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A pilot study to assess utility of changes in elements of the Diabetes Impact Management Scale in evaluating diabetic patients for progressive nephropathy

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Abstract

A prospective study involving the use of the Diabetes Impact Management Scale (DIMS) in individuals with diabetic nephropathy as part of an interventional study of pulsatile intravenous insulin infusion therapy is used to define the utility of repeated subjective DIMS testing. We hypothesized that repeated use of such an evaluation would correlate well with other objective end points. The DIMS was administered at baseline and 12 months for 19 participants randomized to receive either standard insulin treatment of 3 to 4 injections of insulin daily or standard insulin treatment plus an additional day per week of 3 intravenous pulses over an 8-hour period. Measures of glycemic control, renal function, hemostatic factors, hemodynamics, left ventricular mass, and function were assessed at baseline and 12 months. Of 44 questions on impact of diabetes management, only 12 (5 reflecting physical and 7 reflecting emotional status) showed significant change from baseline to 1 year. Changes in the 5 physical questions related to neurologic status correlated with stable creatinine (P = .0001), stable creatinine clearance (P = .0001), and decrease in left ventricular hypertrophy (P =.0117). Repeated use of an abbreviated, standardized subjective instrument uncovered changes in quality of life that correlated with differences in renal function and left ventricular mass over 12 months. Further use of such an instrument may help us focus treatment for maximum impact.

1. Introduction

Multiple instruments developed to assess quality of life in patients with diabetes mellitus rarely concentrate on renal function in either a cross-sectional or a longitudinal fashion. In this study, we present results of a prospective intervention on self-assessment by the Diabetes Impact Management Scale (DIMS) in individuals with diabetic nephropathy with emphasis on the difference between patient's subjective reporting of emotional vs physical status.

The intent of this study was to assess quality of life as determined by DIMS in a prospective randomized study involving pulsatile intravenous insulin infusion [1,2] added to standard care in patients with type 1 diabetic nephropathy followed for 12 months. We hypothesized that repeated use of a simple subjective impact evaluation tool would give information that would correlate with objective changes in clinical and laboratory patient status.

Utility of quality of life scales relates to ease of administration and correlation with objective findings. In scales with large numbers of questions, reduction in the number of questions may be more efficient. Single items or abbreviated scales may be just as valid as their long-form scales [3-5]. In this study, we planned to determine responses that discriminated deterioration or improvement in objective cardiac or renal function during the trial.

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2. Methods

Investigators participating in a multicenter study, with the goal of optimizing glycemia and blood pressure control, saw patients with type 1 diabetes mellitus weekly for 1 year. Individual patients were randomized to either a control group or a treated group. Both groups of patients received 3 to 4 subcutaneous insulin injections per day. The treated group received, in addition, a pulsed intravenous insulin infusion consisting of three 1-hour infusions in a pulsatile fashion over one 8-hour period each week. A description of the full protocol has been previously published [6]. Laboratory investigations included changes in serum creatinine, creatinine clearance, total urinary protein per 24 hours, hemoglobin, glycohemoglobin, and advanced glycated end products. Additional correlations were calculated with left ventricular mass, serum fibrinogen, fibrinolytic activity, factor VII level, plasminogen activator inhibitor 1, von Willebrand factor, diastolic function (by E/A ratio, representing early–late atrial diastolic flow rate), systolic function (fractional fiber shortening, ejection fraction), mean arterial pressure, day to night mean arterial pressure ratio, and measures of time and frequency spectral analysis of 24-hour ambulatory electrocardiographic monitoring (all results not shown) [7-10].

A subgroup of 19 patients seen at the Joslin Diabetes Center (12 men, 7 women) participated in this study [7-10]. The patients were randomly assigned to a control group (n = 9) or an intravenous pulsed insulin infusion group (n = 10). Baseline characteristics and clinical profile are shown in Table 1.

