

# Blood glucose awareness training in Dutch type 1 diabetes patients: one-year follow-up

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## ABSTRACT

**Background:** American studies have shown positive effects of Blood Glucose Awareness Training (BGAT) on the recognition of hypoglycaemia. We evaluated the effects of BGAT among Dutch patients, and compared individual training with training in the original group format.

**Methods:** Fifty-nine type 1 diabetes patients participated in BGAT in either a group (n=37) or an individual (n=22) setting. Before and one year after training they performed up to 70 measurements, two to four a day, at home on a handheld computer. During each measurement they estimated their blood glucose (BG), indicated whether they would be participating in traffic and raised their BG on the basis of their estimation, and then measured their BG. The incidence of severe hypoglycaemia and traffic accidents was also assessed.

**Results:** BGAT had positive effects on hypoglycaemic awareness, decisions not to drive and to raise the blood glucose during hypoglycaemia, severe hypoglycaemic episodes and traffic accidents. The accuracy of BG estimations only improved after group training, while after individual training patients tended to measure more or more extremely high BG values.

**Conclusion:** The training improved awareness of hypoglycaemia, and seems worthy of implementation in the Netherlands.

## KEYWORDS

Awareness, driving, hypoglycaemia, handheld computers, traffic accidents, training

## INTRODUCTION

In type 1 diabetes mellitus, intensive insulin therapy is effective in delaying late complications of the diabetes,<sup>1</sup> but also increases the frequency of hypoglycaemia.<sup>2</sup> Timely recognition and correction of hypoglycaemia is important to avoid severe hypoglycaemic episodes. A quarter of the patients with type 1 diabetes have difficulty recognising hypoglycaemia in time,<sup>3</sup> they suffer from 'reduced hypoglycaemic awareness'.

Cox *et al.*<sup>4-9</sup> developed 'Blood Glucose Awareness Training' (BGAT) to help patients recognise, correct, anticipate and prevent blood glucose (BG) values outside of the normal range. During eight group sessions, information is provided on autonomic symptoms, neuroglycopenic symptoms, mood symptoms, hyperglycaemic symptoms, and the influence of stress, food, insulin and exercise on the BG. Participants exchange experiences and do exercises, for instance to examine the effect of neuroglycopenia on cognitive and motor performance. In between the sessions, patients keep a symptom diary to examine the relationship between their personal symptoms and blood glucose levels. They estimate their BG level before measuring it, and get direct feedback on the accuracy of their estimation from a coloured grid with safe and dangerous estimation zones. In the short term, BGAT improved the ability to estimate BG levels<sup>5-7-9</sup> and the detection of hypoglycaemia<sup>5</sup> in American samples. A Dutch adaptation of BGAT improved BG estimations, the number of hypoglycaemic readings, and fear of hypoglycaemia directly after the training.<sup>10</sup> In the longer term (12 months or more), BGAT reduced the number of road traffic accidents,<sup>4,6</sup> while positive effects on other measures (such as hypoglycaemia

detection) were maintained.<sup>4</sup> There were no differences between the effects six months and 12 months after BGAT.<sup>4</sup> The present study evaluated the effects of a Dutch adaptation of BGAT-III (3rd version of BGAT),<sup>11</sup> and compared training in the original group format with individual training, which may be more easily incorporated into the hospital routine, and more tailored to an individual patient's situation, preferences and concerns. Shortly after BGAT, only handheld computer measures were collected. We observed no significant effects on the recognition of hypoglycaemia or any other measure, with the exception of wiser decisions to raise the BG and not to drive during hypoglycaemia.<sup>12</sup> Aims of the present study were to assess the effects of BGAT one year after training on (handheld computer) measures of BG perception, decisions not to drive and to raise the BG during hypoglycaemia; diabetes regulation; and on (questionnaire) measures of hypoglycaemia related worry, severe hypoglycaemia, and self-monitoring of the blood glucose (SMBG). We furthermore assessed possible differences between the effects of individual and group BGAT.

