possibility that regression to the mean contributed to reduced A1C in this subgroup. Therefore, expected regression to the mean was calculated from the variance in 2001 center A1C means (2). Repeating the analysis with 2001 center means corrected for expected regression to the mean confirmed

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Table 1—Characteristics of the study population in 2001 and 2006

	2001	n	2006	n	P value
Age (years)	12.0 ± 3.8	863	12.3 ± 3.8	1,033	0.059
Proportion male (%)	51.3	873	52.6	1,035	NS
A1C (%)	9.08 ± 1.7	821	8.88 ± 1.63	1,031	0.012
Body weight (kg)	46.7 ± 17.3	792	49.2 ± 19.1	966	0.005
Insulin dose (units/day)	46.5 ± 25.2	770	49.3 ± 29.7	952	0.033
Insulin dose (units/kg/day)	0.96 ± 0.33	770	0.99 ± 0.77	951	NS
Standardized weight (SD)	0.60 ± 1.13	783	0.72 ± 1.16	966	0.044
A1C (%)					
Age <5 years	8.45 ± 1.08	39	8.35 ± 1.07	31	NS
Age 5–9 years	8.53 ± 1.18	184	8.56 ± 1.25	223	NS
Age >10 years	9.28 ± 1.77	596	9.00 ± 1.73	776	0.003
Appointed PDSN	9.59 ± 1.88	242	8.72 ± 1.61	366	<0.001
No new appointment	8.85 ± 1.51	570	8.97 ± 1.63	664	NS

Data are means ± SD or proportion, number in each group, and significant differences. A1C in 2001 and 2006 in the analysis of age-groups is adjusted for sex. ANOVA shows that glycemic control was worse in children aged >10 years compared with children 5–9 years ($P < 0.001$) and compared with children aged <5 ($P < 0.001$). A1C of patients where a new PDSN had been appointed is adjusted for age and sex. A center versus time interaction ($P < 0.001$) indicates that glycemic control improved in centers that appointed a new PDSN compared with centers that did not.

center versus time interaction ($P = 0.007$). Use of individual patient data also showed a center versus time interaction ($P < 0.001$) (Table 1). Appointment of a PDSN did not affect body weight or insulin dose (units per kilogram per day).

None of the five new appointments was associated with additional pediatrician clinics. Three appointees started nurse-led clinics seeing patients between doctor appointments. All reported increased telephone contacts and home and school visits with more frequent insulin dose adjustments, change of regimen, and diabetes education. Few patients were using insulin pumps (~1% in 2006). Formal “dose adjustment for normal eating” (DAFNE-type) programs were not then in use.

Multivariate analysis indicated that number of insulin doses per day bore no relation to A1C. Age ($\beta = 0.15$, $P < 0.001$), insulin dose in units per kilogram per day ($\beta = 0.16$, $P < 0.001$), and the presence of a PDSN ($\beta = -0.12$, $P < 0.001$) were independently associated with A1C (adjusted $R^2 = 0.07$, $F = 43.1$, $P < 0.001$), whereas sex was not. Simple linear regression showed no correlation between number of patients seen at a center and mean A1C either in 2001 ($r = 0.18$, $P = 0.58$) or 2006 ($r = 0.26$, $P = 0.41$).

CONCLUSIONS— Missing data were distributed among contributing centers and patient subgroups at random with no systematic bias. A high propor-

tion of diabetic children were included. We therefore feel that the aggregate data are representative of glycemic control in Welsh children with type 1 diabetes. A1C here was similar to that in Northern Ireland (8.8%), Scotland (8.9%), France (9.0%), and Denmark (8.7%) (3–6). We identified modest improvement in glycemic control over time.

We found no effect of sex on glycemic control. The Hvidøre study found higher A1C in girls (7), but others studies did not (8,9). Adolescent girls have more ketoacidosis (10,11), but overall the sex difference is minimal. In 2006 more insulin was prescribed in proportion to children being heavier. Body weight in our cohort was above the 50th centile for U.K. children in 2001 and greater in 2006 and is cause for concern. Elevated BMI has previously been demonstrated in diabetic children (12).

The differences in A1C among centers were striking. The Hvidøre study also identified differences among centers, which were persistent and largely unexplained (13). As in that study, our data do not indicate that multiple injection regimens are superior (13,14). We included small and large centers, but numbers seen did not relate to A1C achieved. However, improved glycemic control occurred in centers where a PDSN had been appointed. Greater prescribed insulin dose was associated with worse control independently of age and PDSN. Thus, PDSNs did not gain improved control through advising more insulin. It seems likely that

prescribers recommended more insulin in response to rising A1C from reduced compliance. Nurses generated increased contacts between clinic and child/family. Their supportive and educational role may achieve better glycemic control. Their application of other developments in care might also contribute. Children aged >10 years were the ones who showed improvement. PDSNs may influence adverse behavioral factors operative in adolescence.

In 2001, Welsh centers without PDSNs mostly had sessions of time from adult diabetes nurses. The presence of PDSNs reduces median length of stay for children with newly diagnosed diabetes and reduces clinic nonattendance (15). Our study suggests an influence on A1C. We speculate that the benefit occurred from improved self-care in older children.

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M.O'H. conceived the project, liaised with pediatric units to collect data, and undertook initial analysis. J.N.H. carried out the analysis presented here and drafted the manuscript.

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