Blood Glucose Monitoring
Clinical *Applications*

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Topics

- Frequency & timing of blood glucose (BG) monitoring in relation to diabetes meds
- *Structured* testing & pattern analysis
- Using software to identify patterns
- Motivating patients to monitor BG
- What to do when A1c & BG doesn't match

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Key Times To Check Blood Glucose (BG)

- Before Meals
- After Meals
- Before Bed
- Whenever hypoglycemia or hyperglycemia is suspected
- ASK how many times a day is your patient *willing* to monitor their BG?

-Hirsch, et al. (2008). Self-monitoring of blood glucose (SMBG) in insulin- and non-insulin-using adults with diabetes: Consensus recommendations for improving SMBG accuracy, utilization, and research. Diab Tech & Ther, Vol 10, pp. 419-439
-American Diabetes Association (2014). Standards of Medical Care In Diabetes- 2014. *Diabetes Care:* 37(1), S11-67

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American Diabetes Association (ADA) & European Association for the Study of Diabetes (EASD)

Blood Glucose (BG) Target Recommendations

- Pre-meal BG target: 70-130 mg/dl (3.8-7.2 mmol)
- Post-meal BG target: Less than 180 mg/dl (9.9 mmol/l)
- A1c: less than 7% in *most* patients
- Consider: age, life expectancy, years of diabetes, complications, co-morbidities, hypoglycemia unawareness)
- Hypoglycemia: BG below 70 mg/dl (3.8 mmol)
- Hyperglycemia: BG above 180 mg/dl (9.9 mmol/l)

1) American Diabetes Association (2014). Standards of Medical Care In Diabetes- 2014. *Diabetes Care:* 37(1), S11-67.
2) Inzucchi S.E. et al (2012). American Diabetes Association and European Association for the Study of Diabetes: Management of Hyperglycemia in Type 2 Diabetes: A Patient-Centered Approach. Position Statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care 2012;35:1364-1379.

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American Association of Clinical Endocrinologists Blood Glucose (BG) Targets

- Pre-Meal BG: Less than 110 mg/dl (6.1 mmol/l)
- Post-Meal BG: Less than 140 mg/dl (7.7 mmol/l) at 2 hours
- Checking BG before & *2 hours* after *same* meal
  -helps *clinician* evaluate meal plan & mealtime medication (Checking in Pairs)
  -helps *patient* learn how food choices & medication affects BG and if adjustments are needed

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BG Monitoring Based on Insulin Regimen

- **Basal Insulin Only:** *Fasting BG at least 3x/week*
- **Bolus Insulin Only:** *BG pre/post same meal, vary meal*
- **Basal/Bolus Insulin:** *Combination of fasting (at least 3x/week) and pre/post meal pairs (minimum one pair per week for each meal)*
- **Pre-Mix Insulin:** *Combination of fasting (at least 3x/week) and pre/post meal pairs (minimum one pair per week for each meal) and a few* bedtimes since pre dinner injection has two peak times

-AACE Diabetes Care Plan Guidelines (2011). Endocrine Practice: 17 (Suppl 2). Available at :https://www.aace.com/files/dm-guidelines-ccp.pdf
-Polonsky WH, Fisher L, Schikman CH, Hinnen DA, Parkin CG, Jelsovsky Z, Peersen B, Schweitzer, M, Wagner RS.
Structures self-monitoring of blood glucose significantly reduces A1c levels in poorly controlled, noninsulin-treated type 2 diabetes.
Diabetes Care, 34:262-267, 2011.

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What To Do With The Data

- ***Use "checking in pairs" & short experiments to problem solve adjusting meals, medications & physical activity***

BGM: What Would You Recommend?

- A newly diagnosed 37 year old pharmacist with Type 2 DM and an A1c of 8.2% placed on lifestyle modifications and metformin 850 mg twice daily.

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BGM: What Would You Recommend?

- A 28 year old school teacher with Type 1 DM and an A1c of 7.2% who takes glargine once daily and lispro pre-meals based on current BG and grams of carbs to be eaten

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BGM: What Would You Recommend?

- A 52 y.o. evening restaurant manager with Type 2 DM on metformin, glipizide and detemir with an A1c of 9.4%

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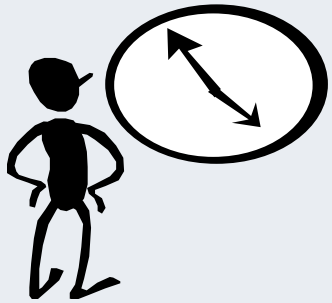
BGM: What Would You Recommend?

- A 19 year old college student with Type 1 DM for 10 years on intensive management with an Omnipod insulin pump and a Dexcom sensor

BGM: What Would You Recommend?

- An elderly Korean man with type 2 diabetes for 14 years on pre-mix insulin twice daily with multiple co-morbidities and an A1c of 7.9

BGM: What Would You Recommend?



Consider:

- A1c & BG Status & Goals
- Current diabetes medication regimen and how you & patient will use information
- Lifestyle/Schedule
- Hypoglycemia Risk
- Reimbursement