All patients completed the 44-question DIMS at baseline and 12 months. Validation of the methodology and scoring of this instrument in a standardized manner has been previously published [11-13].

Each patient's DIMS response at 12 months was compared with his/her individual baseline response to minimize interindividual variability. All patients had at least a 75% question response rate on both the baseline and 12-month questionnaires. Because missing data occurred for different questions in the 2 study groups, we created a data set for analysis where each missing value was replaced with the mean response for that question for the total group [14,15]. Thirty-two of the 44 questions showed no significant change between baseline and 12 months for the group ($P \geq .10$) and were excluded from further analysis. The 12 remaining questions (Table 2) were then classified by the investigators as reflecting 5 physical and 7 emotional responses. Annual changes of individual patient scores were calculated for each of the 2 response question groups and were correlated with changes in laboratory values measured during the study.

Data analyses were performed using SAS Version 8.2 (SAS Institute, Cary, NC). Significance of annual responses from zero was determined by Student paired *t* tests. Tests of significance between groups of data were determined by Student unpaired *t* tests. Frequency data were compared using Fisher exact test. Pearson product moment correlations were used to determine the relationships between variables. Values are reported with standard error of the mean as a measure of dispersion. A *P* value not exceeding .05 was considered statistically significant.

Table 1
Demographics: baseline variables

Variables	N = 19
Age (y)	40.3 ± 2.1
Duration of DM (y)	26.8 ± 1.2
Body weight (kg)	73.0 ± 2.2
Serum creatinine (mg/dL)	1.8 ± 0.1
Creatinine clearance (mL/min)	57.9 ± 4.5
24-h proteinuria (g/d)	3172 ± 554
Hemoglobin (g%)	13.6 ± 0.4
Hemoglobin A_{1c} (%)	9.3 ± 0.3
Advanced glycated end products (units)	12.0 ± 1.9

DM indicates diabetes mellitus.

Table 2
Twelve of 44 questions showed a significant change in response from baseline to 1 year

During the past month	
• Did burning, tingling, pain, or numbness bother you in your hands?	P
• Have you been bothered by blurring of vision?	P
• How often did you have diarrhea?	P
• How often were you able to function sexually as well as you wanted to?	P
• Have you been bothered by feeling faint/dizzy on sitting up/standing up?	P
• How much of the time were you lacking enough energy?	E
• Have you felt optimistic about your diabetes?	E
• During the past month, how well have you slept?	E
• Have you felt depressed during the past month?	E
• Have you eaten what you wanted to?	E
• Have you participated in and enjoyed family life?	E
• How often have you been able to function well in your usual occupation?	E

Five questions relate to physical and 7 to emotional status during the 1 year of follow-up. Responses were based on a 6-point scale (worst case response being 6 points, best case receiving 1 point): never, rarely, sometimes, often, usually, and always. The neuropathy question was scored on responses including no discomfort, mild, moderate, severe, nearly unbearable, and unbearable (worst case response being 6 points, best case receiving 1 point). P indicates physical; E, emotional.

3. Results

Using standardized scoring of the DIMS instrument, we found no statistically significant relationship between changes in the baseline and 1-year DIMS scoring for 44 questions and simultaneous change in renal function or resultant diabetes control (*P* = not significant).

When the 12-question score Δ was reviewed (Table 3) with respect to change in renal function (serum creatinine,

Table 3
Relationship of changes in questionnaire response to glycemia control and changes of renal function