## MATERIALS AND METHODS

### Patients

Patients in the sample participated in a research project on reduced hypoglycaemic awareness.<sup>13</sup> They were diagnosed with type 1 diabetes mellitus before the age of 40 and at least two years prior to invitation, had become insulin dependent within 18 months after diagnosis, used multiple injections a day or continuous subcutaneous insulin infusion (CSII), were under 65 years of age, and had no serious physical or psychological comorbidity. All 123 patients in

the original sample were invited to participate in the training. Baseline characteristics of participants and those who declined participation are displayed in *table 1*.

Participants were a mean of five years older ( $p=0.05$ ) and had more impaired hypoglycaemic awareness than patients who did not participate in BGAT ( $p=0.00-0.03$ ).

### The intervention

BGAT-III was adapted and translated into Dutch by the Dutch Psychosocial Diabetology Working Group.<sup>11</sup> The original eight classes were reduced to six weekly sessions. The chapters on food, insulin and exercise were integrated into one chapter, as it was assumed that these topics were covered well enough by the standard diabetes education available for every patient in the Netherlands.

Group BGAT was offered in the evenings, to small groups of five to nine patients, by a diabetes educator and a psychologist. The six weekly sessions lasted 1.5 to 2 hours. Individual BGAT was offered in the daytime, and consisted of up to six 30-minute sessions with a diabetes educator. While the same manual was used for both interventions, individual training was more tailor-made: topics of specific importance to an individual patient received more attention, and appointments were scheduled in accordance with the patient.

### Procedure

Patients were interviewed at the hospital, completed questionnaires, and a blood sample was sent to the laboratory for HbA<sub>1c</sub> assessment (HPLC technique).<sup>15</sup> They then performed up to 70 handheld computer (HHC, Psion P-250, Hoofddorp, the Netherlands) measurements at home, two to four measurements a day, over a four to six week period.

**Table 1**  
*Mean (SD) baseline characteristics*

	NO TRAINING (N=64) <sup>a</sup>	GROUP BGAT (N=37)	INDIVIDUAL BGAT (N=22)	P TRAINING VS NO TRAINING <sup>b</sup>	P GROUP VS INDIVIDUAL <sup>b</sup>
Age (years)	39.3 (11.8)	43.7 (9.2)	42.5 (11.1)	0.05	0.65
Gender	45% male	68% male	50% male	0.08	0.18
Education <sup>c</sup>	5.1 (2.2)	5.6 (1.9)	4.8 (2.1)	0.74	0.14
Duration of DM (years)	20.2 (10.9)	23.9 (9.4)	21.3 (12.1)	0.17	0.36
HbA <sub>1c</sub> (%)	7.9 (1.4)	7.5 (1.4)	7.5 (1.0)	0.11	0.93
Neuropathy <sup>d</sup>	1.4 (1.7)	1.4 (1.8)	1.3 (1.4)	0.86	0.84
CSII	6%	11%	5%	0.64	0.40
Hypo awareness 0-10 <sup>e</sup>	6.4 (2.8)	4.0 (2.4)	5.2 (2.7)	0.00	0.09
BG level of detecting hypo <sup>e</sup>	3.7 (1.0)	2.7 (1.0)	2.7 (0.8)	0.00	0.97
Accuracy index <sup>f</sup>	19.0 (22.5)	7.7 (15.4)	13.1 (16.2)	0.01	0.21
Recognised hypoglycaemia <sup>f</sup> (%)	45.6 (31.0)	31.7 (22.8)	34.8 (25.6)	0.03	0.67
No. of severe hypos last year <sup>e</sup>	3.0 (6.2)	6.6 (7.0)	6.6 (6.9)	0.03	0.98

<sup>a</sup>Participants who did not receive blood glucose awareness training (BGAT) were not included in the present study (see discussion). <sup>b</sup>Significance of independent sample t-test, except for gender and CSII: significance of  $\chi^2$  test. <sup>c</sup>Educational level ranged from 1 (primary school) to 8 (university). <sup>d</sup>Three cardiovascular function tests were used: heart rate response to standing up, heart rate response to deep breathing and blood pressure response to standing up.<sup>14</sup> A higher score reflects more severe autonomic neuropathy. <sup>e</sup>Self-report.<sup>14</sup> <sup>f</sup>Handheld computer data.

