Self-Monitoring of Blood Glucose (SMBG)

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Objectives

- History of SMBG
- Use and Accuracy of SMBG machines
- Evidence behind SMBG in Diabetes
- Clinical Guidelines for use of SMBG
- Examples of Practical Approach

Learning Objectives

At the end of the presentation, participants will be able to:

- Incorporate FDA approved indications for using SMBG in managing patients with diabetes.
- Summarize the information regarding the accuracy of SMBG meters and glycemic control.
- Find and utilize the IHS Standards of Care for Diabetes regarding clinical guidelines for use of SMBG in both insulin and non-insulin patients with diabetes.
- Identify at least one change you will incorporate into your clinical or public health practice.

What is SMBG

- Self Monitoring of Blood Glucose
- Checking your blood glucose with a blood glucose meter[1]

[1] http://www.joslin.org/info/diabetes_glossary.html

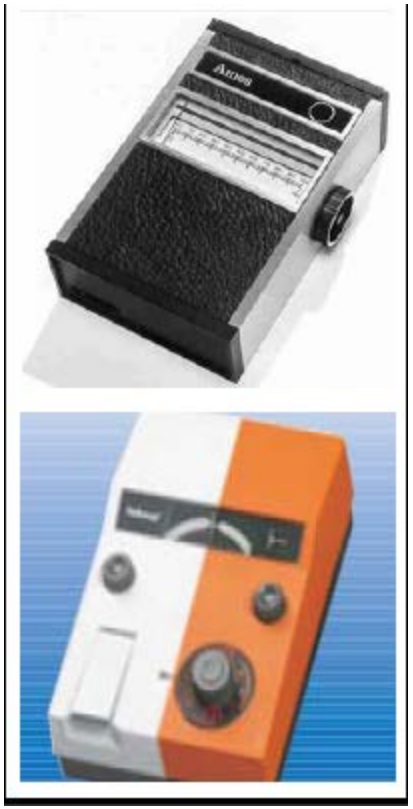
Urine Testing

Origins of SMBG

- First was dextrostick by Ames, 1968, read color visually

Reflectance Meters

- Bulky
- Heavy
- Expensive



First Generation

- Qualitative
- Considerable user interference and narrow hematocrit ranges
- Relatively long result time

Second Generation

- No timing or blood removal
- Capillary filling
- Small amounts of blood required
- Shorter test times
- Improved accuracy
- Less interference

Blood Glucose Machine Regulations

- In vitro diagnostic monitoring devices (IVD)-
  - IVD is a reagent instrument or system intended for use in the diagnosis of a disease or other conditions, including a determination of the state of health, in order to cure, mitigate, treat or prevent disease, or its sequellae in man.
- Blood glucose monitoring devices are regulated by FDA and are considered class 2 or moderate risk

Transcripts from FDA Blood Glucose Meter Meeting March 16, 2010

FDA Indications for Blood Glucose Monitors

- Intended for quantitative measurement of glucose and whole blood by lay users at home, or by health care professionals in clinical settings, to assist in the ongoing evaluation and management of individuals with diabetes.
- They are for monitoring, not for diagnosing or screening.
- Currently there is no distinction between the performance requirements for over-the-counter and professional use glucose meters.

Transcripts from FDA Blood Glucose Meter Meeting March 16, 2010

Components of Blood Glucose Monitoring System

- Include a meter, test strips, quality control solutions and sometimes lancing devices, lancets and alcohol wipes.
- FDA considers each meter and test strip, when used together, to be a separate system, and each system requires its own performance and is evaluated separately.

Transcripts from FDA Blood Glucose Meter Meeting March 16, 2010

International Standards Organization (ISO) 15197

- 95% of individual glucose results shall fall within ± 15 milligrams of the results of the reference measurement at glucose concentrations less than (<) 75 mg/dl
- 95% of individual results shall fall within ±20% greater than or equal to (≥)75 mg/dl

Transcripts from FDA Blood Glucose Meter Meeting March 16, 2010

Other Components Evaluated

- User Performance
- Alternate Site Testing
- Linearity
- Endogenous Interference
  - Cholesterol and hematocrit
- Exogenous Interference
  - Acetaminophen
- Labeling
- Environmental effects such as temperature, humidity, and altitude,
- Conformance to the International Electrical Commission Standards for medical electrical equipment
- Electromagnetic compatibility

Transcripts from FDA Blood Glucose Meter Meeting March 16, 2010

Controversy Over Current Standards for Accuracy

- Stems from increasing use in inpatient settings for tight glycemic control
- Appears consensus is that the standard should be that 95% of values are within:
  - 15% total error for glucose greater than (>)75 mg/dl
  - 10mg/dl error for glucose less than (<)75 mg/dl

Transcripts from FDA Blood Glucose Meter Meeting March 16, 2010

Table 1. Summary of potential sources of variation and error.

Source of error	Blood glucose result error
Pre-analytical	
Incomplete deposition of reagents on test strip	↓ ↑
Test, calibration, control strip surface damaged	↓ ↑
Test strip exposure to high temperature during storage	↑
Test strip is date expired	↓ ↑*
Testing at high altitude	↑ – glucose oxidase
Operator	
Diet or medication containing excessive galactose	↑ – GDH-PQQ
Diet or medication containing, maltose or xylose	↑ – GDH-PQQ
Diet containing excessive ascorbic acid (vitamin C)	↓ or ↑ – GDH biosensor only
Acetaminophen (paracetamol)	↓ – glucose oxidase biosensor
L-Dopa	↓ or ↑ – glucose oxidase biosensor
High haematocrit	↓
Low haematocrit	↑
High blood triglycerides	↓ – Glucose oxidase
Low blood oxygen	↑ – Glucose oxidase
High blood uric acid	↓ – Glucose oxidase
Analytical errors	
Miscoding test, calibration, control strip to meter	↑ or ↓
Contamination to sampling site (e.g., with fruit juice)	↑
Insufficient blood applied to test zone	↓
Reagent strip not fully inserted into meter	↓
Overloaded test strip	↑
Post-analytical	
Misreading of result display	↑ or ↓

GDH: glucose dehydrogenase, PQQ: pyrroloquinoline quinone. *Varies according to blood glucose monitoring system.

British Journal of Biomedical Science 2012 69(2)

Table 1: Substance Interferences

Strip Chemistry:	GDH-FAD*	GDH-NAD*	GDH-PQQ*	Glucose Oxidase*
Test Strip Brand:	Bayer Contour®	Precision Xtra®	ACCU-CHEK®, FreeStyle Lite™	OneTouch®
High/non-normal concentrations of:				
Oxygen	No	No	No	Yes
Uric Acid	No	No	No	Yes
Acetaminophen (consumer use)	No	No	No	Yes
Salicylates (consumer use)	No	No	No	Yes
Ascorbic Acid	No	No	No†	Yes
Maltose (HCP initiated)	No	No	Yes	No
Galactose (HCP initiated)	No	No	Yes	No
Xylose (HCP initiated)	Yes	Yes	Yes	No

Roche: Blood Glucose Monitoring: The Facts about System Limitations

Table 3: Performance Parameters

Parameter*	ACCU-CHEK Aviva	ACCU-CHEK Compact Plus	OneTouch Ultra®2	Bayer Contour®	FreeStyle Lite/ FreeStyle Freedom™	Precision Xtra
Measurement Range (mg/dL)	10–600	10–600	20–600	10–600	20–500	20–500
Hematocrit	20%–70%	25%–65%	30%–55%	0%–70%	15%–65%	30%–60%
Humidity	10%–90%	20%–85%	10%–90%	10%–90%	5%–90%	10%–90%
Strip Expiration	Remains stable up to the expiration date on the test strip vial	Remains stable up to the expiration date on the test strip vial	3 months after opening	Remains stable 6 months after vial is opened or by expiration date	Remains stable up to the expiration date on the test strip vial	Remains stable up to the expiration date on test strip packet
Operating Temperature	43°F–111°F	50°F–104°F	43°F–111°F	41°F–113°F†	40°F–104°F	50°F–122°F
Underdose Protection	Yes	Yes	No	No	Yes	Yes
Double Dosing	Yes	Yes	No	No	Yes	Yes
Altitude (feet)	<10,150	<10,150	<10,000	Not known	<10,000	<7,200
Total Cholesterol	<500	n/a	<700	<500	<500	<500
Trigycerides	<4,800	<5,000	<3,000	<3,000	<3,000	<1,000