	12 Questions (mean ± SEM)	*P* value	5 Questions, physical	*P* value	7 Questions, emotional	*P* value
Glycemia control						
By Δ HbA_{1c}						
>1% decrease (n = 7)	−3.95 ± 1.65	.2602	−2.62 ± 1.11	.7376	−1.33 ± 1.13	.1297
≤1% decrease (n = 10)	−0.56 ± 2.56		−1.91 ± 1.90		1.36 ± 1.18	
By Δ AGE						
≥4 decrease (n = 7)	−6.21 ± 2.14	.0147	−3.46 ± 1.96	.1644	−2.76 ± 0.82	.0102
<4 decrease (n = 6)	2.08 ± 1.84		0.10 ± 1.17		1.98 ± 1.36	
Renal function						
By Δ Cr						
<0.2 mg/dL increase (n = 10)	−5.85 ± 1.50	.0005	−4.84 ± 0.81	.0001	−1.01 ± 1.06	.1713
≥0.2 mg/dL increase (n = 9)	3.06 ± 1.39		1.87 ± 1.03		1.19 ± 1.12	
By Δ CrCl						
<10 mL/min loss (n = 6)	−4.18 ± 1.52	.0056	−4.03 ± 0.75	.0001	−0.15 ± 1.06	.7510
≥10 mL/min loss (n = 13)	3.88 ± 1.75		3.47 ± 1.00		−0.42 ± 1.11	
By Δ Hgb						
≤1 g% decrease (n = 11)	−5.12 ± 2.54	.2209	−4.24 ± 1.01	.0824	−0.88 ± 2.04	.6454
> g% decrease (n = 8)	−1.09 ± 1.63		−1.29 ± 1.21		0.20 ± 0.88	
Cardiac status						
By LV mass						
≥20 g decrease (n = 10)	−5.55 ± 5.18	.0140	−7.23 ± 4.99	.0117	1.21 ± 3.60	.2717
<20 g decrease (n = 6)	1.68 ± 4.62		0.80 ± 3.30		0.90 ± 4.00	
By E/A						
>0 (improved)	−3.91 ± 5.36	.4389	−3.94 ± 2.72	.2583	−0.42 ± 3.85	.9973
≤0	1.46 ± 6.96		−1.03 ± 5.50		−0.43 ± 3.43	

Scores are 1-year minus baseline value; thus, a negative value corresponds to improvement. HbA_{1c} indicates hemoglobin A_{1c}; Cr, serum creatinine; CrCl, creatinine clearance; LV, left ventricular.

creatinine clearance, whole blood advanced glycated end products [AGE]), patients with more stable renal function expressed responses reflecting a significant improvement. There was no significant relationship between the 12-question total score and proteinuria, whole blood hemoglobin, or glycohemoglobin A_{1c}. The 5-question physical status DIMS score accounted for the statistically significant difference between study patients defined by renal function and insulin administration. For the 7-question emotional response, we observed a statistically significant relationship between change in score and change in 24-hour protein excretion and advanced glycated end products, but not serum creatinine or creatinine clearance.

Of the 19 patients, 13 had improved DIMS and 10 had stable creatinine. Of the 13 patients with improved DIMS, 10 had a stable serum creatinine (≤0.2 mg/dL over 1 year) and 9 (of 12) had decreased left ventricular mass. Of the 6 with no improvement in DIMS, none had a stable serum creatinine and 1 (of 4) had a decrease in left ventricular mass. There were significant relationships between improvement in the DIMS 12-question (−5.55 ± 1.64 vs 1.68 ± 1.89, $P = .0140$) or 5-question (physical; −6.84 ± 1.11 vs −2.67 ± 1.35, $P = .0117$) but not the 7-question (emotional; −3.54 ± 1.03 vs −3.31 ± 1.63, $P = .2717$) results and decrease in left ventricular mass during this 1-year study. For the cardiovascular measurements, there was no significant relationship between changes in the results of the 12-, 5-, or 7-question DIMS score and changes in serum fibrinogen, fibrinolytic activity, factor VII level, plasminogen activator inhibitor 1, von Willebrand factor, left ventricular diastolic function (by E/A ratio), left ventricular systolic function (fractional fiber shortening, ejection fraction), 24-hour mean arterial pressure, day to night mean arterial pressure ratio, or measures of time and frequency spectral analysis of 24-hour ambulatory electrocardiographic monitoring.