They were instructed to perform these HHC measurements when they habitually checked their blood glucose, and when they expected their blood glucose to be high or low. During every HHC measurement, they estimated their BG, indicated whether they would raise their BG and whether they would participate in traffic on the basis of their estimation, and then determined their blood glucose level. They were lent a One Touch Profile blood glucose memory meter (Lifescan, Beerse, Belgium) to obtain uniform measurements. The study was not randomised because of practical considerations. Resources were limited, and some patients were not able to attend the group meetings during the evenings, while others were unable to attend individual sessions during the day. Therefore patients chose either group or individual BGAT, conform clinical practice. After BGAT, patients again performed HHC measurements and one year after BGAT they were asked to perform HHC measurements and to again complete questionnaires. All participants gave their written informed consent, and the Medical Ethics Committee of Leiden University Medical Centre (LUMC) approved the study.

### Outcome measures

#### *Handheld computers*

Only handheld computer (HHC) measurements that were not preceded by another measurement within two hours were used to calculate the aggregated HHC measures. Only data of patients with at least 30 measurements were used.

- Accuracy index (AI): This measure was developed, used and described by Cox *et al.*<sup>4,9</sup> It reflects the clinically relevant accuracy of blood glucose estimations on the HHC. The AI ranges from -100% to +100%, higher values indicate higher accuracy.
- Percentage of recognised hypoglycaemic episodes: The percentage of estimates below 3.9 mmol/l or within 20% of the measured BG, when the actual BG was lower than 3.9 mmol/l.
- Percentage of recognised hyperglycaemic episodes: The percentage of estimates above 10 mmol/l or within 20% of the measured BG when the actual BG was above 10 mmol/l.
- Low blood glucose index (LBGI):<sup>16,17</sup> The LBGI reflects the number and/or extent of low BG readings on the handheld computer. BG values >6.25 mmol/l receive a weighting of zero, while values of 6.25 mmol/l receive progressively increasing weights, until 100 at a BG of 1.1 mmol/l. These weights are then averaged. A higher LBGI reflects more frequent, or more severe, hypoglycaemia.
- High blood glucose index (HBGI):<sup>16,17</sup> The HBGI reflects the number and/or extent of high BG readings on the HHC. It is calculated in the same way as the LBGI, but now readings <6.25 mmol/l receive zero weighting,

and readings at 6.25 mmol/l progressively increasing weighting, up to 100 at a BG of 33.3 mmol/l. A higher HBGI reflects more frequent, or more severe, hyperglycaemia.

- Blood glucose risk index (BGRI):<sup>16,17</sup> LBGI + HBGI. The BGRI increases with the number and/or extent of extreme BG values (HHC).
- Judgement on driving during hypoglycaemia: The percentage of decisions to drive while the actual BG was below 3.6 mmol/l.
- Judgements on raising the BG during hypoglycaemia: The percentage of decisions to raise the BG (HHC) while the actual BG was below 3.9 mmol/l.

### Questionnaire measures

- Frequency of self-monitoring of the blood glucose (SMBG) was assessed by the open questions: 'How many days of the week do you measure your BG? On these days, how often do you measure your BG?' The mean number of measurements a day was calculated.
- Frequency of severe hypoglycaemic episodes during the preceding year was assessed by the open question: 'During the last year, how often did you experience a severe hypoglycaemic episode during the day which you were unable to correct by yourself?' The same question was asked about episodes during the night. The numbers of episodes during the day and night were added up.
- Fear of hypoglycaemia (HFS): The Hypoglycaemia Fear Survey (HFS-95) worry subscale<sup>18,19</sup> is a validated measure of hypoglycaemia-related worry. Patients answer 13 items on a 0 (never) to 4 (always) scale. Scores range from 0 to 52, high scores reflect increased worry about hypoglycaemia.
- Traffic accidents: 'During the previous 12 months, how often have you been involved in a traffic accident?' (open question)

### Statistics

SPSS 6.0 was used to analyse the data. All variables were normally distributed, except for SMBG. Nonparametric tests were used for this variable. Descriptive statistics and frequencies were used to describe the sample. T-tests (Mann-Whitney U) and  $\chi^2$  tests were used to assess differences between participants *vs* nonparticipants and patients in group *vs* patients in individual training. Repeated measures analysis (2 (time: pre BGAT *vs* one year after BGAT) x 2 (treatment: group *vs* individual training) ANCOVA, with the baseline value as a covariate) was used to assess the significance of change over time and the possible differential effect of individual and group treatment.  $P < 0.05$  was considered significant. When the time x treatment interaction was significant, post hoc within-group comparisons were made, by means of paired t-tests.