Roche: Blood Glucose Monitoring: The Facts about System Limitations

Adverse Events - Injuries

- Glucose meters have one of the highest number of device adverse events reported per year
- Device Reporting:
  - Events/malfunctions generally under-reported – particularly for OTC devices
  - Limitations of database – data analysis difficult
- Thousands of Medical Device Reports (MDRs) sent each year
  - Greater than (>)12,000 reports/year
  - Billions of tests performed per year

FDA Blood Glucose Meter Meeting March 16, 2010

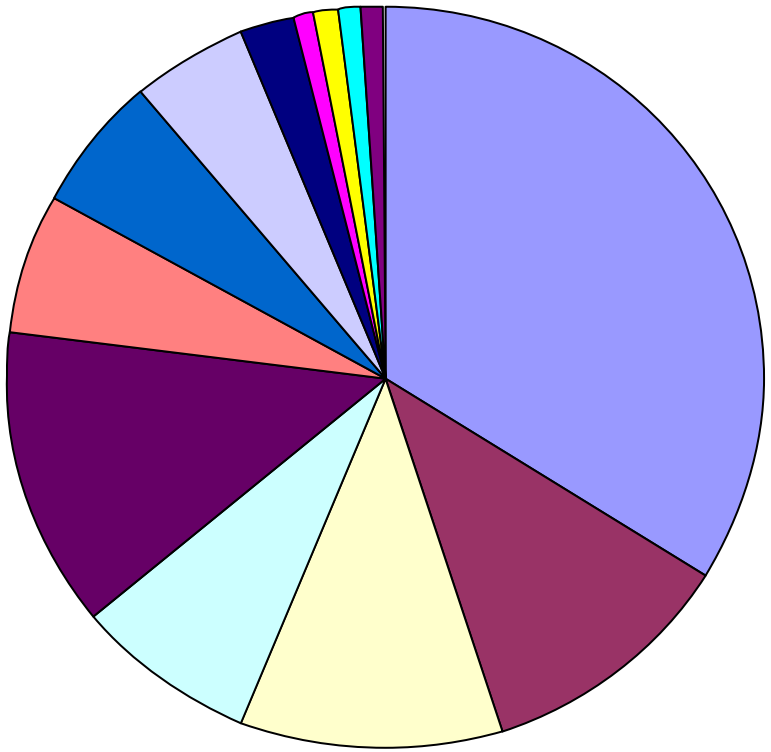
Adverse Events - Injuries

- 12,672 serious injuries reported from 2004 – 2008

Injury	% of Reports with Injury	Number of Reports with Injury
Treatment with medication(s)	44.67%	5662
Hospitalization required	42.74%	5417
Therapy/non-surgical treatment	40.06%	5077
Blood glucose, low	25.05%	3175
Hypoglycemia	23.30%	2953
Consciousness, loss of	20.03%	2538
Blood glucose, high	13.93%	1766
Shaking/tremors	13.33%	1689
Dizziness	11.60%	1470
Hyperglycemia	7.42%	941

FD Blood Glucose Meter March 16, 2010

Adverse Events – Deaths
1992 – 2009: 100 deaths associated with glucose meters reported



- Unknown cause (34)
- Meter malfunction (11)
- False High Results (11)
- Diabetic Ketoacidosis (8)
- Maltose/non-glucose interference (13)
- Use on Critically Ill Patient (6)
- False Low results (6)
- Possible Medication Interference (5)
- Renal patient (2)
- Dehydration (1)
- Hyperosmolar Hyperglycemia (1)
- Feeding tube –glucose (1)
- Neonatal death (1)

FDA Blood Glucose Meter Meeting March 16, 2010

Summary

- Technology has come a long way!
- Lots of external factors can influence accuracy of meters
- Controversy over accuracy of current meters
- Significant number of adverse events reported each year from use of home monitors

Is SMBG Useful in Non-Insulin Treated Diabetes?

The Debate

- SMBG effective for patients with Type 1 diabetes and for Type 2 diabetes patients who use insulin
- Much debate on the effectiveness of SMBG as a tool in self management of patients with Type 2 diabetes who are not using insulin

Self monitoring of blood glucose in patients with type 2 diabetes mellitus who are not using insulin. Cochrane Library 2012 Issue 5

Cochrane Review - 2012

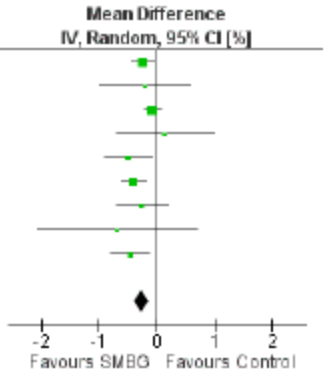
- 12 RCT included
- Evaluated 3,259 patients
- Intervention duration ranged from 6 months to 12 months
- Types of trials
  - 9- compared SMBG with usual care w/o monitoring
  - 1- compared SMBG to SMUG
  - 1- three armed – SMBG, SMUG, usual care
  - 1- three armed – more intensive, less intensive, usual care
  - Self monitoring of blood glucose in patients with Type 2 diabetes mellitus who are not using insulin (Review) The Cochrane Collaboration 2012

Cochrane Review - 2012

Figure 4. Forest plot of comparison: 1 SMBG (self-monitoring of blood glucose) vs control (6 months follow-up), outcome: 1.1 HbA1c [%].

Study or Subgroup	SMBG Mean [%]	SMBG SD [%]	SMBG Total	Control Mean [%]	Control SD [%]	Control Total	Weight	Mean Difference IV, Random, 95% CI [%]
Barnett 2008	-1.15	1.14	311	-0.91	1.29	299	22.0%	-0.24 [-0.43, -0.05]
Davidson 2005	-0.8	1.6	43	-0.6	2.1	45	2.6%	-0.20 [-0.88, 0.58]
DIGEM trial 2007 (1)	-0.15	0.81	301	-0.08	0.73	152	27.7%	-0.07 [-0.22, 0.08]
Fontbonne 1989	-0.36	3.14	68	-0.5	1.54	68	2.3%	0.14 [-0.69, 0.97]
Franciosi 2011	-1.2	0.81	46	-0.7	0.7	16	7.9%	-0.50 [-0.92, -0.08]
Guerci 2003	-0.9	1.54	345	-0.5	1.54	344	18.3%	-0.40 [-0.63, -0.17]
Kleefstra 2010	-0.18	0.87	22	0.07	0.75	18	7.0%	-0.25 [-0.70, 0.20]
Muchmore 1994	-1.54	1.46	12	-0.85	1.87	11	0.9%	-0.69 [-2.07, 0.69]
SMBG study group 2002	-1	1.08	113	-0.54	1.41	110	11.3%	-0.46 [-0.79, -0.13]
Total (95% CI)			**1261**			**1063**	**100.0%**	**-0.26 [-0.39, -0.13]**

Heterogeneity: Tau² = 0.01; Chi² = 11.29, df = 8 (P = 0.18); I² = 29%
Test for overall effect: Z = 3.99 (P < 0.0001)



(1) Both intervention groups are combined

Self monitoring of blood glucose in patients with Type 2 diabetes mellitus who are not using insulin (Review) The Cochrane Collaboration 2012

Conclusions of Cochrane Review

- SMBG in newly diagnosed type 2 diabetes patients who are not using insulin is beneficial in lowering HgbA1c
- In patients with diabetes duration greater than (>)1 yr
  - Overall effect of SMBG in non-insulin treated patients glycemic control is small up to 6 months and subsides after 12 months