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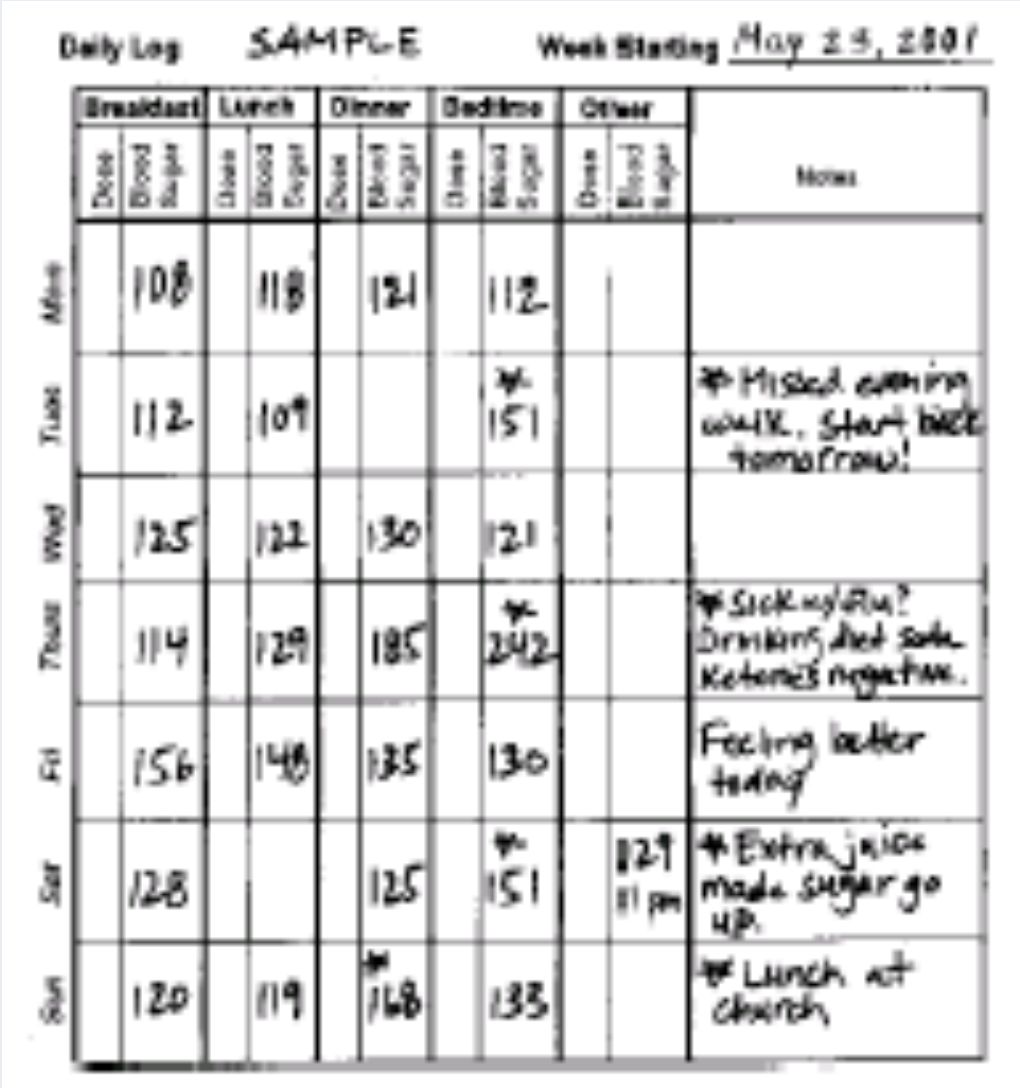
Interpreting Blood Glucose Data



Daily Log SAMPLE Week Starting May 25, 2001

	Breakfast		Lunch		Dinner		Bedtime		Other		
	Date	Blood Sugar	Date	Blood Sugar	Date	Blood Sugar	Date	Blood Sugar	Date	Blood Sugar	Notes
Mon		108		118		121		112			
Tues		112		109				* 151			* Missed evening walk. Start back tomorrow!
Wed		125		122		130		121			
Thurs		114		129		185		* 242			* Sick w/flu? Drinking diet soda. Ketones negative.
Fri		156		148		135		130			Feeling better today
Sat		128				125		* 151		129 11 pm	* Extra juice made sugar go up.
Sun		120		119		* 168		133			* Lunch at church

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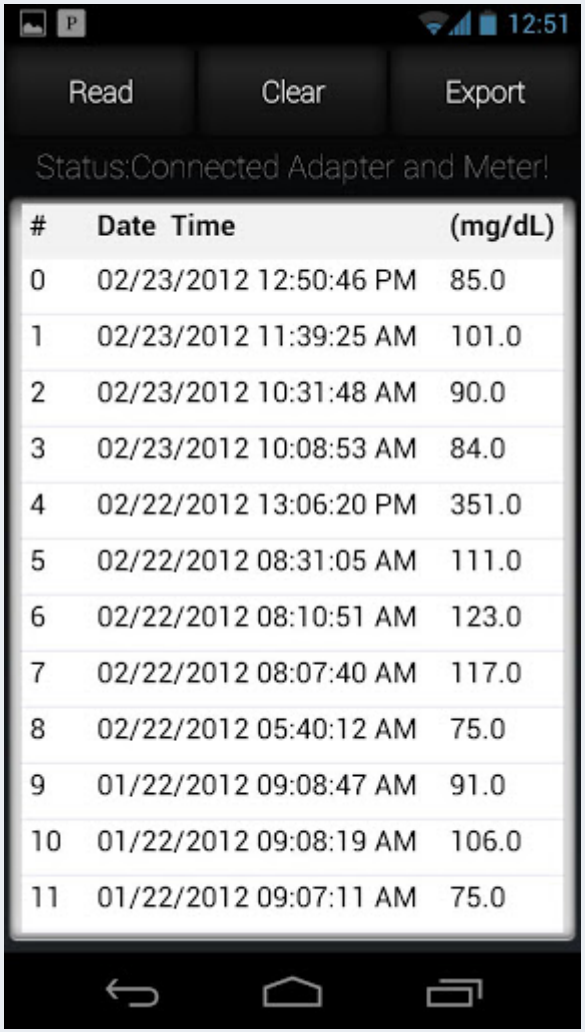
The Perils of Reviewing BG Data *Directly on Meter*

Pattern Anyone?