4. Discussion

We reasoned that questions relating to the subjective physical as opposed to emotional impact of diabetic nephropathy or its management might be more sensitive to the objective laboratory changes observed in individuals. Of the 5 physical questions, 3 relate directly to autonomic, 1 to peripheral, and 1 potentially to cranial nerve function [16]. We anticipated as well that changes in the individual responses to the DIMS would be associated with measurable changes in the kidney and the heart. Physical, but not emotional, responses corresponded nearly identically to stability of renal function and reduction of left ventricular mass (Table 3). The response to physical status questions was not associated with any improvement in hemoglobin or

control of diabetes as assessed by glycohemoglobin concentration or advanced glycated end products.

The current pilot study was limited to type 1 diabetes mellitus patients with abnormalities in renal function. The findings cannot be generalized to type 1 diabetes mellitus patients with normal renal function or to individuals with type 2 diabetes mellitus. Our results, however, suggest that repeated use of abbreviated DIMS (rather than the standard long form) questionnaires may provide useful information in prospective interventional studies.

A review of the literature suggests that the treatment described in this pilot study is a unique effort to use repeated standardized questions to follow subtle subjective physical responses of diabetic individuals with early cardiac and renal pathology. We have correlated changes in DIMS score with changes in renal and cardiac function as part of a prospective treatment protocol. We found 5 attributes of neuropathy that followed a measurable pattern in micro- and macrovascular diabetic complications.

Some studies have demonstrated little relevant clinical value for the full DIMS tool. Other studies have focused on the efficiency of smaller number of questions that are more likely to speak directly to outcome results [3-5]. We believe that this is due to the static produced by questions that are only loosely associated with physical illness, though certainly related to perceived quality of life.

Parkerson et al [17] found no effect of intensity of insulin therapy or duration of diabetes on a health-related quality of life survey. They suggested that certain comorbidities such as marital status, medications, and hemoglobin level were the most reliable predictors of quality of life. Kurella et al [18] found a significant association between gradations of renal dysfunction and sleep deprivation using a quality of life scale. We found no statistically significant relationship between method of administration of insulin or progression of renal dysfunction and the single question on sleep in our study.

In a large population (10 525 participants studied in the Australian Diabetes, Obesity, and Lifestyle Study), Chow et al [19] described statistically significant relationships, using a Medical Outcome 36-Item Short Form, between mental health impairment in younger respondents and physical function impairment in older respondents, according to the degree of renal dysfunction. This study was a single point of time cross-sectional analysis, as was that of Kusek et al [20] who reported a significant relationship between physical status responses and levels of renal function in African American patients.

In a longitudinal study, Gorodetskaya et al [21] followed 115 (50% with type 2 diabetes mellitus) people with chronic renal disease. They observed an association between decline in renal function and an increased burden on physical and mental health (Kidney Disease Quality of Life–36 question: burden of kidney disease and effects of kidney disease subscales) over a 6- to 24-month period (mean, 10 months) in patients approaching and entering maintenance dialysis therapy.

Thirty-two questions of the 44 in the full DIMS did not change significantly over 12 months and therefore gave little information related to changes in renal or cardiac status in our patients. Changes noted in the response to 7 questions relating to emotional issues of daily life did not correspond to changes in cardiorenal measures. However, the 5 questions dealing with physical status (neurologic features) changed over 12 months and corresponded closely to changes in cardiac and renal measures. Thus, use of 5 questions demonstrating improved neurologic status may be a reliable indicator of cardiac and renal measures undergoing favorable responses to therapy over the same period. Because the changes noted for perceived neurologic function paralleled those in the kidney and heart, a common mechanism may be considered.

We believe this to be a potentially important observation in the clinical evaluation of patients with progressive nephropathy, as the full DIMS tool may obscure some important results with respect to the progressive changes of diabetes. If this finding is confirmed in larger data sets, it may lead to improvement in the precision and utility of the DIMS for further clinical research in patients with type 1 diabetes mellitus.

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