Conclusions of Cochrane Review

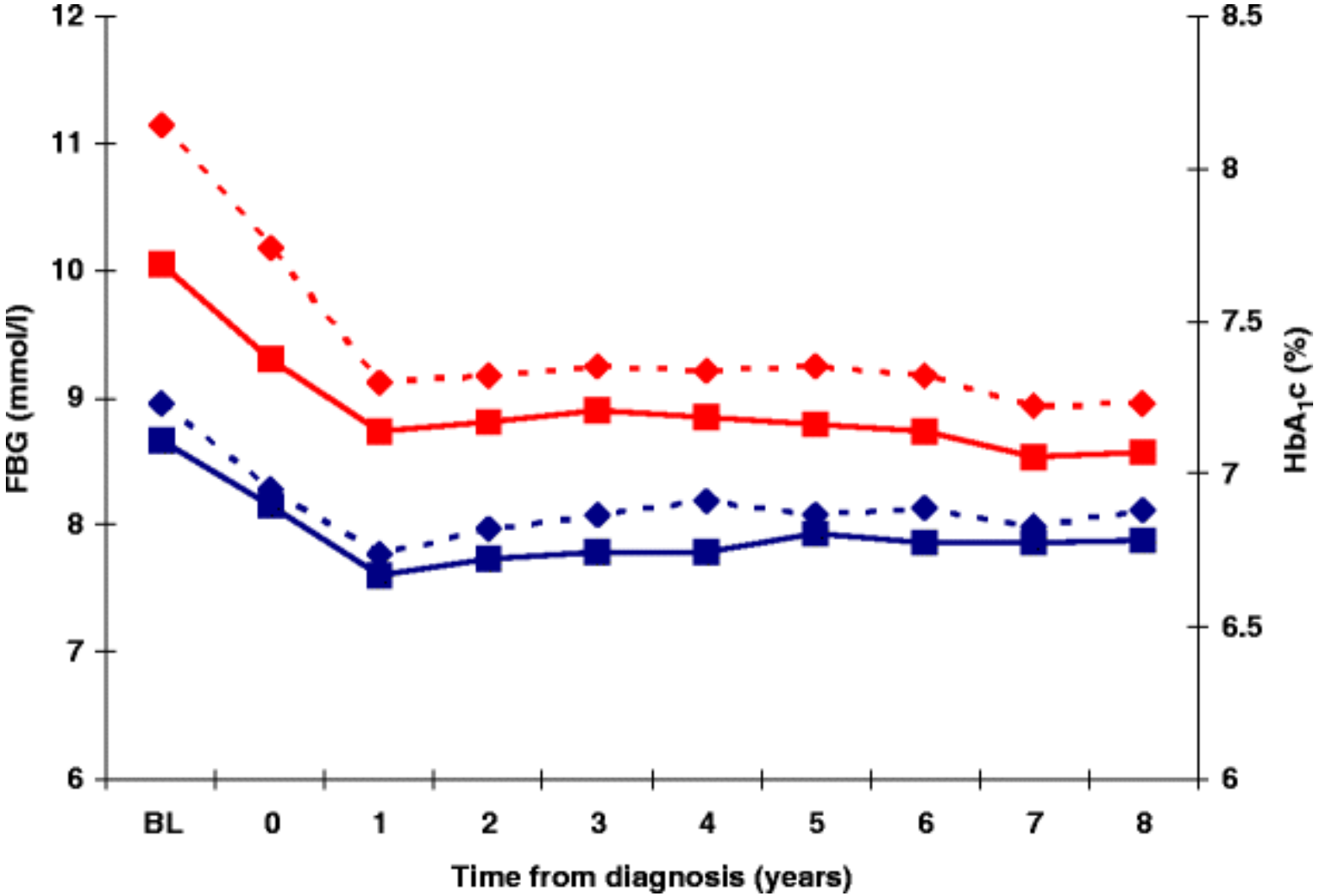
- Despite possible beneficial glycemic effects, SMBG has no relevant effect on general well-being and health related quality of life.
- Patients performing SMBG are equally satisfied with their treatment as those not using SMBG.
- SMBG increases reported hypoglycemic episodes.

ROSSO Study

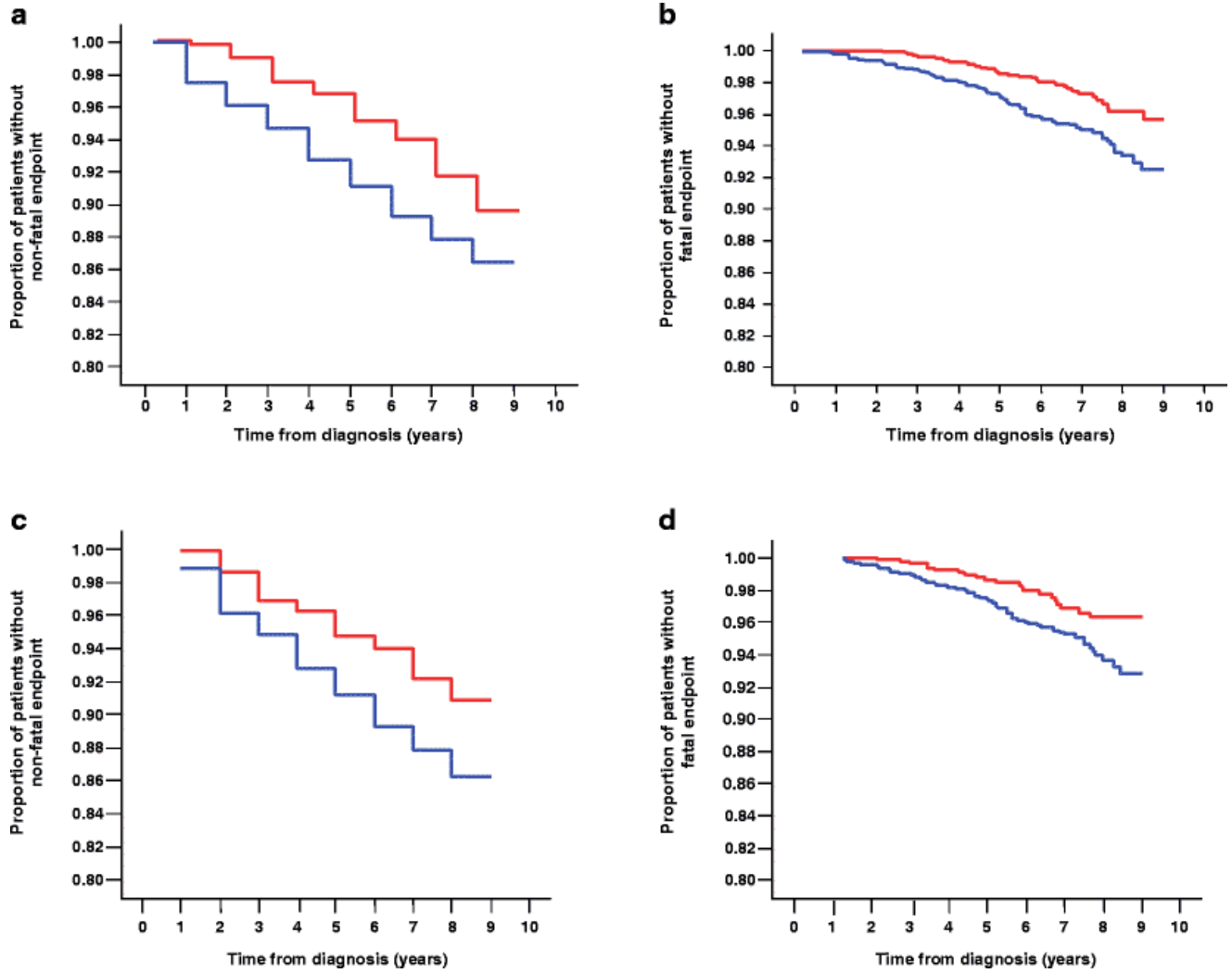
- ROSSO design
  - 3268 patients
  - Retrospective observational study
- Endpoints
  - All cause mortality, blindness, dialysis, MI, stroke, amputation

Martin, et. al. 2006. Diabetologia, 49:271-278

ROSSO Study
Fasting Blood Glucose and A1C



"Survival" Curves for fatal and Non-fatal endpoints



Fremantle Diabetes Study 1280 patients in Western Australia

Cross sectional with longitudinal follow-up

Compared 3 groups: diet, oral meds, multiple insulin injections

Found no improvement in A1C or similar endpoints (to ROSSO) by using SMBG over the 5.7 year study period

