Automatic Processing of Self-Monitoring of Blood Glucose (SMBG) Data with Glucoprint Device: SMBG Frequency and HbA1c Trends

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BACKGROUND

- The assessment of the patient's SMBG results stored in the blood glucose (BG) meter memory is difficult due to limited endocrinologist's time.
- Only some patients record their SMBG data in a logbook, and even then, such data are not always reliable.
- Glucoprint was designed to address these problems **(Figure 1).** For operation, the device requires only a color printer. Report consists of one page with three diagrams and a table, showing SMBG values distribution over the last month, and uses the color-coding of red for hyperglycemia, green for normoglycemia, and blue for hypoglycemia **(Figure 2).** Time of generating the report is less than 30 seconds.

OBJECTIVE

- Evaluate Glucoprint's impact on SMBG frequency and HbA1c levels.

Figure 1. Glucoprint device for automatic processing of SMBG data. The device is connected to a color printer; once BG meter is plugged into the Glucoprint, a report is printed out.

METHODS

- **Subjects:** 1173 subjects with type 2 (T2DM) (84%) or type 1 diabetes mellitus (T1DM) (16%), mean age 58.0±17.7 years, using OneTouch® BG meters.
- **Study design:** The study was conducted in 109 sites of Russia from November 2014 to December 2015. Glucoprint devices were installed in the offices of endocrinologists of out-patient clinics. Endocrinologists used the reports generated by the device to correct the therapy and motivate patients to perform SMBG according to the Clinical Recommendations of Healthcare Ministry of Russia. For each subject, at least 8 reports for one year were received and processed.
- **Statistical analysis:** Statistical analysis included paired *t*-test and chi-square test methods with *P*-values reported.

RESULTS

- Subjects' baseline characteristics are shown in **Table 1.**

Change in HbA1c

- Use of Glucoprint was associated with statistically significant reduction in HbA1c across all subjects (–0.6%; P < 0.001) **(Table 2).**
- The most significant reductions in HbA1c were observed in subjects with T1DM (–0.8%; P < 0.001) and in the cohort of subjects under 18 years (–1.1%; P < 0.001).
- The proportion of subjects who achieved HbA1c < 7% was significantly higher in subjects with T2DM **(Table 2).**

Change in SMBG frequency

- Use of Glucoprint was associated with statistically significant increase in frequency of SMBG across all subjects (0.49 times/day; P < 0.001) **(Table 3).**
- The most significant absolute increase in frequency of SMBG was observed in subjects with T1DM (0.7 times/day; P < 0.001), however the cohort of subjects with T2DM had the highest relative growth of frequency of SMBG (98% on insulin, 109% on OAD, 158% on diet).

CONCLUSION

- Glucoprint device was effective tool that helped increase SMBG frequency and decrease HbA1c levels while saving time of healthcare professionals.

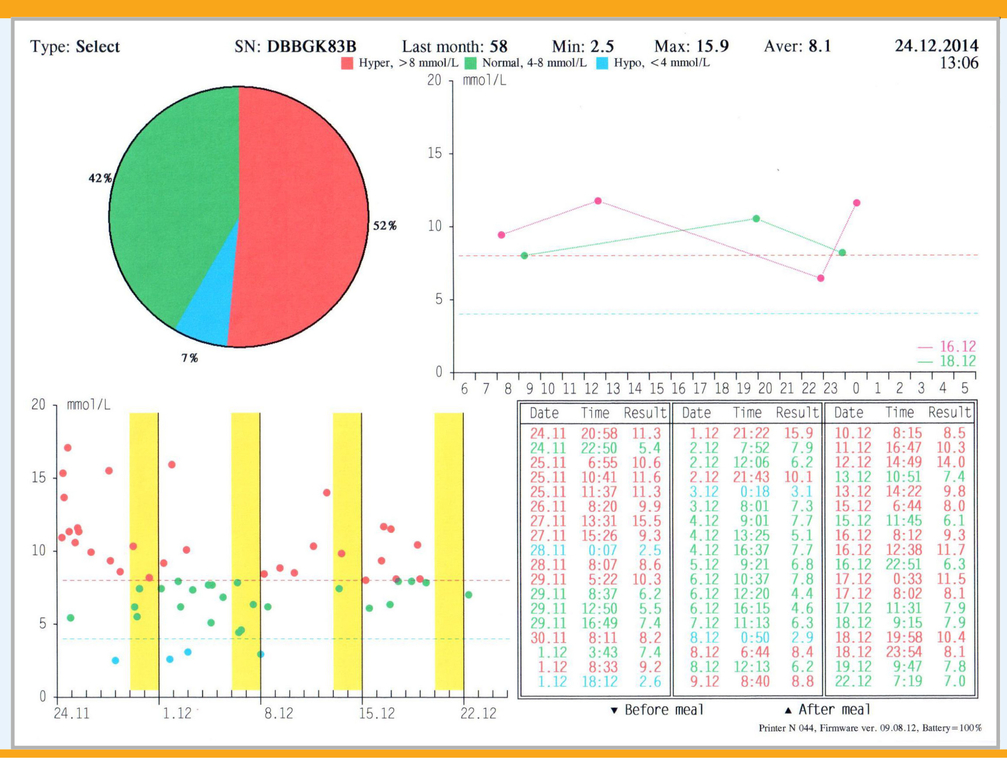
Table 1. Baseline characteristics.