#	Date Time	(mg/dL)
0	02/23/2012 12:50:46 PM	85.0
1	02/23/2012 11:39:25 AM	101.0
2	02/23/2012 10:31:48 AM	90.0
3	02/23/2012 10:08:53 AM	84.0
4	02/22/2012 13:06:20 PM	351.0
5	02/22/2012 08:31:05 AM	111.0
6	02/22/2012 08:10:51 AM	123.0
7	02/22/2012 08:07:40 AM	117.0
8	02/22/2012 05:40:12 AM	75.0
9	01/22/2012 09:08:47 AM	91.0
10	01/22/2012 09:08:19 AM	106.0
11	01/22/2012 09:07:11 AM	75.0

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Blood Glucose (BG) Record Keeping

Log Book

- Helps review results quickly by time of day and meal
- Assists with *real time* basic pattern identification
- Comments can be easily added when BG is higher or lower than expected to discuss with clinician

Meter Memory

- Eliminates data entry errors e.g. wrong day, time (if clock is set right), wrong result or illegible handwriting
- Can be downloaded to PC or other device to analyze
- Provides charts, graphs and data statistics to facilitate pattern management

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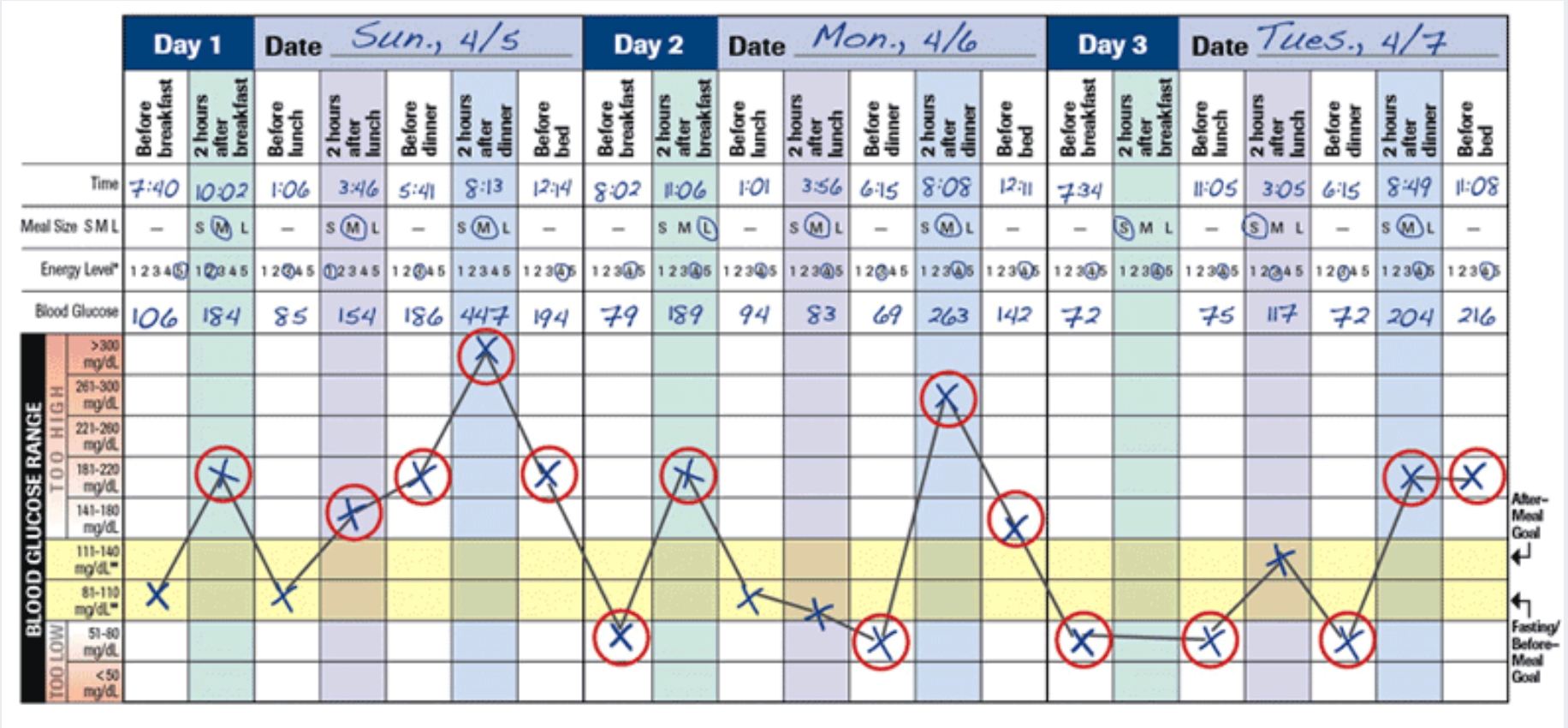
Roche 360° View: *Handwritten* Structured Testing 3 Day/7 point profile