Davis, et.al. 2006 *Diabetes Care*, 29(8):1764-1770

Fremantle A1C results

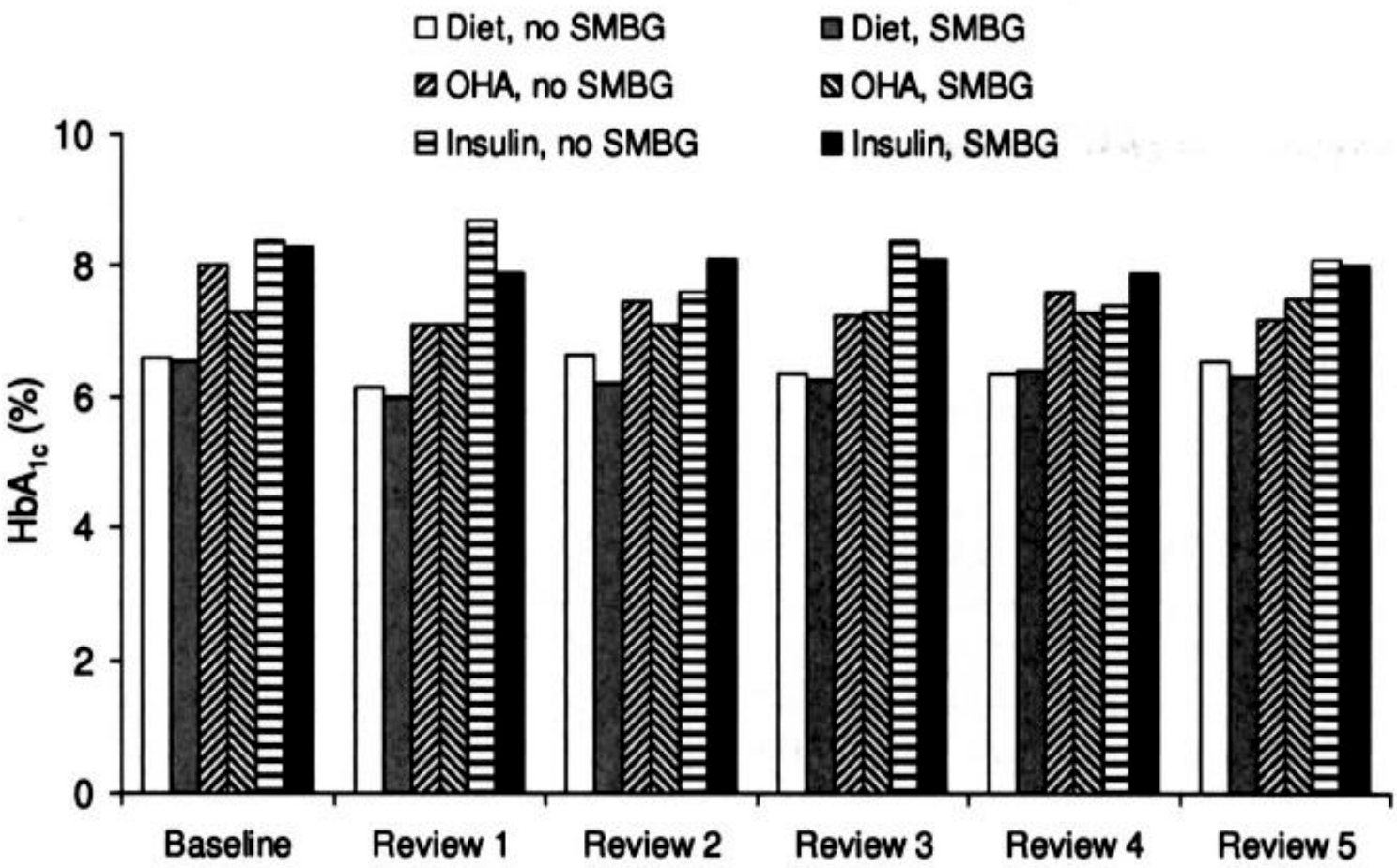


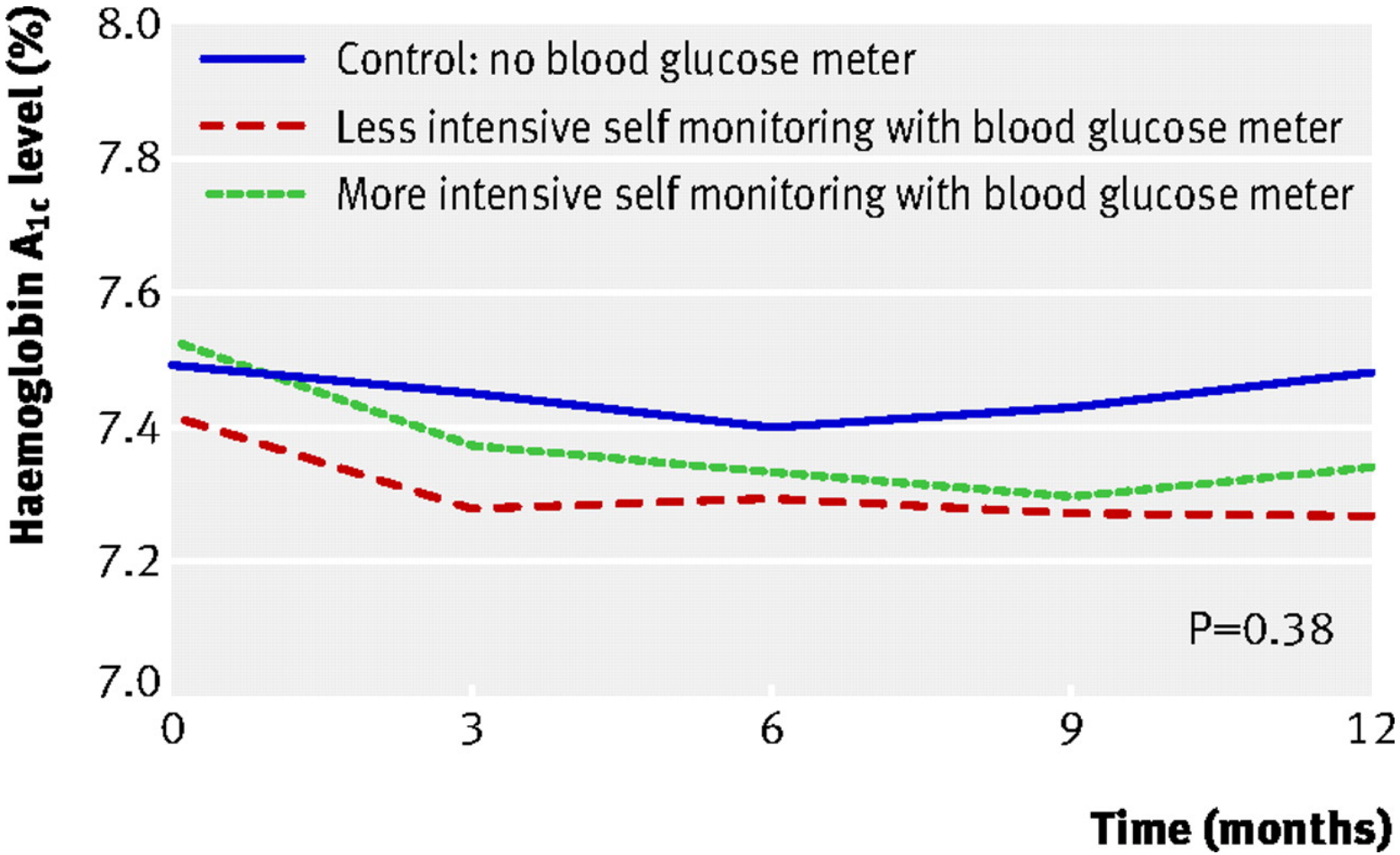
Figure 1—*A1C by diabetes treatment type, year of follow-up, and SMBG status for the 531 FDS participants with type 2 diabetes who attended at least six annual assessments.*

DiGem

- 453 non-insulin treated Type 2 Diabetics average HbA1c 7.5%
- Randomized into 3 groups
- Main outcome measure: HbA1c level measured at 12 months.

Farmer, A. et al. BMJ 2007;335:132

Change in HbA1c levels over 12 months' follow-up of patients with non-insulin treated type 2 diabetes according to randomisation group