## RESULTS

Fifty-nine patients participated in BGAT, 37 in a group and 22 in an individual setting. Baseline characteristics of the participants were displayed in *table 1*. No baseline differences between patients in group training vs patients in individual training emerged, but there was a trend for patients in individual training to self-report higher awareness of hypoglycaemia ( $p=0.09$ ). Differences between them at more objective measures of hypoglycaemic awareness did not reach significance.

### Handheld computer data

Valid handheld computer measurements both at baseline and at follow-up were completed by 36 patients (61%; 24 group, 12 individual). *Table 2* shows baseline and follow-up HHC data and HbA<sub>1c</sub>, the significance of change after BGAT (time effect), and the significance of the differential effect of the two treatment conditions (interaction term).

After BGAT, the percentage of recognised hypoglycaemic episodes ( $p=0.02$ ), decisions not to drive during hypoglycaemia ( $p=0.01$ ) and decisions to raise the BG during hypoglycaemia ( $p=0.02$ ) improved.

The change in scores after group and individual BGAT differed significantly for two measures: the accuracy index ( $p=0.04$ ) and the high blood glucose index ( $p=0.03$ ). Post hoc comparisons showed that the accuracy index improved after group BGAT (5.3 to 18.8,  $p=0.005$ ), but not after individual BGAT (13.6 to 11.7,  $p=0.75$ ). The high blood glucose index tended to deteriorate after individual BGAT (HbGI 11.4 to 13.4,  $p=0.09$ ), but not after group BGAT (10.7 to 9.9,  $p=0.25$ ).

### Questionnaire data

Questionnaires were returned by 49 patients (83%, 31 group, 18 individual). *Table 3* shows their baseline and follow-up scores on the questionnaire variables, the significance of change after BGAT (time effect), and the significance of the differential effects of the two treatment conditions (interaction term).

After BGAT, the number of severe hypoglycaemic episodes decreased ( $p=0.001$ ), patients more often performed self-monitoring of the BG (SMBG,  $p=0.000$ ), and patients were less often involved in a traffic accident ( $p=0.04$ ) than before training. There were no significant differences between the effects of individual or group BGAT on the questionnaire measures.

## DISCUSSION

To our knowledge, this is the first study to assess long-term effects of BGAT in a European sample. American long-term studies on the effects of BGAT reported improved detection of high and low BG readings; wiser judgments concerning BG corrections and not driving during hypoglycaemia; reduced ketoacidosis, severe hypoglycaemia, and traffic accidents; improved quality of life and diabetes knowledge and reduced worry about hypoglycaemia one year after the training;<sup>4</sup> fewer car crashes at a mean of five years after the training;<sup>6</sup> and improved BG estimations and hypoglycaemic awareness a mean of five years after training when patients had received a booster training.<sup>6</sup> The present study partly replicated these positive results, despite a modest sample size. We observed significant

**Table 2**

Mean (SD) handheld computer scores and HbA<sub>1c</sub> before and one year after blood glucose awareness training (BGAT)