Avaiable at: www.accu-chekconnect.com

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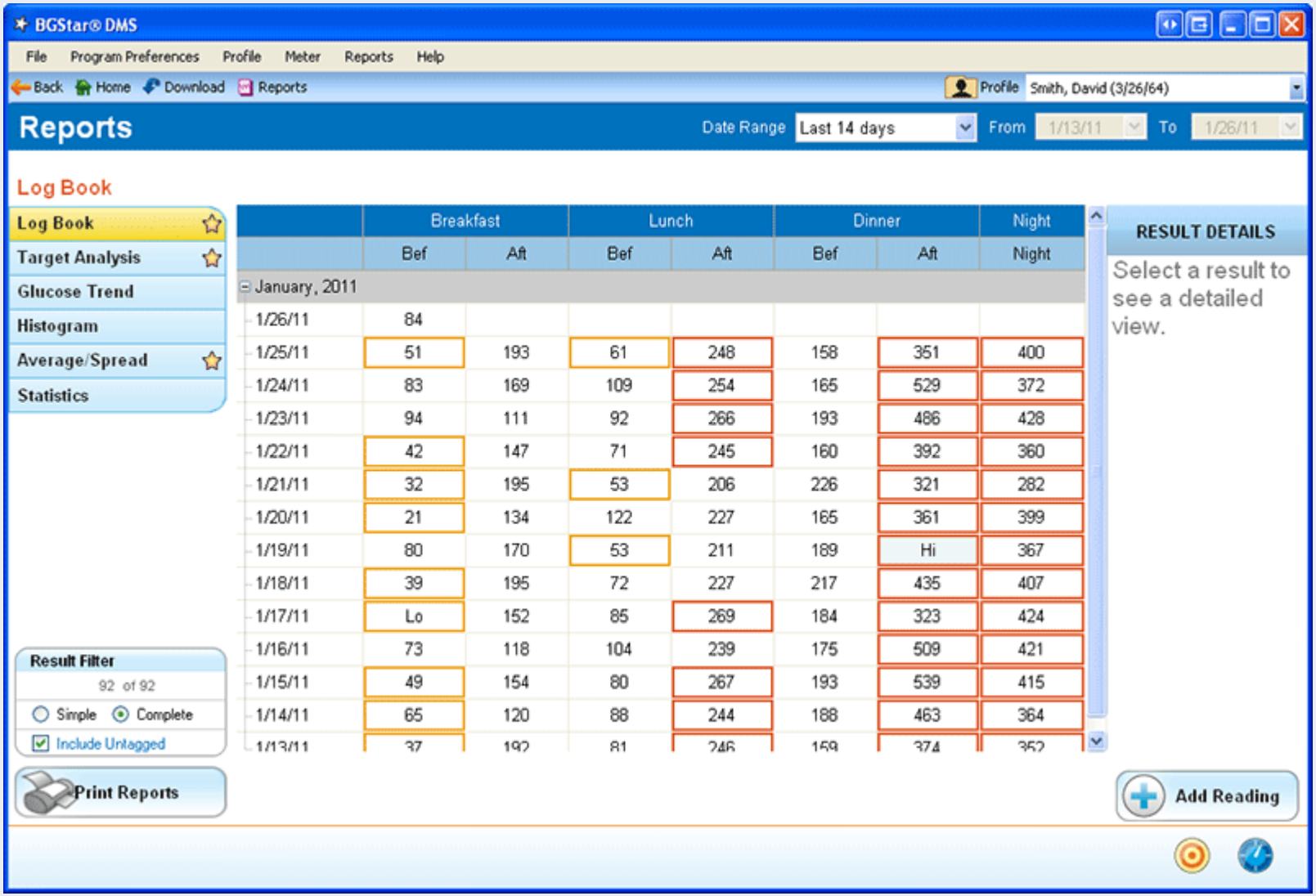
Identifying Patterns by Downloading Data

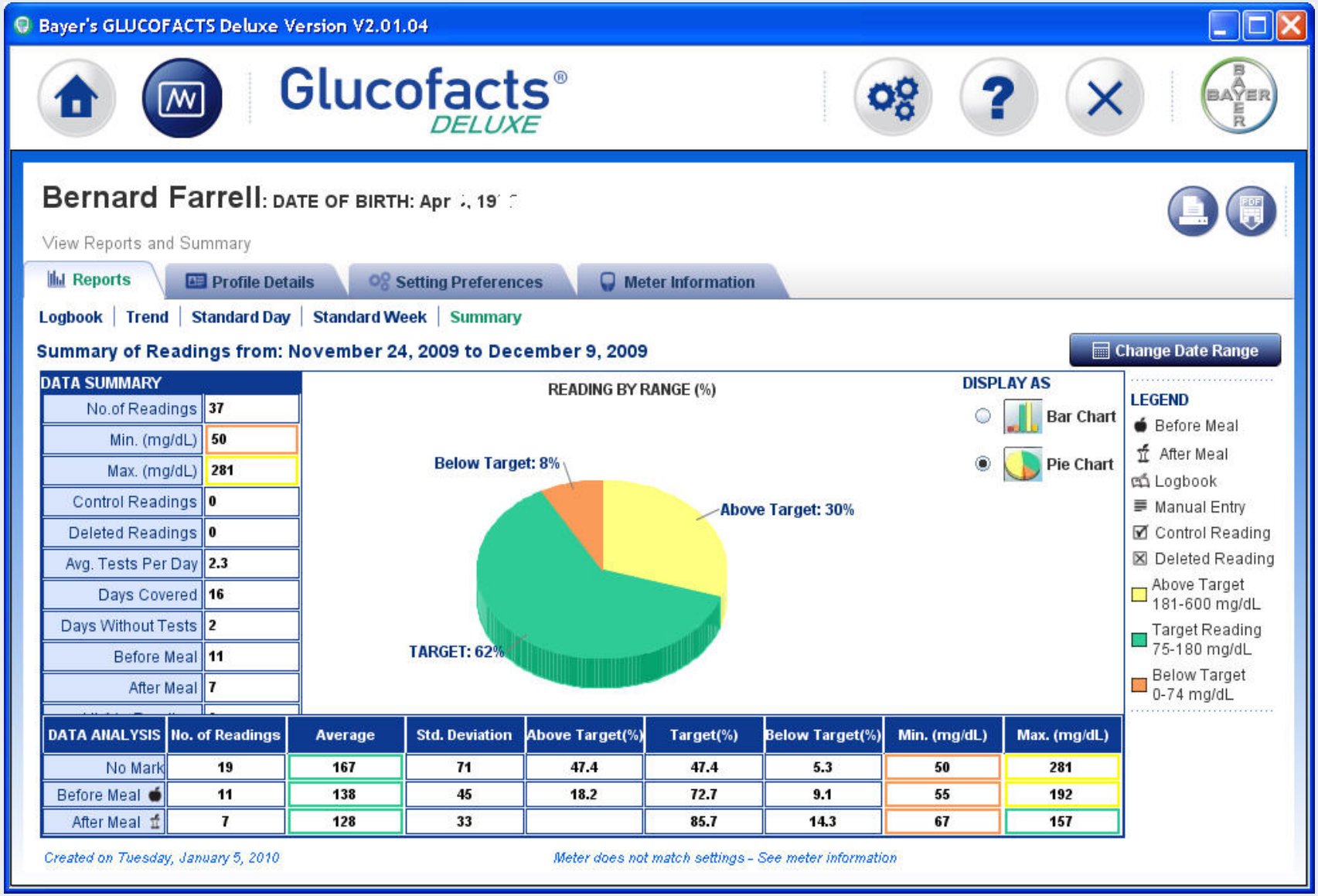
Types of Reports:

- *Electronic* **Log Book**
- **Pie Chart**: Shows % of lows, highs & in range
- **Modal or *Standard* Day**: Plots all the results for a time period in one 24 hr chart
- **Two Week Summary Report**: Plots results day by day
- **Histogram**: Frequency Distribution by BG Range
- **Statistics**: highest & lowest BG, means, standard deviations for pre & postprandial BGs, by time of day, frequencies

Meter Downloads: Electronic Log Book

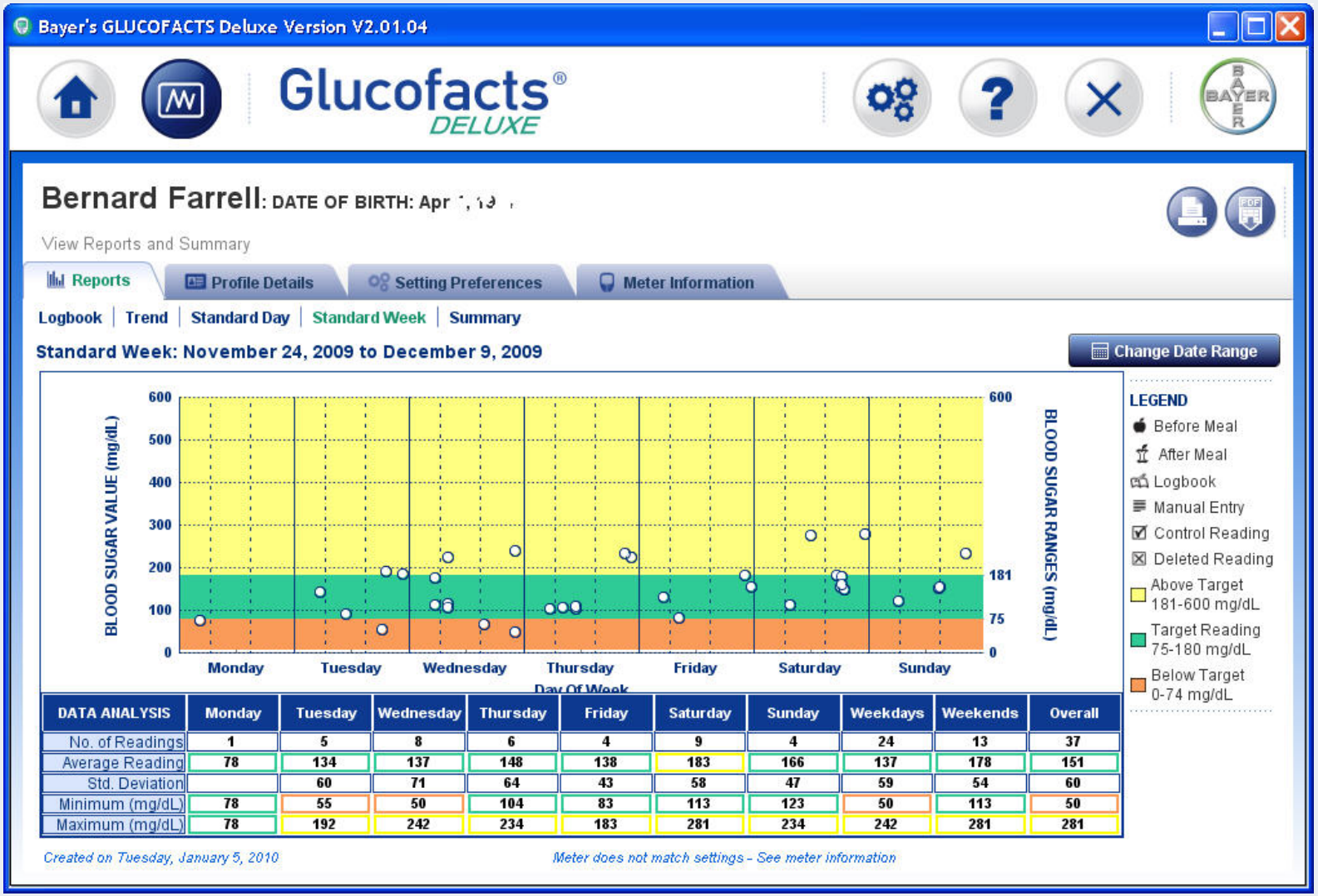


Meter Downloads:
Pie Charts



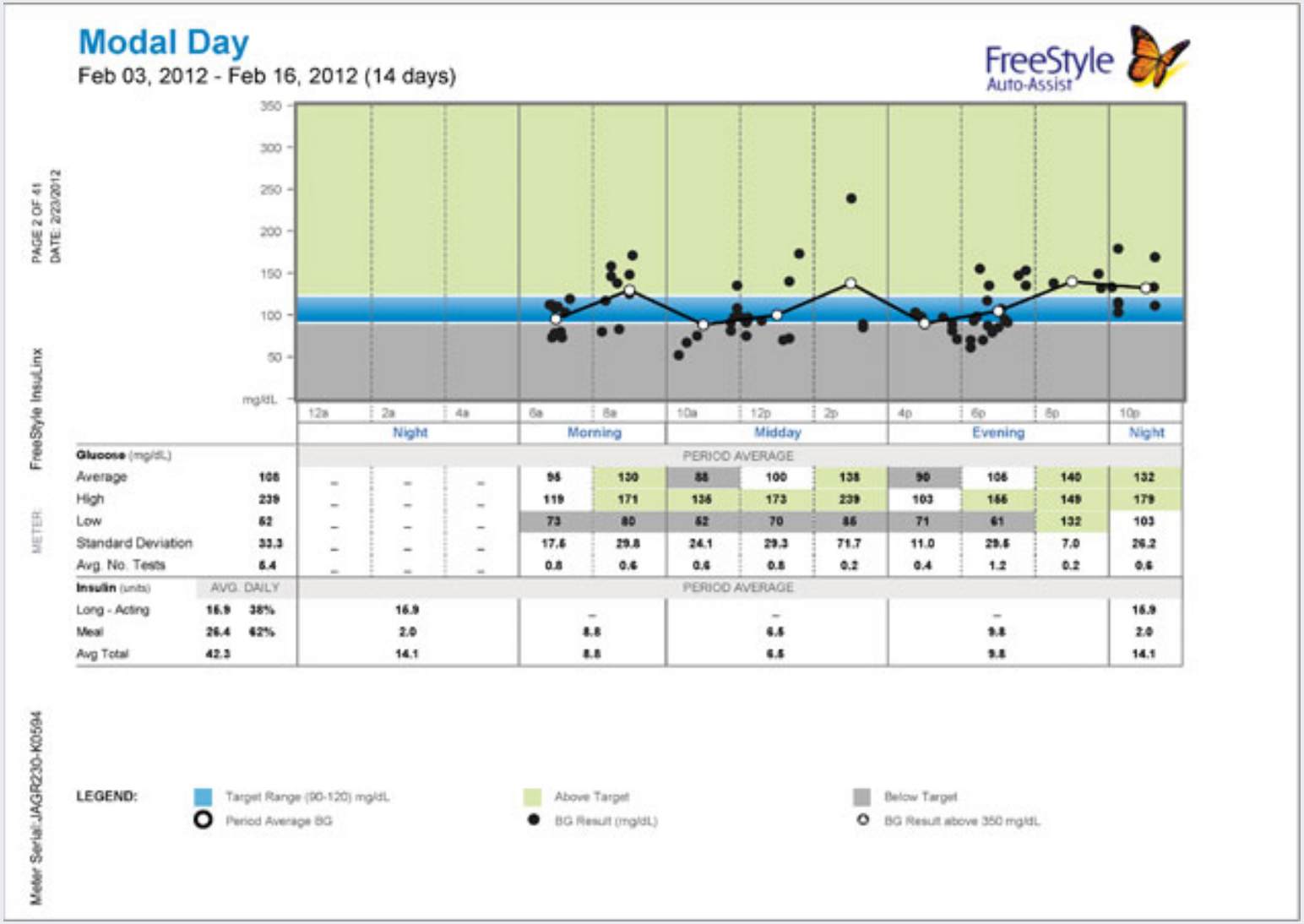
Meter Downloads: Standard Week

Plots BG by Day of Week



DATA ANALYSIS	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Weekdays	Weekends	Overall
No. of Readings	1	5	8	6	4	9	4	24	13	37
Average Reading	78	134	137	148	138	183	166	137	178	151
Std. Deviation		60	71	64	43	58	47	59	54	60
Minimum (mg/dL)	78	55	50	104	83	113	123	50	113	50
Maximum (mg/dL)	78	192	242	234	183	281	234	242	281	281

Meter Downloads: **Modal Day**
Plots BGs by Time of Day on 24hr Graph



Modal Day

Feb 03, 2012 - Feb 16, 2012 (14 days)