Farmer, A. et al. BMJ 2007;335:132

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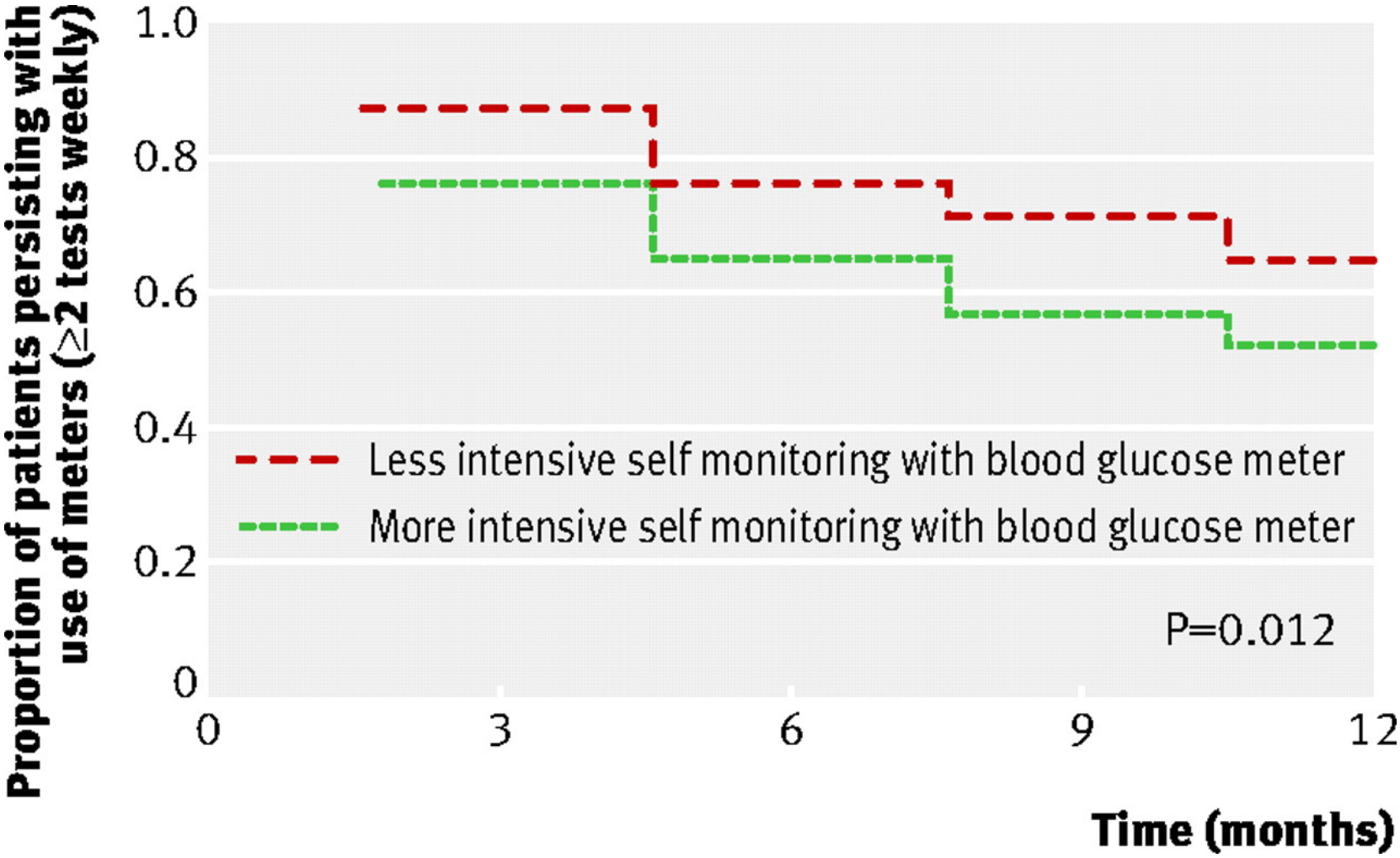
Adherence to minimal level of self monitoring of blood glucose levels using a meter



Farmer, A. et al. BMJ 2007;335:132

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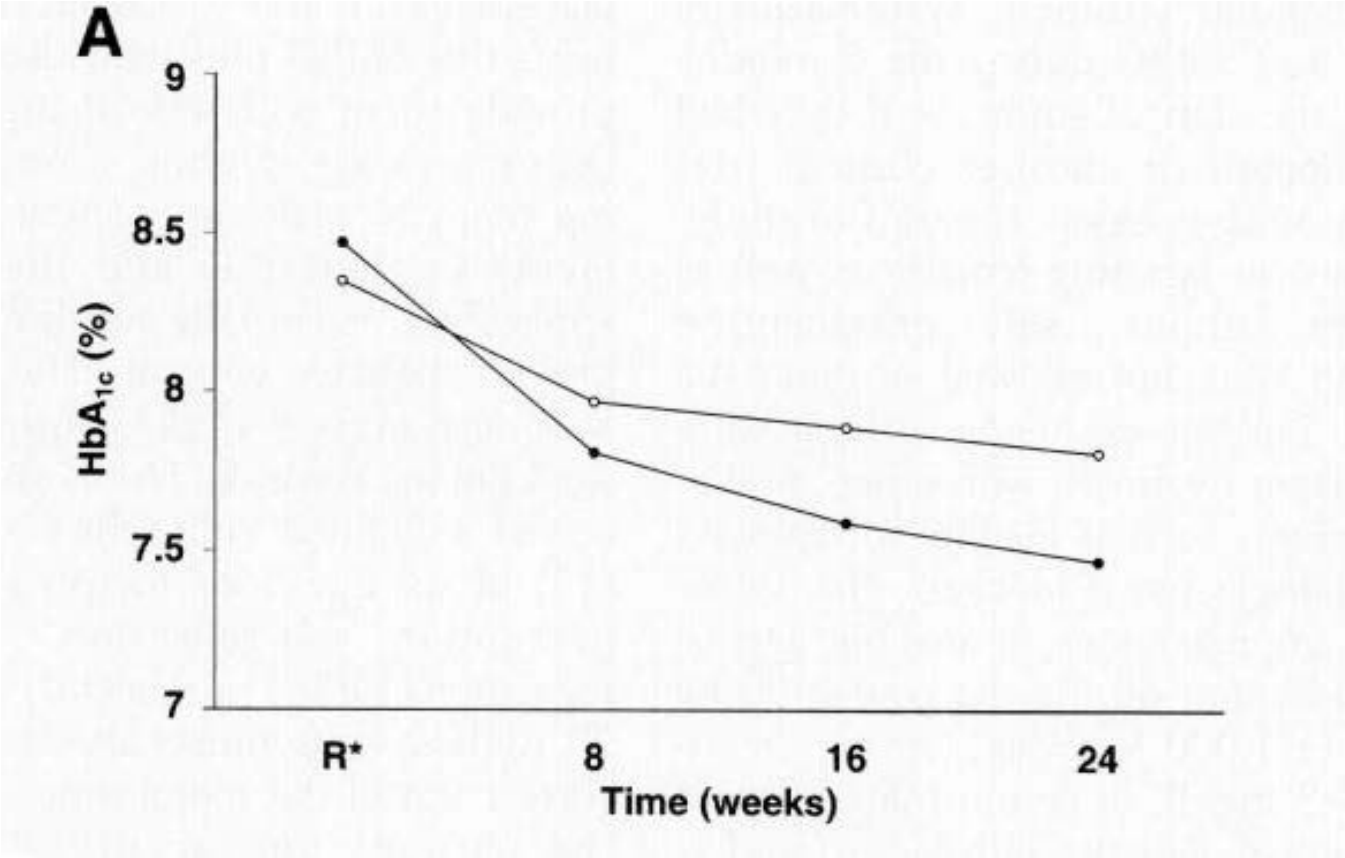
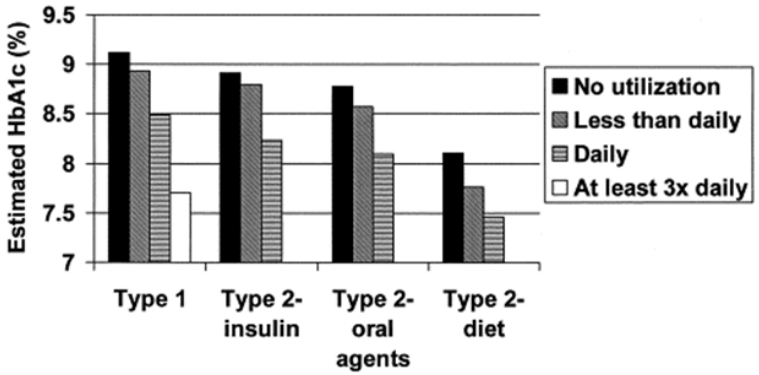
Meal-Related Structured Self Monitoring of Blood Glucose

RCT that compared and education intervention combined with SMBG to standard diabetic education with no testing



Self-monitoring of blood glucose levels and glycemic control: the Northern California Kaiser Permanente Diabetes registry

- 24,000 Kaiser patients reviewed for 1996 for strip use and their first A1C of 1997 recorded.
- Careful statistical manipulation ensures that the groups were matched for all attributes except strip use.



Karter et.al. *American Journal of Medicine,* 2001. 111:1-9.

