INSULIN PUMP THERAPY FROM DIAGNOSIS OF TYPE 1 DIABETES

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A growing experience indicates that continuous subcutaneous insulin infusion (CSII) is the best available means of insulin replacement therapy for patients with type 1 diabetes (T1DM). CSII has an improved quality of life compared to that obtainable using multiple daily injections (MDI) and less risk of hypoglycemia. We reasoned that implementation of CSII at time of diagnosis should therefore be evaluated. We have initiated a formal study to test the feasibility and possible metabolic benefits of this approach. Fifteen pediatric patients (average age = 12.9 years at diagnosis) and one adult patient (61.7 years) were started on Animas insulin pumps within their first month after diagnosis of T1DM. All patients/families were receptive to CSII and proved to be able to learn pump mechanics as well as patients with established T1DM. All have achieved excellent metabolic control without significant hypoglycemia, with blood sugars in the near-normal range thus far (up to 6 months). While this treatment protocol is initially time-intensive for the diabetes team, it eventually becomes time-saving since there are fewer educational requirements thereafter. Furthermore, CSII is anticipated to be cost-effective by decreasing costs associated with hypoglycemic events and diabetes-related hospitalizations. In our 16 patients, good metabolic control has been achieved with modest exogenous insulin requirements, and all have expressed satisfaction with pump therapy. Now that we have shown that CSII is feasible as the initial therapy for T1DM, further studies are required to determine whether there is a significant metabolic and psychosocial benefit from this approach.

INTRODUCTION

Various studies have demonstrated a beneficial effect of intensive insulin therapy on pancreatic β cell function through the induction of β cell "rest" (1, 2). Suppression of β cell function at the time of diagnosis of immune-mediated (type 1) diabetes (T1DM) may render insulin-producing cells less susceptible to immunological destruction because of their lowered expressions of islet cell autoantigens such as glutamic acid decarboxylase (GAD_{65}) and the tyrosine phosphatases (IA-2 and IA-2B) on resting β cells. This would have the effect of making the β cells less immunologically "visible" to the immune system that had been reacting against them (3). Schnell et al (4) demonstrated that as initial treatment for patients with newly diagnosed type 1 diabetes, high dose IV insulin infusions and intensive insulin therapy were both effective in preserving insulin secretory capacity after a one-year follow-up period. Preservation of the pancreatic β cells from complete destruction allows continued endogenous insulin secretion with physiological signals, which is important in reducing metabolic disturbances and maintaining better metabolic control. The national Diabetes Control and Complications Trial (DCCT) has already documented that tight diabetes control can significantly reduce the development of complications (5). In light of this, it is our view that good diabetes control is important to achieve from the time of diagnosis, even in children, and that the most effective method of accomplishing this is by continuous subcutaneous insulin infusion (CSII). This also streamlines the education process, as there is only one paradigm that patients and families would ever need to learn.

STUDY AIMS

Aim 1

To demonstrate that initiation of continuous subcutaneous insulin infusion (CSII) using an insulin pump as an initial therapy at time of diagnosis of T1DM is feasible, will lead to enhanced educational efficiency, and will produce better metabolic control with fewer episodes of hypoglycemia than will standard multi-dose SQ insulin replacement injections (MDI), over a 1-2 year follow-up period.

Aim 2

To demonstrate that the use of CSII immediately after the onset of T1DM will result in the improved preservation of pancreatic β cell function compared to conventional multi-dose insulin therapy, over a 1-2 year follow-up period. *(work in progress)*

METHODS

- Study personnel: Diabetes MD (2), Diabetes NP, Nutritionist (part-time), Pediatric Endocrinology team as backup (Fellows, MD's), office staff.
- Subjects/families approached, study explained, and consent obtained.
- Baseline 3-hour Mixed Meal Tolerance Test (MMTT) done on most, BG's and C-peptides drawn.
- Subjects started on CSII using a loaner pump within first month of diagnosis of T1DM.
    - Inpatients started straight on insulin (n=4).
    - Outpatients started on saline (n=11), and returned within 1 week for switchover to Humalog insulin.
- All pump training done by Diabetes NP; CHO counting taught by Nutritionist and reviewed by Diabetes Team.
- First training session: explanation of basal/bolus therapy, pump mechanics, frequency of changing pump infusion sets/cartridges & rotation of sites, basic CHO counting (1½ - 2 hours). Order for pump placed.
- Second training session (3-7 days later): review of material covered in first session, troubleshooting hypoglycemia & hyperglycemia, frequency of SBGM, who to call and when (30-45 min.).

- Initially intensive follow-up:
    - Diabetes NP on call until 11pm-midnight for first day on CSII with insulin (for outpatients), Fellow on call covered rest of night.
    - Daily phone calls from patient to Diabetes NP for first 2 days, then spaced to every few days to weekly to prn with increased patient/family comfort and documented stability of BG's.
- Patient switched over from loaner pump to their own pump upon receipt of own pump, often in clinic, and returned loaner pump to Diabetes Team.
- Clinical follow-up: 1 month after initiation of CSII, then every 3 months thereafter.
- Study follow-up: 3-hour MMTT q6 months with BG's & C-peptides drawn. Pump d/c'd at 6am for scheduled 9am MMTT; nothing to eat or drink after midnight the night before, last bolus no later than 5am.

RESULTS

n	16
Average duration of T1DM (months)	4.25 ± 2.60
# of dropouts	0

DEMOGRAPHICS
(n=15)*

Age at diagnosis (years)	12.9 ± 4.7
% Male	86.7%
HbA1c at diagnosis (%)	10.7 ± 2.9
u/kg at diagnosis	0.58 ± 0.29
% on MDI	86.7%
Duration of MDI (weeks)	2.06 ± 1.44

*Demographics do not include one adult patient, age 61.7 years at diagnosis, F, HbA1c at diagnosis not available, started straight on CSII, 0.30 u/kg/day

t = 3 months

n	6
u/kg/day	0.34 ± 0.14
HbA1c (%, n=3)	6.03 ± 0.31

t = 6 months

n	2
u/kg/day	0.13 ± 0.08
HbA1c (%)	5.25 ± 0.25

ANECDOTAL INDICATORS OF SUCCESS

- For patients on CSII who had been on injections (n=13), none wanted to return to MDI.
- BG seldom outside range of 50-140 mg/dl for any patient.
- HbA1c's at 6 months after diagnosis in normal range.
- Most patients with no symptomatic hypoglycemia.
- Correction factors hardly being used by 3 months' duration of disease, if at all.
- Two patients reported not having to bolus for food for some duration of time because BG's (measured 4+x/day) were all in target range. Basal rates decreased in these patients and bolusing encouraged.
- Pump "failure" (n=2 – batteries died and repeated occlusion alarms) managed successfully over the phone using both diabetes team and pump company's customer support line.
- Two patients worried/anxious because they saw one blood sugar in the low 200's!
- Patients able to eat birthday cake, participate in activities with friends, and sleep in without worry.
- No problems with insurance companies in ordering patient's own pump, as long as HbA1c available.

CONCLUSIONS

- While initially intensive and time-consuming for the health care team, initiation of CSII at time of diagnosis of type 1 diabetes is both feasible and safe.
- CSII is acceptable and actually preferred over MDI as treatment for type 1 diabetes in this population.
- Further research needs to be done to determine the metabolic and psychosocial effects of such therapy in comparison to MDI.

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