Sex, n (%)	
Male	330 (28)
Female	827 (71)
N/A	16 (1)
Age, years	58 ± 18
Diabetes type, n (%)	
T1DM	182 (16)
T2DM	991 (84)
HbA1c, mean (range), %	
All subjects	8.2 (4.0 – 19.2)
T1DM	9.3 (4.7 – 16.9)
T2DM	8.0 (4.0 – 19.2)
Treatment for T2DM, n (%)	
Insulin	441 (44)
OAD	512 (52)
Diet only	38 (4)
SMBG frequency, times/day	
All	0.52 ± 0.59
T1DM	1.08 ± 0.97
T2DM	0.43 ± 0.44
T2DM on insulin	0.53 ± 0.46
T2DM on OAD	0.34 ± 0.40
T2DM on diet	0.33 ± 0.39

OAD, oral antidiabetes drug.

Figure 2. One-page report.

- **Pie chart** is a color-coded visual representation of high, normal and low BG values distribution. Each sector of the chart shows the numerical value in percent.
- **31-day graph** helps the patient to see SMBG results during the last month (31 days). Values higher than 20 mmol/L are indicated at 20 mmol/L. Vertical black lines indicate the division of the month into weeks for further convenience. Horizontal dashed lines are borders of normoglycemia (4-8 mmol/L). BG values with meal tagging are represented as triangles: downward for before-meal BG values, upward for after-meal BG values.



- **Profile days graph** helps analyze BG values at different time of day (within 24hour window). A profile day is recognized as such if during it the patient performs 3 or more BG measurements. Every day is marked with a different color. The graph shows 3 most recent profile days for the last 2 weeks.
- **Date – Time – Result table** contains 54 color-coded BG values obtained from the meter memory. Results over 31 days will be shown in regular black font, if there is space in the table. The table will contain empty rows if the meter's memory is less than 54 results.

Table 2. HbA1c changes after one year.

	All subjects	Subjects with T1DM	Subjects with T2DM			
			all	on insulin	on OAD	on diet
HbA1c, %						
Baseline	8.2 ± 1.9	9.3 ± 2.4	8.0 ± 1.8	8.7 ± 1.8	7.5 ± 1.6	7.1 ± 1.2
After one year	7.6 ± 1.6	8.5 ± 2.6	7.5 ± 1.5	8.0 ± 1.5	7.1 ± 1.4	6.6 ± 1.2
Difference (95% CI)	–0.6 (–0.1; –1.0)	–0.8 (–0.7; –1.2)	–0.6 (–0.5; –0.7)	–0.7 (–0.6; –0.8)	–0.4 (–0.5; –0.6)	–0.5 (–0.3; –0.7)
P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
% Subjects achieving HbA1c < 7.0%						
Baseline	26	14	28	15	37	53
After one year	37	24	39	24	50	69
Difference (95% CI)	11 (10; 13)	10 (6; 15)	11 (9; 14)	9 (7; 13)	13 (10; 16)	16 (5; 29)
P value	< 0.001	0.094	< 0.001	0.016	0.039	0.447

Data are shown as mean ± standard deviation of the mean.

Table 3. SMBG frequency changes after one year.

	All subjects	Subjects with T1DM	Subjects with T2DM			
			all	on insulin	on OAD	on diet
Baseline SMBG frequency, times/day	0.52 ± 0.59	1.08 ± 0.97	0.43 ± 0.44	0.53 ± 0.46	0.34 ± 0.40	0.33 ± 0.39
SMBG frequency after one year, times/day	1.01 ± 0.88	1.82 ± 1.38	0.87 ± 0.66	1.05 ± 0.70	0.71 ± 0.57	0.85 ± 0.65
Difference (95% CI), times/day	0.49 (0.48; 0.59)	0.74 (0.69; 1.13)	0.44 (0.43; 0.52)	0.52 (0.50; 0.67)	0.37 (0.33; 0.43)	0.52 (0.30; 0.68)
P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Data are shown as mean ± standard deviation of the mean.