ESMON

- Prospective RCT
- Assessed SMBG vs no monitoring on glycemic control and psychological indices in newly diagnosed type 2 diabetes
- Evaluated 184 non-insulin treated patients with no prior experience with SMBG over 12 months

ESMON

- No significant difference in HgbA1c between groups over 12 month period
- SMBG was associated with 6% higher score on the depression subscale of the well being questionnaire

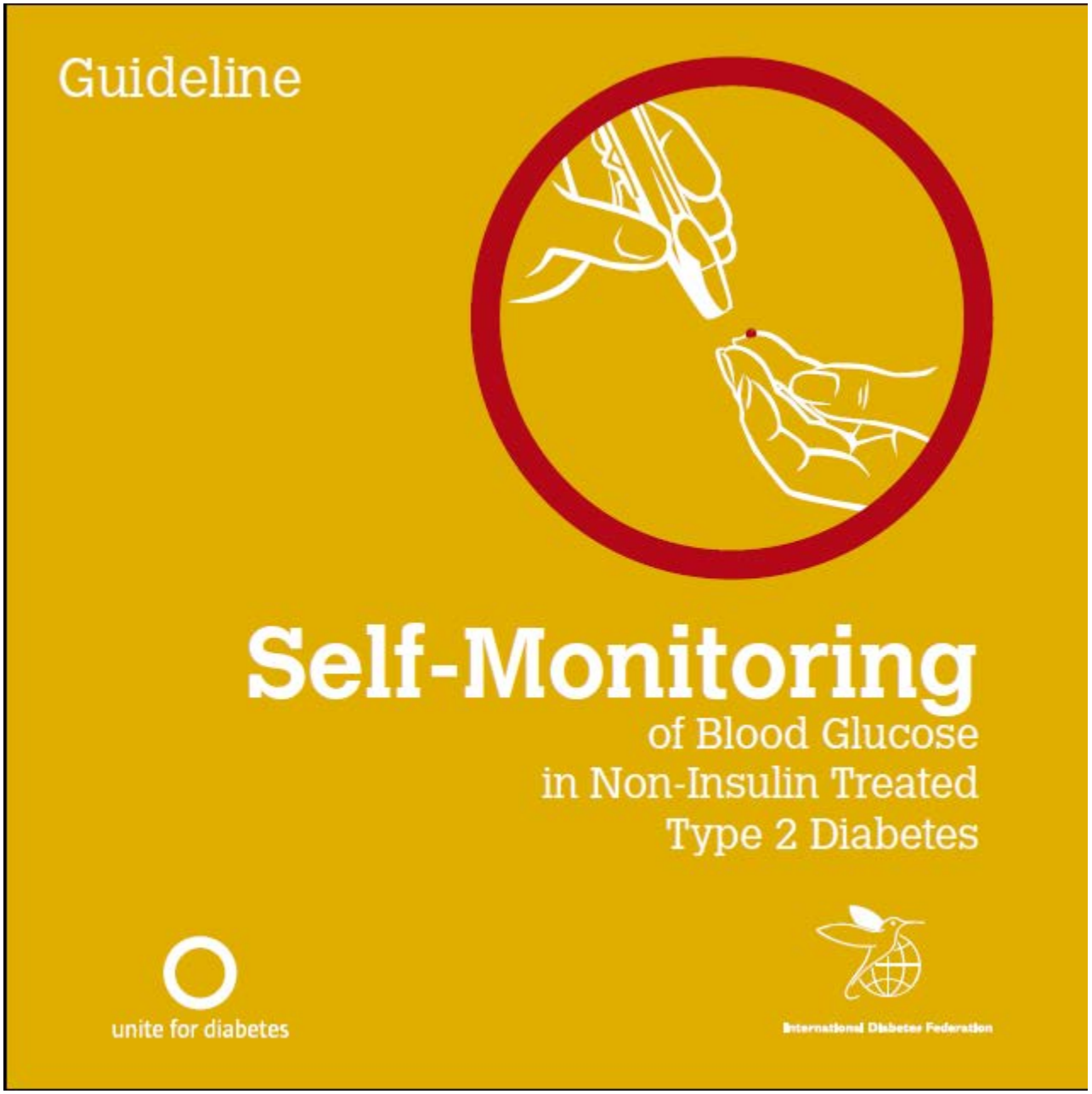
Cost

- In 2002 the cost of SMBG (strips, meters, lancets, calibration solutions and batteries) in 2002 for diabetic patients not taking insulin enrolled in the Medicare B program was US $465,000,000!
- It is estimated that $6 billion is spent worldwide on SMBG per year

Summary

- There is conflicting data to support a benefit of standardized SMBG for non-insulin treated diabetic patients
- Benefit would be most in the first year of initial diagnosis
- Despite possible beneficial glycemic effects, SMBG has no relevant effect on general well-being and health related quality of life
- SMBG is expensive!

Official Recommendations


Guideline
Self-Monitoring
of Blood Glucose
in Non-Insulin Treated
Type 2 Diabetes
unite for diabetes
International Diabetes Federation

International Diabetes Federation Guidelines for SMBG in Non-Insulin Treated Type 2 Diabetes

- Findings from studies used in non-insulin treated Type 2 DM are inconsistent due to differences in designs, populations, and interventions used.
- Further studies are needed to better assess the benefits, optimal use and cost effectiveness of SMBG
- SMBG likely only to be an effective self-management tool when results are reviewed and acted upon by individuals or healthcare providers to actively modify behavior and/or adjustment treatment

IDF Guidelines on Self-Monitoring of Blood Glucose in Non-Insulin Treated Type 2

1. SMBG should only be used when individuals with diabetes and their healthcare team have knowledge, skills, and willingness to incorporate SMBG monitoring and therapy adjustment into their diabetes care plan in order to attain agreed treatment goals.
2. SMBG should be considered at time of diagnosis to enhance the understanding of diabetes as part of individuals' education and to facilitate timely treatment initiation and titration optimization
3. SMBG should be considered as educational tool for ongoing diabetes self-management

http://www.idf.org/idf-guideline-self-monitoring-blood-glucose-non-insulin-treated-type-2-diabetes

IDF Recommendations for Non-Insulin Treated Type 2 DM

4. SMBG protocols should be individualized to address each individual patients educational/behavioral/clinical requirements
5. Purpose of SMBG and using the data should be agreed upon between patient and healthcare provider
6. SMBG use requires an easy procedure for patients to regularly monitor the performance and accuracy of their glucose meter

American Diabetes Association

- Self-monitoring of blood glucose (SMBG) should be carried out three or more times daily for patients using multiple insulin injections or insulin pump therapy. (A)
- For patients using less-frequent insulin injections, non-insulin therapies, or medical nutrition therapy (MNT) alone, SMBG may be useful as a guide to the success of therapy. (E)
- To achieve postprandial glucose targets, postprandial SMBG may be appropriate. (E)

Diabetes Care, Vol 34, Supplement 1, January 2011

American Diabetes Association

- When prescribing SMBG, ensure that patients receive initial instruction in, and routine follow-up evaluation of, SMBG technique and their ability to use data to adjust therapy. (E)
- Continuous glucose monitoring (CGM) in conjunction with intensive insulin regimens can be a useful tool to lower A1C in selected adults (age greater than or equal to (≥) 25 years) with type 1 diabetes. (A)
- Although the evidence for A1C-lowering is less strong in children, teens, and younger adults, CGM may be helpful in these groups. Success correlates with adherence to ongoing use of the device. (C)
- CGM may be a supplemental tool to SMBG in those with hypoglycemia unawareness and/or frequent hypoglycemic episodes. (E)

Diabetes Care, Vol 34, Supplement 1, January 2011

IHS Division of Diabetes Treatment and Prevention SMBG Recommendations

» **Clinical Practice Recommendations**

Assessment of Glycemic Control ⊕

Self-Monitoring of Blood Glucose (SMBG) ⊖

✓ **Recommendations for Self-Monitoring of Blood Glucose**

- All insulin-treated patients should perform SMBG. If on multiple daily injections or an insulin pump, SMBG should be performed ≥ 3 times/day.
- The decision as to whether and how often to prescribe SMBG in non-insulin treated patients should be **individualized**. Providers are encouraged to consider SMBG when needed, such as when medication therapy is initiated or changed, in patients with any indication that their diabetes control is not stable (e.g., recent history of hypoglycemia), or in medically complex patients on multiple glucose-lowering medications.
- Prescribe the SMBG schedule so as to collect the information needed to adjust a patient's meal plan and medications, particularly insulin (e.g., check pre-supper values to see if the morning NPH insulin dose needs to be adjusted).
- Instruct patients clearly as to when and how often to check their blood glucose, and what to do with the results.
- Review SMBG data and A1C results with the patient at each diabetes visit, and take them into consideration when making therapeutic management decisions.

http://www.ihs.gov/MedicalPrograms/Diabetes/index.cfm?module=SOCGlycemic

Key Point

Shift from self monitoring of blood glucose to Self Management of blood glucose

Key Points

- Give clear and consistent message when to test
- Clear goals – agreed upon by patients
- Teach patients how to respond to highs and lows
- Look for glucose patterns – teach difference between individual readings and patterns