	GROUP BGAT (N=24)		INDIVIDUAL BGAT (N=12)		P TIME	P INTERACTION	N
	BASELINE	FOLLOW-UP	BASELINE	FOLLOW-UP			
Accuracy index (%)	5.3 (15.2)	18.8 (18.9)	13.6 (11.7)	11.7 (10.6)	0.12	0.04	36
Recognised hypoglycaemic episodes (%)	27.9 (24.6)	42.1 (23.7)	35.3 (33.7)	42.4 (25.6)	0.02	0.40	34 <sup>a</sup>
Recognised hyperglycaemic episodes (%)	33.9 (23.4)	38.9 (27.5)	40.1 (20.0)	39.8 (18.7)	0.55	0.49	36
HbA <sub>1c</sub> (%)	7.3 (1.2)	7.3 (1.3)	7.2 (0.9)	7.5 (1.1)	0.30	0.22	44
Low blood glucose index	3.8 (1.4)	4.2 (3.0)	4.1 (2.7)	3.1 (1.8)	0.61	0.15	36
High blood glucose index	10.7 (4.8)	9.9 (6.4)	11.4 (4.6)	13.4 (7.1)	0.33	0.03	36
Blood glucose risk index	14.5 (4.6)	14.1 (5.8)	15.5 (3.7)	16.5 (6.3)	0.61	0.31	36
Not driving during hypoglycaemia (%)	43.5 (29.7)	57.8 (27.8)	36.1 (29.8)	47.2 (27.1)	0.01	0.73	35 <sup>b</sup>
Raising BG during hypoglycaemia (%)	51.3 (29.7)	64.3 (33.5)	41.5 (31.1)	54.9 (27.9)	0.02	0.98	35 <sup>b</sup>

Significance of change after BGAT ('time') and significance of the difference in effect of the treatment conditions ('interaction'). <sup>a</sup>Two patients measured less than two hypoglycaemic episodes. <sup>b</sup>One patient did not measure any hypoglycaemic episodes.

**Table 3**  
Mean (SD) questionnaire scores at baseline and one year after blood glucose awareness training (BGAT)

	GROUP BGAT		INDIVIDUAL BGAT		P TIME	P INTERACTION	N <sub>a</sub>
	BASELINE	FOLLOW-UP	BASELINE	FOLLOW-UP			
HFS worry <sup>b</sup>	20.2 (11.3)	18.9 (10.1)	19.4 (11.3)	17.9 (11.9)	0.29	0.95	46
Severe hypoglycaemia <sup>c</sup>	7.9 (7.5)	1.7 (2.4)	6.6 (7.6)	.3 (8.5)	0.001	0.26	26
SMBG <sup>d</sup>	2.4 (2.0)	3.2 (1.7)	2.4 (1.5)	3.7 (1.6)	0.000	0.28	49
Traffic accidents <sup>e</sup>	0.3 (0.4)	0.1 (0.4)	0.6 (0.5)	0.2 (0.4)	0.04	0.32	33

Significance of change after BGAT ('time') and differential effect of the treatment conditions ('interaction'). <sup>a</sup>49 patients returned questionnaires, smaller n's are the result of missing data. <sup>b</sup>HFS = hypoglycaemia fear survey. <sup>c</sup>Number of reported severe hypoglycaemic episodes per year. <sup>d</sup>SMBG = times a day of self-monitoring of blood glucose. <sup>e</sup>Number of reported traffic accidents per year.

positive effects on the recognition of hypoglycaemia, decisions not to drive and to raise the BG during hypoglycaemia, the frequency of severe hypoglycaemic episodes, self-monitoring of the blood glucose, and traffic accidents. The present study had no control group and was not randomised. It is therefore uncertain if the observed improvements were due to the training *per se*. Nonparticipants were younger and tended to be more often female than participants, but did not differ from participants in diabetes-related characteristics. Unreported data of a small available control sample of patients who had not participated in BGAT showed that while participants improved, controls remained stable or deteriorated on most outcome measures. This strengthens our conclusion that BGAT may have had beneficial effects. Data on these control subjects were not presented here because at baseline, controls differed from participants in hypoglycaemic awareness, as was shown in *table 1*. They are available from the authors on request. Other studies also show that it is unlikely for patients to improve their BG estimations with the passing of time alone.<sup>7</sup> For these reasons, we are quite confident that the observed improvements could be attributed to BGAT.

