



THE NEW WORLD OF MONITORING

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CVPH

Relationships with commercial interests:

Grants/Research support NOVONORDISK; SANOFI

Speaker's bureau/honoraria:DEXCOM; ANIMAS; MEDTRONIC; ELI LILLY
NOVORDISK; BI ; SANOFI; ABBOTT

Consulting/Advisory Board:SAME AS ABOVE

Other/Patents

Personal Decisions

Diabetes Technology

How will I monitor glucose?

1. Manual blood glucose meter
2. Intermittent scan sensor
3. Real-time continuous automated sensor

Consider

- a. Personal tolerance for finger-sticks to calibrate/confirm accuracy
- b. How sensor/meter interacts with pumps or smart-devices
- c. Desire for an automated insulin delivery (AID) system (requires rtCGM)

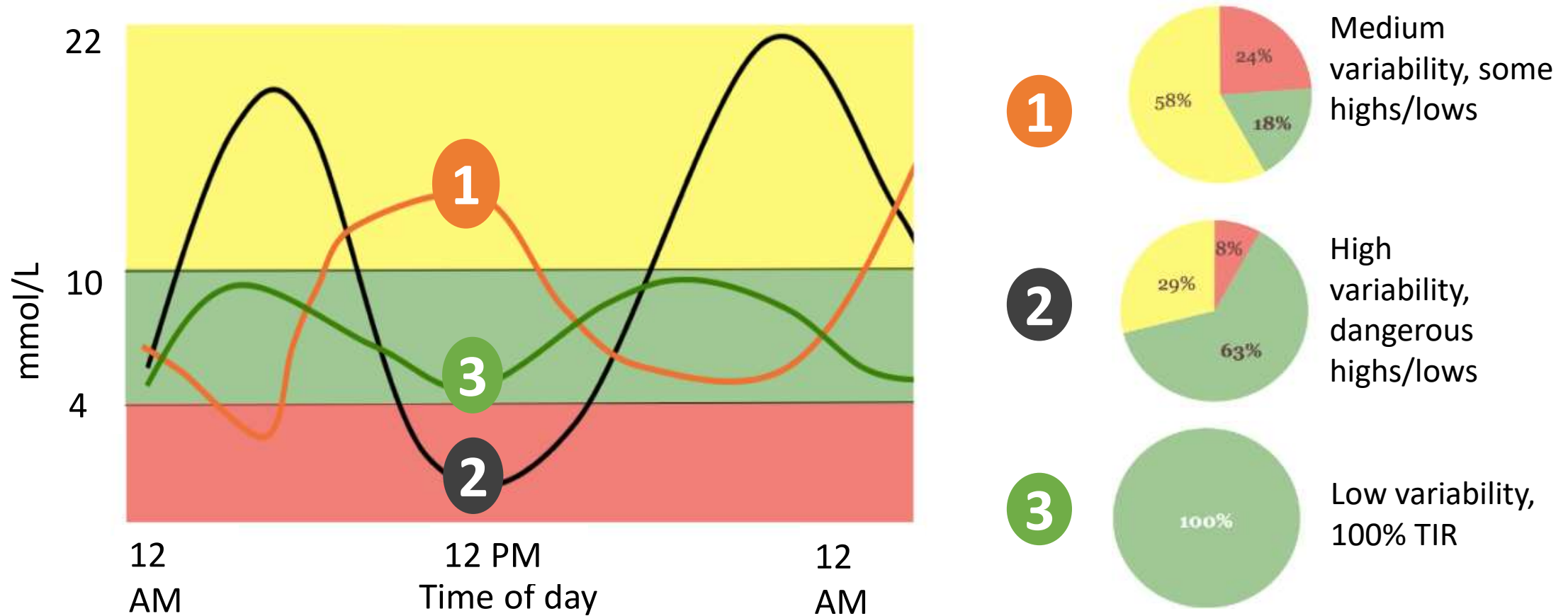
How will I deliver insulin?

1. Manual injection
 - Pen
 - Syringe
2. Continuous pump
 - Tubeless
 - Tubed
 - Automated Basal
 - Automated Basal and Bolus*

*Light grey font indicates options **not** currently available in Canada as of March 2019