Estimated Average Glucose

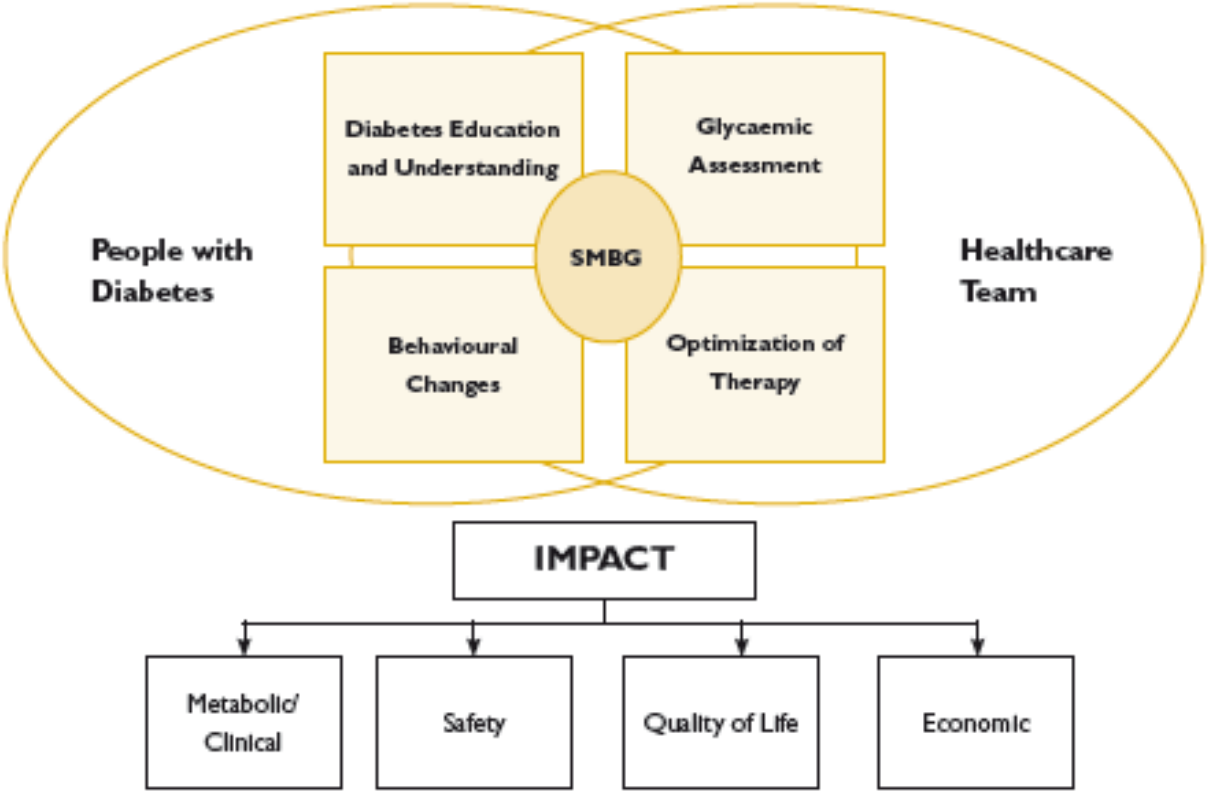
Correlation of A1C and Estimated Average Glucose (eAG) Results

A1C %	eAG mg/dL
6	126
7	154
8	183
9	212
10	240
11	269
12	298

Source: ADA Standards of Medical Care in Diabetes—2012, p. S18.

http://www.ihs.gov/MedicalPrograms/Diabetes/index.cfm?module=SOCGlycemic

SMBG as a Component of the Education/Treatment Programme



http://www.idf.org/idf-guideline-self-monitoring-blood-glucose-non-insulin-treated-type-2-diabetes

Metering with a Purpose

Diet and Exercise Only Plan – "I'm not taking any diabetes medicine"

	Start Phase	Adjust Phase	Maintain Phase
Diet and Exercise	1-3 times daily for 2 weeks – before and after a meal or exercise	Before and after meals or exercise – testing around one or 2 events each week	1 test before and 1 test after meal or exercise each week

"Events" 1) Meal or Snack* - a "snack" is 100 calories or less

2) Exercise** - ask your doctor for an exercise plan

3) Low blood sugar symptoms (Hypoglycemic)

*Remember -if your blood sugar before your meal is at goal, and it's too high after your meal, think about what kind of food you just ate, and how much.

•Did you drink something with sugar in it?? (regular soda, tea, Gatorade, coffee with "real" sugar)

•Did you eat too much starchy food? (Bread, tortilla, potato, pasta)

**Remember - when you first begin to exercise, you MAY see your blood sugar go up a little bit...your body thinks you need extra energy to deal with this "stress"...Just stay with your exercise plan, and you'll see your blood sugars start to go down after exercise.

***Remember – if you are dizzy, shaky, you have blurred vision or frequent urination or you feel "some way" – test your blood sugar. If blood sugar is below 70 mg/dl, drink ½ glass (4 oz) of juice or regular soft drink or 1 glass (8 oz) of milk or eat some soft candies (not chocolate!).

Oral Medication Plan – "I only have to take diabetes pills"

	Start Phase	Adjust Phase	Maintain Phase
Oral Medications	Before and after an event – 2-4 times daily for 2 weeks	Before and after an event – 2-3 days/week – for 1 to 3 months	1 test before and 1 test after an event each week

"Events" 1) Meal or Snack* - a "snack" is 100 calories or less

2) Exercise** - ask your doctor for an exercise plan

3) Low blood sugar symptoms (Hypoglycemic)

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Oral Medication and Bedtime Insulin - "I take diabetes pills and one shot of insulin"

	Start Phase	Adjust Phase	Maintain Phase
Oral Medications and Bedtime Insulin	Fasting daily for 1 week – return to clinic for adjustments	Fasting daily for 1-2 weeks – AND – Before and after an event 1-2 days/week	Fasting and 1 test before and 1 test after an event each week

"Events" 1) Meal or Snack* - a "snack" is 100 calories or less

2) Exercise** - ask your doctor for an exercise plan

3) Low blood sugar symptoms (Hypoglycemic)

The purpose of the bedtime insulin is to control the blood sugar while you are asleep. Checking your blood sugar before you eat breakfast will tell you if the dose is correct.

Don't hesitate to check your blood sugar if you wake up in the middle of the night and are shaky, hungry, having nightmares, etc.

**Remember - when you first begin to exercise, you MAY see your blood sugar go up a little bit...your body thinks you need extra energy to deal with this "stress"... Just stay with your exercise plan, and you'll see your blood sugars start to go down after exercise.

***Remember – if you are dizzy, shaky, you have blurred vision or frequent urination or you feel "some way" – test your blood sugar. If blood sugar is below 70 mg/dl, drink ½ glass (4 oz) of juice or regular soft drink or 1 glass (8 oz) of milk or eat some soft candies (not chocolate!).

Insulin Plan – "I take insulin every day"

	Start Phase	Adjust Phase	Maintain Phase
Insulin	4 times or more daily – before and after an event	2 – 4 times daily – before and after an event	2 – 4 times per day at least 2 days per week. Before and after an event

"Events" 1) Meal or Snack* - a "snack" is 100 calories or less

2) Exercise** - ask your doctor for an exercise plan

3) Low blood sugar symptoms (Hypoglycemic)

*Remember -if your blood sugar before your meal is at goal, and it's too high after your meal, think about what kind of food you just ate, and how much.

•Did you drink something with sugar in it?? (regular soda, tea, Gatorade, coffee with "real" sugar)

•Did you eat too much starchy food? (Bread, tortilla, potato, pasta)

**Remember - when you first begin to exercise, you MAY see your blood sugar go up a little bit...your body thinks you need extra energy to deal with this "stress"...Just stay with your exercise plan, and you'll see your blood sugars start to go down after exercise.

***Remember – if you are dizzy, shaky, you have blurred vision or frequent urination or you feel "some way" – test your blood sugar. If blood sugar is below 70 mg/dl, drink ½ glass (4 oz) of juice or regular soft drink or 1 glass (8 oz) of milk or eat some soft candies (not chocolate!).

'Staggered' SMBG regimen

	Pre-Breakfast	Post-Breakfast	Pre-Lunch	Post-Lunch	Pre-Supper	Post-Supper	Bedtime
Monday	X	X					
Tuesday			X	X			
Wednesday					X	X	
Thursday	X	X					
Friday			X	X			
Saturday					X	X	
Sunday	X	X					

Meal-based testing

	Pre-Breakfast	Post-Breakfast	Pre-Lunch	Post-Lunch	Pre-Supper	Post-Supper	Bedtime
Monday	X	X					
Tuesday							
Wednesday			X	X			
Thursday							
Friday							
Saturday					X	X	
Sunday							

http://www.idf.org/idf-guideline-self-monitoring-blood-glucose-non-insulin-treated-type-2-diabetes

http://www.ihs.gov/MedicalPrograms/Diabetes

U.S. Department of Health and Human Services

www.hhs.gov

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- Diagnosis of Type 2 Diabetes and Prediabetes
- Glycemic Control

http://www.ihs.gov/MedicalPrograms/Diabetes/index.cfm?module=toolsGCHowToMonitoring

Algorithm Card
[PDF - 208KB]

Guidelines for Monitoring

Self-monitoring of blood glucose (SMBG):

- Useful especially for patients on insulin and for pregnant patients with diabetes:
  - Clinical utility and cost-effectiveness in other patients unclear.
  - For patients not pregnant or on insulin, provider should weigh cost of SMBG with usefulness of the data obtained to determine whether and how often to recommend SMBG.
- Patients prescribed a SMBG regimen should be educated initially and then periodically on SMBG technique and on how to use the data to adjust their diet/exercise/medication.
- SMBG results should be reviewed with patients at each diabetes visit.