The effects of training in the original group format were compared with the effects of individual training, and two differences emerged. Group training had positive effects on the accuracy of BG estimations while individual training did not. Furthermore, after individual training, patients tended to measure more frequent, and/or more extreme, high BG levels than at baseline (an undesired effect). Both findings indicate that group training was superior to individual training. Possibly the group process fostered an attitude change and the acceptance of information. The possible relationship between reduced awareness of hypoglycaemia (and even type 1 diabetes) and driving mishaps has been an area of recent debate.<sup>20-28</sup> In the present study, directly after BGAT, participants decided less often to participate in traffic when their BG was low.<sup>12</sup>

At follow-up, the rate of traffic accidents was reduced compared with baseline. In an American sample, reductions in traffic accidents were also reported six and 12 months after BGAT.<sup>4</sup> Although traffic accidents were measured by means of retrospective self-report, in our opinion, it seems unlikely that after BGAT patients would be unable to remember accidents to a lesser degree, or that they would be more reluctant to report accidents. We think it is likely that BGAT was able to reduce the rate of traffic accidents among participants.

While the present follow-up data showed positive results of BGAT, the data directly after training did not.<sup>10</sup> Intuitively, training effects would be expected to abate (rather than increase) with time, when no follow-up booster is provided. Directly after the training, changes in outcome measures were in the right direction, but did not reach statistical significance. Maintenance of BGAT effects up to one year after the training was also reported in two American studies.<sup>4,6</sup> We can think of two further explanations for the fact that the effects of the training were only significant at the follow-up measurement. First, directly after BGAT, after the baseline assessment and keeping the symptom diary during the training, patients were reluctant to use the handheld computers again. They were a bit 'fed up' with the effort of keeping note of BG readings and estimations, and answering additional questions. This may have influenced the results. Second, about a year after the training, one of the patients mentioned that right after the training, she was alert to specific symptoms that would tell her that her BG was low. At times she misjudged her BG level on the basis of these separate symptoms. After a while, however, she developed a type of 'overall feeling', which helped her to recognise hypoglycaemia more readily. During the year after the training, on the basis of her experience in monitoring BG symptoms, she may have developed intuition (skilled pattern recognition, understanding without a rationale),<sup>29</sup> which takes time to develop, and is generally considered an element of expertise.

## CONCLUSION

We observed significant improvements in clinically relevant measures one year after BGAT, despite a modest sample size. Group training should be preferred over individual training, but individual training also improved hypoglycaemic awareness. This adapted version of BGAT seems worthy of implementation in the Netherlands.