FreeStyle Auto-Assist

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DATE: 2/23/2012

METER: FreeStyle InsuLinx

Meter Serial: JAGR230-K0594

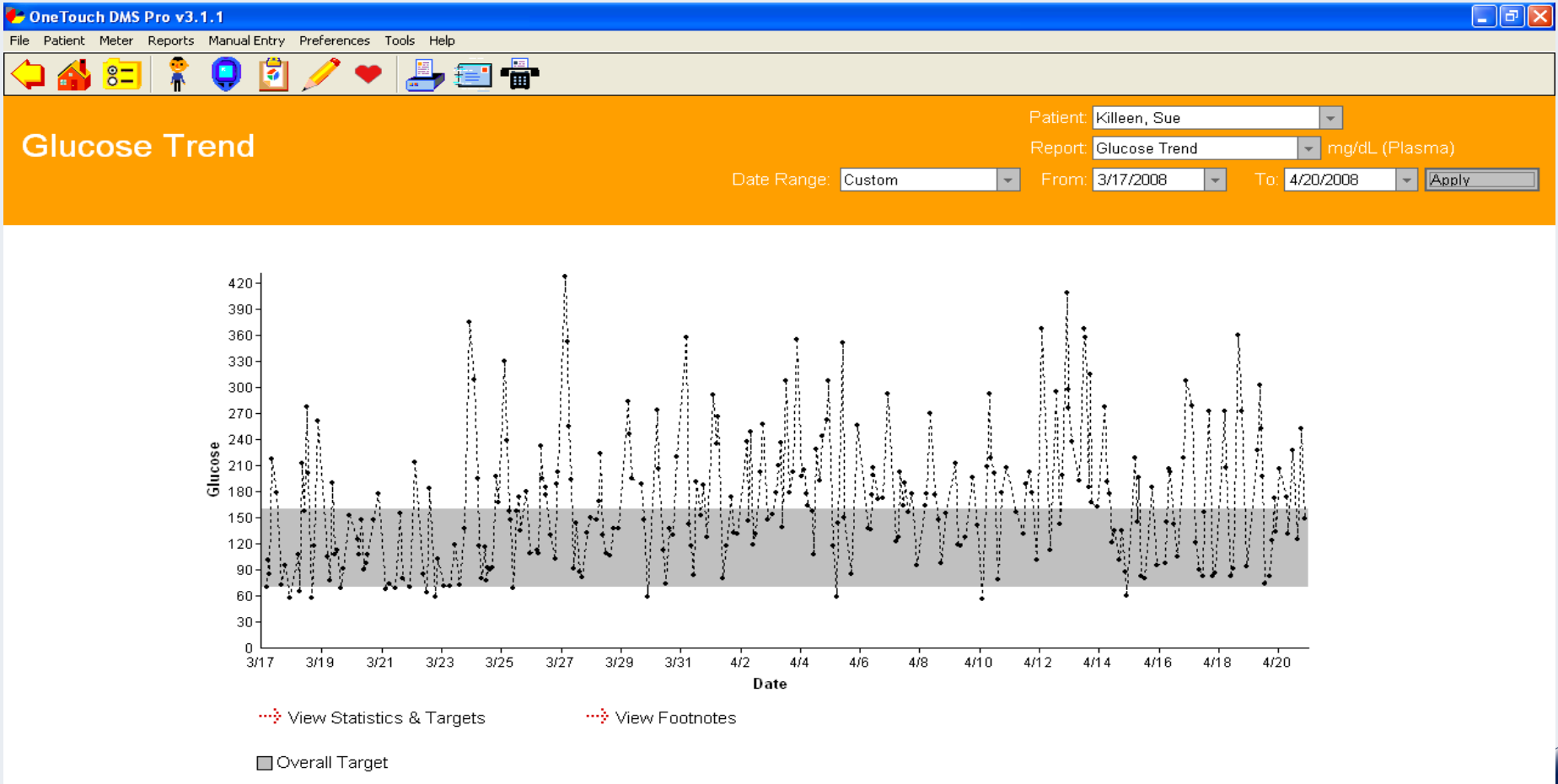
Glucose (mg/dL)		PERIOD AVERAGE											
Average	108	–	–	–	95	130	88	100	138	90	106	140	132
High	239	–	–	–	119	171	136	173	239	103	166	149	179
Low	62	–	–	–	73	80	62	70	86	71	61	132	103
Standard Deviation	33.3	–	–	–	17.6	29.8	24.1	29.3	71.7	11.0	29.6	7.0	26.2
Avg. No. Tests	5.4	–	–	–	0.8	0.6	0.6	0.8	0.2	0.4	1.2	0.2	0.6