Exams and Tests Used to Monitor Type 2 Diabetes:

- A1C – every 3-6 months
- Creatinine and eGFR – yearly
- UACR – yearly
- Lipid panel – yearly
- LFTs – yearly
- ECG – every 2-5 yrs
- Complete foot exam – yearly
- Foot inspection – each visit
- Retinopathy exam – yearly
- Paps, mammograms, contraception – as indicated
- Evaluate sexual function
- Depression, tobacco, ETOH, DV screening – yearly

Estimated Average Glucose (eAG).

The table below shows the correlation of A1C with average plasma glucose levels.

A1C %	Mean Plasma Glucose mg/dL
6	126
7	154
8	183
9	212
10	240
11	269
12	298

Case Study #1

- Ms. A is a 31 year old female with 3 children.
  - Normoglycemic in her first pregnancy.
  - Post delivery she kept an extra 10lbs post over pre-pregnancy weight.
  - She had gestational diabetes in her next 2 pregnancies.
  - She was able to: follow a meal pattern, do SMBG, and use insulin to successfully manage her gestational diabetes. She kept on an extra 10 lbs with each additional pregnancy.

Case Study #1 Ms. A

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
First Clinic Visit	175lbs	32	3 meals/day	None	None	7.6%

Diet and Exercise – Adjust Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
First Clinic Visit	175 lbs	32	3 meals/day	None	None	7.6%
Start Phase			Carb Count Food diary with SMBG associated with meals	None	Check blood glucose daily, before and after 2 meals each day	

Diet and Exercise – Adjust Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
Second Clinic Visit (at 2 weeks)	171lbs (4 lb loss)	31.3	Carb Count Food diary with SMBG associated with meals	None	Check blood glucose daily, before and after 2 meals each day	
Adjust Phase			Carb Count Food diary with SMBG associated with meals	Add 15 min walk/day	Test around one or two events per week. Before and after meals or exercise	

Diet and Exercise – Maintain Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
Third Clinic Visit (at 6 weeks)	167 lbs	30.5	Carb Count Food diary	15 min walk/day	Test around one or two events per week. Before and after meals or exercise	6.5%
Maintain Phase			Carb Count Food diary with SMBG associated with meals	Continue and slowly increase 15 min walk/day	Weekly; one test before and after an event.	

SMBG Protocol for Diet and Exercise Alone

Treatment Regimen/Plan	Event	Start Phase	Adjust Phase	Maintain Phase
Diet and Exercise Only	Meal or snack* Exercise**	1-3 times daily for 2 weeks. Before and after an event	Test around one or two events per week. Before and after meals or exercise	Weekly; one test before and after an event.

Ms. A - 4-5 years later

- Has been followed quarterly, continued to do well with weight, healthy life style and generally well but blood sugars have crept up.
- HgbA1c 7.8%.
- She is started on Metformin, instructed on hypoglycemia signs, symptoms, and treatment, and the protocol for SMBG with Oral Meds is used.

Oral Meds - Start Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
First Clinic Visit	180 lbs	32.9	3 meals/day Carb counts	Walking 30 min 3/week	Weekly; one test before and after an event.	7.8%
Start Phase			Carb Count Food diary with SMBG associated with meals	Continue walking	2-4 times daily for 2 weeks. Before and after an event	

Oral Meds – Adjust Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
Two Week Visit	176 lbs (4 lbs loss)	32.2	3 meals/day Carb counts	Walking 30 min 3/week	2-4 times daily for 2 weeks. Before and after an event	BS fasting now 120-150 and 2 hr pp <200
Adjust Phase			Carb Count Food diary with SMBG associated with meals	Continue walking	2-3 days/week for 1 – 3 months. Before and after an event	

Oral Meds- Maintain Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
Six Week Visit	170 lbs (6 lbs loss)	31.1	3 meals/day Carb counts	Walking 30 min 3/week	2-3 days/week for 1 – 3 months. Before and after an event event	HgbA1c 7.0%
Maintain Phase			Carb Count Food diary with SMBG associated with meals	Continue/ Increase walking	Weekly; one test before and after an event.	

SMBG Protocol for Oral Meds

Treatment Regimen/Plan	Event	Start Phase	Adjust Phase	Maintain Phase
Oral Medications	Meal or snack* Exercise** Hypo-glycemia	2-4 times daily for 2 weeks. Before and after an event	2-3 days/week for 1 – 3 months. Before and after an event.	Weekly; one test before and after an event.

Ms. A – 5 years later

- Has been followed quarterly, Metformin maximized continued to do well with weight, healthy life style and but blood sugars have crept up.
- HgbA1c now 9.5%.

Oral Meds and Bedtime Insulin – Start Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
First Clinic Visit	183 lbs	33.5	3 meals/day Carb counts	Walking 30 min 3/week	Weekly; one test before and after an event.	9.5%
Start Phase			Carb Count Food diary with SMBG associated with meals	Continue walking	Fasting daily for 1 week and return to clinic for adjustment	

Oral Meds and Bedtime Insulin – Adjust Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
One Week Visit	185 lbs (2 lbs gain)	33.8	3 meals/day Carb counts	Walking 30 min 3/week	Fasting daily for 1 week and return to clinic for adjustments	BS fasting now 120-150 and 2 hr pp <200
Adjust Phase			Carb Count Food diary with SMBG associated with meals	Continue walking	Fasting daily for 1-2 weeks AND before and after an event 1-2 days per week.	

Oral Meds and Bedtime Insulin – Maintain Phase

Phase	Weight	BMI	Diet	Exercise	SMBG	Glycemic Status
Four Week Visit	188 lbs (3 lbs gain)	34.4	3 meals/day Carb counts	Walking 30 min 3/week	Fasting daily for 1-2 weeks AND before and after an event 1-2 days per week.	HgbA1c 8.0%
Maintain Phase			Carb Count Food diary with SMBG associated with meals	Continue/ Increase walking	Fasting and 1 test before and after an event each week.	

SMBG Protocol for Oral Meds and Bedtime Insulin

Treatment Regimen/Plan	Event	Start Phase	Adjust Phase	Maintain Phase
Oral Medications and Bedtime Insulin	Meal or snack* Exercise** Hypo-glycemia***	Fasting daily for 1 week and return to clinic for adjustments	Fasting daily for 1-2 weeks AND before and after an event 1-2 days per week.	Fasting and 1 test before and after an event each week.

SMBG Protocol for Insulin

Treatment Regimen/Plan	Event	Start Phase	Adjust Phase	Maintain Phase
Insulin	Meal or snack* Exercise** Hypo-glycemia***	4 times or more daily; before and after an event	2-4 times daily; before and after an event.	2-4 times per day at least 2 days per week; before and after an event.

- ***Events – Meal or snack – a snack is 100 calories or less.**
- Remember: If your blood sugar before your meal is at goal, and it's too high after a meal, think about what kind of food you just ate and how much.
- Did you drink something with sugar in it (like regular soda, tea, sports drink, coffee with 'real' sugar?
- Did you eat a lot of starchy food like bread, tortilla, potato, rice?

- ****Exercise – ask your provider for an exercise plan.**
- Remember: when you first begin to exercise, you MAY see your blood sugar go up a little bit because your body thinks you need extra energy to deal with this 'stress'. Just stay with your exercise plan and you'll see your blood sugars start to go down after exercise.

- *****Hypoglycemia – low blood sugar symptoms**
- Remember: if you are dizzy, shaky, have blurred vision or frequent urination or you feel "some way" - test your blood sugar. If your blood sugar is below 70mg/dL, drink 1/2 glass (4 ounces) of juice or regular soft drink or 1 glass (8 ounces) or milk or eat some soft candies (but not chocolate).

- ******Bedtime Insulin** - Don't hesitate to check your blood sugar if you wake up in the middle of the night and are shaky, hungry, having nightmares, etc.

Questions???

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