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## REFERENCES

1. The Diabetes Control and Complications Trial Research Group. Hypoglycemia in the Diabetes Control and Complications Trial. *Diabetes* 1997;46:271-86.
2. The DCCT Research Group. Epidemiology of severe hypoglycemia in the diabetes control and complications trial. *Am J Med* 1991;90:450-9.
3. Gerich JE, Mokan M, Veneman T, Korytkowski M, Mitrakou A. Hypoglycemia unawareness. *Endocr Rev* 1991;12:356-71.
4. Cox D, Gonder-Frederick L, Polonsky W, Schlundt D, Kovatchev B, Clarke W. Blood glucose awareness training (BGAT-2): Long term benefits. *Diabetes Care* 2001;24:637-42.
5. Cox D, Gonder-Frederick L, Polonsky W, Schlundt D, Julian D, Clarke W. A multicenter evaluation of Blood Glucose Awareness Training-II. *Diabetes Care* 1995;18:523-8.
6. Cox DJ, Gonder-Frederick L, Julian DM, Clarke W. Long term follow-up evaluation of Blood Glucose Awareness Training. *Diabetes Care* 1994;17:1-5.
7. Cox DJ, Gonder-Frederick L, Julian D, et al. Intensive versus standard BG awareness training (BGAT) with insulin-dependent diabetes: mechanisms and ancillary effects. *Psychosom Med* 1991;53:453-62.
8. Cox DJ, Gonder-Frederick LA, Lee JH, Julian DM, Carter WR, Clarke WL. Effects and correlates of Blood Glucose Awareness Training among patients with IDDM. *Diabetes Care* 1989;12:313-8.
9. Cox DJ, Carter WR, Gonder-Frederick LA, Clarke WL, Pohl SL. Blood Glucose Discrimination Training in insulin-dependent diabetes mellitus (IDDM) patients. *Biofeedback Self Regul* 1988;13:201-17.
10. Ter Braak EWMT, de Valk HW, de la Bijde YF, van der Laak MF, van Haeften TW, Erkelens DW. Response to training in blood glucose awareness is related to absence of previous hypoglycaemic coma. *Diabetes Care* 2000;23:1199-200.
11. Snoek FJ, van der Ven NCW. Bewust van je bloedglucose: de Hypoglykemie Preventie Training. Introductie van een nieuwe cursus voor insuline afhankelijke diabetespatiënten. *EADE Nieuwsbrief* 1997;4:134-6.
12. Broers S, le Cessie S, van Vliet KP, Spinhoven Ph, van der Ven NCW, Radder JK. Blood glucose awareness training in Dutch type 1 diabetes patients. Short-term evaluation of individual and group training. *Diabet Med* 2002;19:157-61.
13. Broers S, van Vliet KP, Everaerd W, le Cessie S, Radder JK. Modest contribution of psychosocial variables to hypoglycaemia awareness in type 1 diabetes. *J Psychosom Res* 2002;52:97-106.
14. Ewing DJ, Martyn CN, Young RJ, Clarke BF. The value of cardiovascular autonomic function tests: 10 years experience in diabetes. *Diabetes Care* 1985;8:491-8.
15. Mosca A, CarPELLI A. Automated determination of glycated haemoglobin with a new high performance liquid chromatograph analyser. *Clin Chem* 1986;32:202-3.
16. Kovatchev BP, Cox DJ, Gonder-Frederick LA, Clarke W. Symmetrization of the blood glucose measurement scale and applications. *Diabetes Care* 1997;20:1655-8.
17. Kovatchev BP, Cox DJ, Gonder-Frederick LA, Young-Hyman D, Schlundt D, Clarke W. Assessment of risk for severe hypoglycemia among adults with IDDM. Validation of the low blood glucose index. *Diabetes Care* 1998;21:1870-5.
18. Cox DJ, Irvine A, Gonder-Frederick L, Nowacek G, Butterfield J. Fear of hypoglycemia: quantification, validation and utilization. *Diabetes Care* 1987;10:617-22.
19. Snoek FJ, Pouwer F, Mollema ED, Heine RJ. De angst voor hypoglykemie vragenlijst (AHV). Interne consistentie en validiteit. *Gedrag & Gezondheid* 1996;24:287-93.
20. Cox D, Clarke W, Gonder-Frederick L, Kovatchev B. Driving mishaps and hypoglycaemia: risk and prevention. *Int J Clin Pract Suppl.* 2001;123:38-42.
21. Cox DJ, Penberthy JK, Zrebiec J, et al. Diabetes and driving mishaps: frequency and correlations from a multinational survey. *Diabetes Care* 2003;26:2329-34.
22. Adams KM. Driving and diabetes: one piece of the picture. *Diabetes Care* 2003;26:2464-5.
23. Cox DJ, Gonder-Frederick L, Clarke W. Driving decrements in type I diabetes during moderate hypoglycemia. *Diabetes* 1993;42:239-43.
24. Cox DJ, Gonder-Frederick LA, Kovatchev BP, Julian DM, Clarke WL. Progressive hypoglycaemia's impact on driving simulation performance. Occurrence, awareness and correction. *Diabetes Care* 2000;23:163-70.
25. Barry-Bianchi S. "Real-life" driving behavior while hypoglycemic? *Diabetes Care* 2000;23:1210-2.
26. Burden AC, Spiers N. Progressive hypoglycemia's impact on driving simulation performance: occurrence, awareness, and correction. *Diabetes Care* 2000;23:1866-7.
27. Marrero D, Edelman S. Hypoglycemia and driving performance: a flashing yellow light? *Diabetes Care* 2000;23:146-7.
28. Frier BM. Hypoglycemia and driving performance. *Diabetes Care* 2000;23:148-50.
29. Benner P, Tanner C. Clinical judgement: how expert nurses use intuition. *Am J Nurs* 1987;87:23-31.