Insulin (units)	AVG. DAILY		PERIOD AVERAGE										
Long - Acting	16.9	38%		16.9			–			–			16.9
Meal	26.4	62%		2.0			8.8			6.6			2.0
Avg Total	42.3			14.1			8.8			6.6			14.1

LEGEND:

- Target Range (90-120) mg/dL
- Period Average BG
- Above Target
- BG Result (mg/dL)
- Below Target
- BG Result above 350 mg/dL

Meter Downloads:
Glucose Trends *Day by Day*



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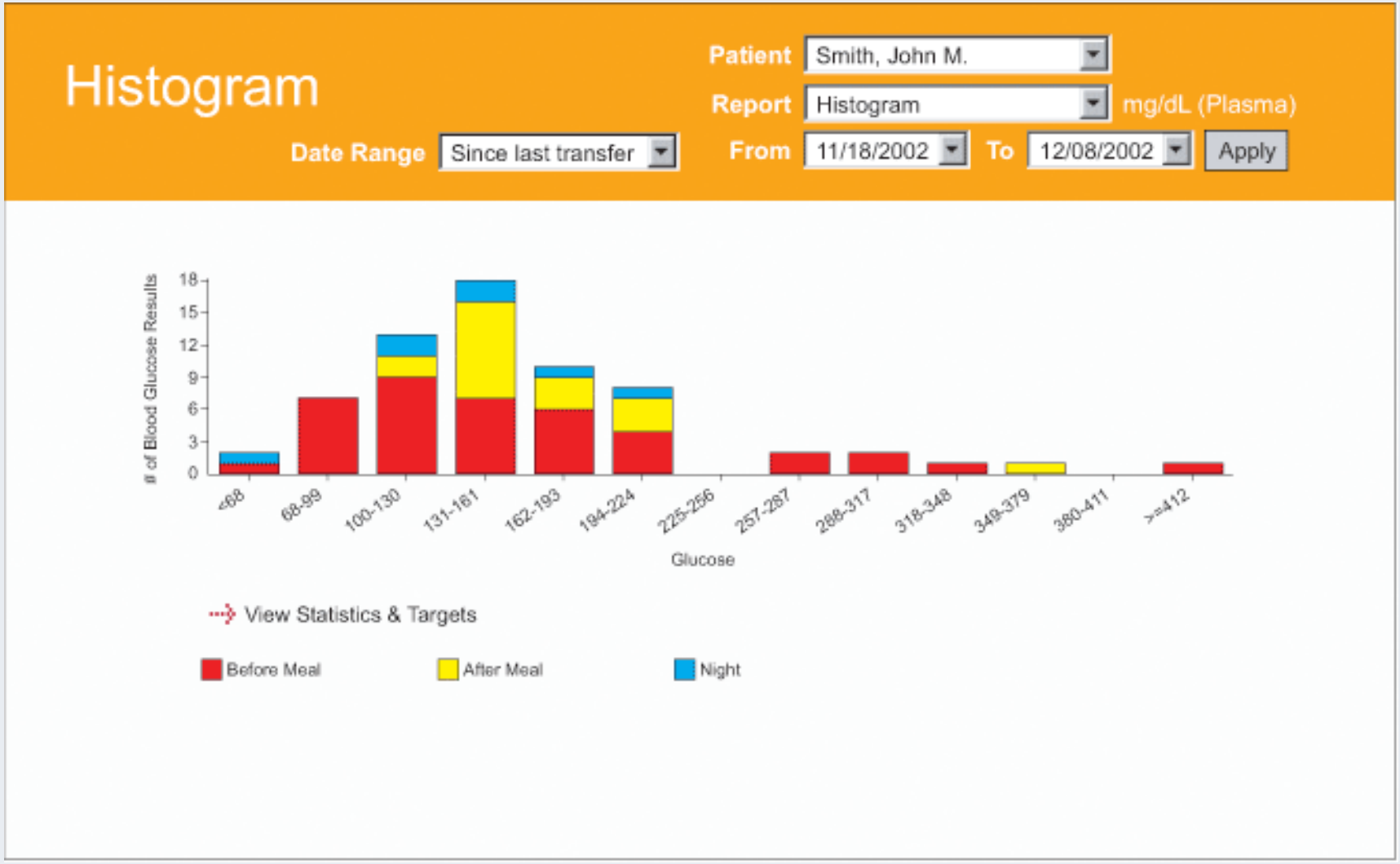
Meter Downloads: Histograms
Frequency by BG Ranges



Adjusting Meals, Physical Activity & Diabetes Medications

Consider:

- Are pre and post prandial glucose targets met? Is A1c at goal?
- Carbohydrate intake (amount, type, timing)
- Diabetes medication (amount, type, timing)
- Activity level/exercise (frequency, type, timing)
- Factors that could influence high or low glucose levels: Physical stress or illness (e.g. menses, flu), Emotional stress (short term or ongoing?)

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Motivating Patients To Monitor BG

Education & Practice

Focus On…

Why?

-What BG numbers mean at different times of day

–Set individual targets

When?

Frequency of BGM? Times to check?

How?

Practice with return demos, Review technique over time

Nattrass M. Instruments for self-monitoring of blood glucose. *Clinical Chemistry, 48(7)979-980, 2002.*
Kruger D. Psychological motivation and patient education: a role for continuous glucose monitoring. *Diab Tech & Ther, 2(1)S-93-S-97, 2000.*

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Motivating Patients To Monitor BG

- Consider ways to improve comfort e.g. site selection & preparation, equipment used
- Optimize reimbursement, preferred brands, lower out-of-pocket costs
- Look at when patient skips BG monitoring and discuss barriers
- Offer extra meter to leave at work or school
- *Discuss* BG results at every visit and make changes based on data

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Motivating Patients To Monitor BG

Recommend:

- Use sides of fingers and *rotate* sites to improve comfort
- Milk/massage site prior to puncture to increase flow
- Experiment with different lancets, lancing devices and depth settings on lancing devices
- Encourage patients to change lancets at least once a day
- Encourage use of lancing device every time to minimize trauma

-Hirsch, et al. (2008). Self-monitoring of blood glucose (SMBG) in insulin- and non-insulin-using adults with diabetes: Consensus recommendations for improving SMBG accuracy, utilization, and research. Diab Tech & Ther, Vol 10, pp. 419-439.
-Klonoff, D.C. (2011). Improving the safety of blood glucose monitoring. *J Diabetes Sci Technol*; 5(6):1307-1311

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Motivating Patients to Monitor BG: Consider Alternative Site Testing (AST)

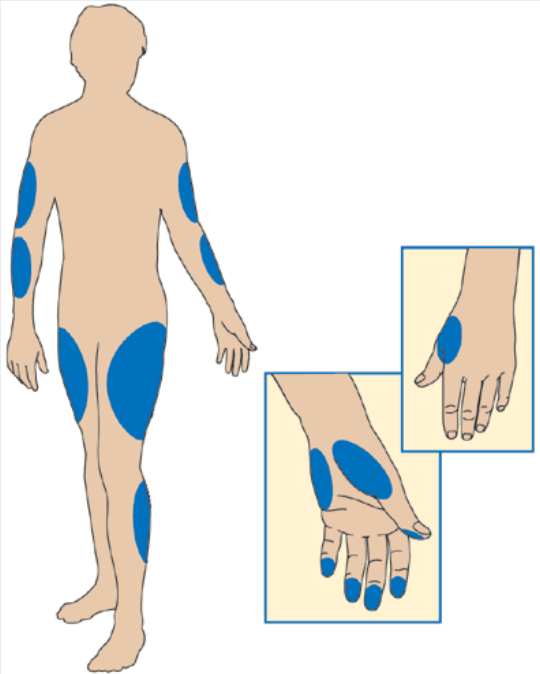
- AST can help patients give their fingers a rest
- Beware of possible *lag time* of 5-20 minutes
- Rub site before lancing to increase blood flow, may reduce "lag" time
- Recommend using finger or palm:

  -when BG is rapidly rising or falling

  e.g. *post* meals or post exercise

  -before driving

  -if hypoglycemia is suspected



Last But Not Least:
What to do when A1c & BG don't match

- **Measurement Errors?** Check presence of hemoglobinopathies, hemolytic anemia, post- blood transfusion or any nutritional deficiencies (e.g. iron, folate, B12)
- **Glucose variability?** Average (mean) blood glucose may be a reflection of extremes ranging from low to high
- **Number of BGs?** Are there enough readings to give you a fair representation to identify patterns?
- **Timing of BGs?** Are they done at the *right* times throughout the day and night?

-Cohen, R.M. & Lindsell, C.J. (2012). When the blood glucose and HbA1c don't match: Turning uncertainty into opportunity. Diabetes Care: 35; pp. 2421-2422,
--Hirsch, et al (2012). Using Multiple Measures of Glycemia to Support Individualized Diabetes Management: Recommendations for Clinicians, Patients, and Payors. Diab Tech & Ther, 14(11), 973-983

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Questions?