Same A1C

CGM pattern drives different treatment plans



A1C as a Measure Of Glycemia

PROS

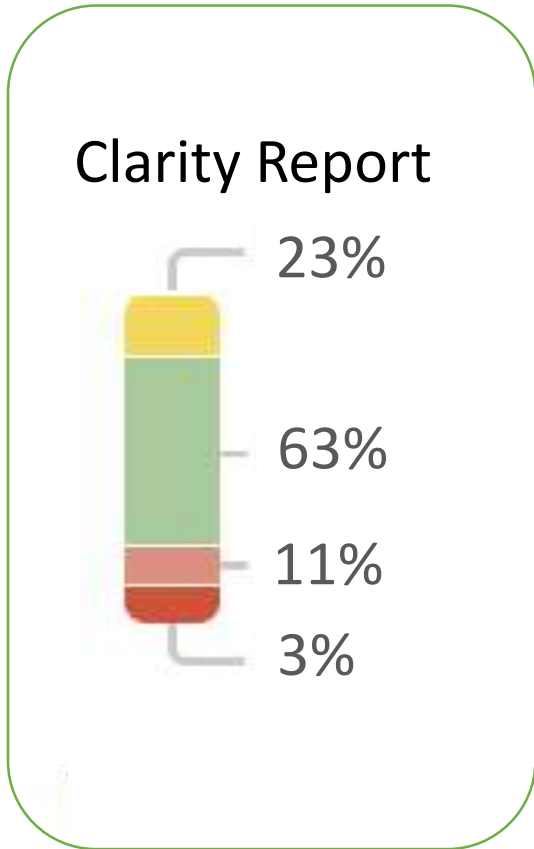
- Standardized measure for epidemiologic diabetes assessment
- Predicts long term complications
- Primary outcomes measure for RCTs
- Diagnostic

CONS

- For the same A1C mean glucose can vary widely
- A1C goals for patients may be misleading
- Does not provide insight into quality of glucose control
- Not actionable



2019 International CGM targets



	mmol/L	
TAR: Time above range	> 13.9	Level 2 hyperglycemia < 5%
	> 10.0	Level 1 hyperglycemia < 25%
TIR: Time in range	3.9 -10.0	> 70%
TBR: Time below range	< 3.9	Level 1 hypoglycemia < 4%
	< 3.0	Level 2 hypoglycemia < 1%



Continuous Glucose Monitoring (CGM) Systems

Measure glucose concentration in interstitial fluid

2 types:

Real time or personal: continuously displays BG levels

Blinded or professional: captures BG levels that can be downloaded later

Real-time CGM has been shown to

reduce A1C

in adults and children with type 1 diabetes with and without CSII

in adults with type 2 diabetes

reduce time spent in hypoglycemia

Successful use of CGM is dependent on adherence with duration of time used

BG, blood glucose; CSII, continuous subcutaneous insulin infusion

Dexcom G5 or G6 continuous rtCGM

Use with MDI, manual entry or connected to pump

Share with Followers optional



†For a list of compatible devices, visit www.dexcom.com/compatibility



The FreeStyle Libre System

Small sensor size (35mm x 5mm)

Wear for up to 14 days

No finger stick calibrations

Automatically measures, captures, and stores

Each scan of the sensor gives:

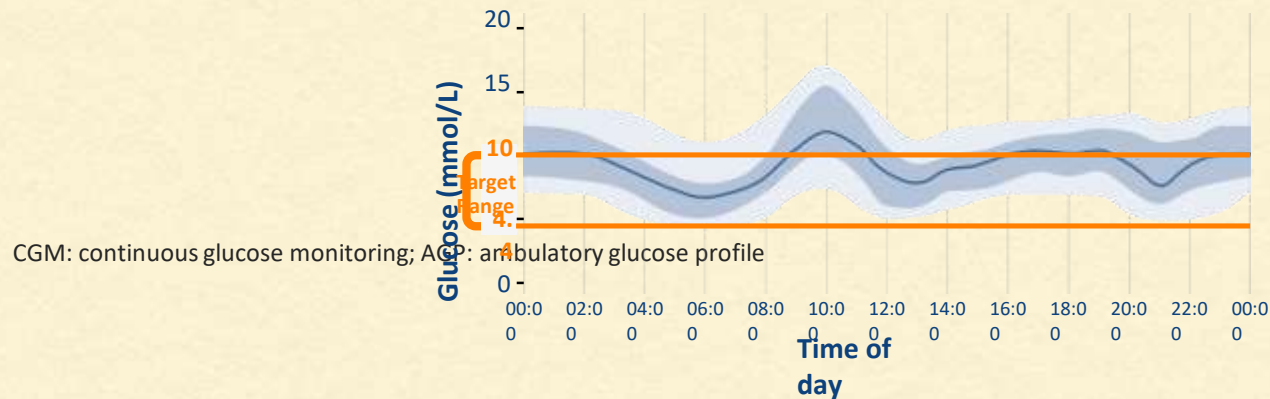
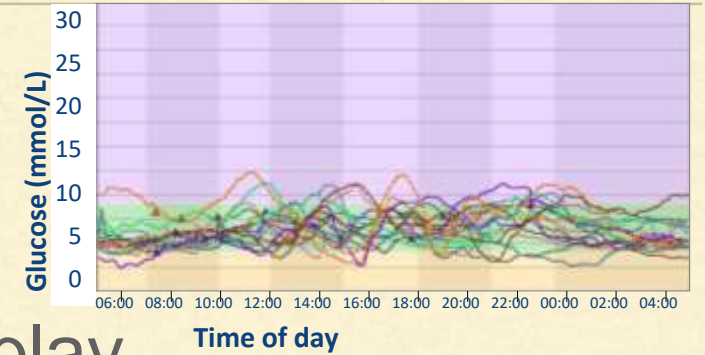
- Current glucose reading
- 8 hour history
- Trend arrow – shows direction glucose is heading

ISSUES OF TEST IN CLINICAL PRACTICE

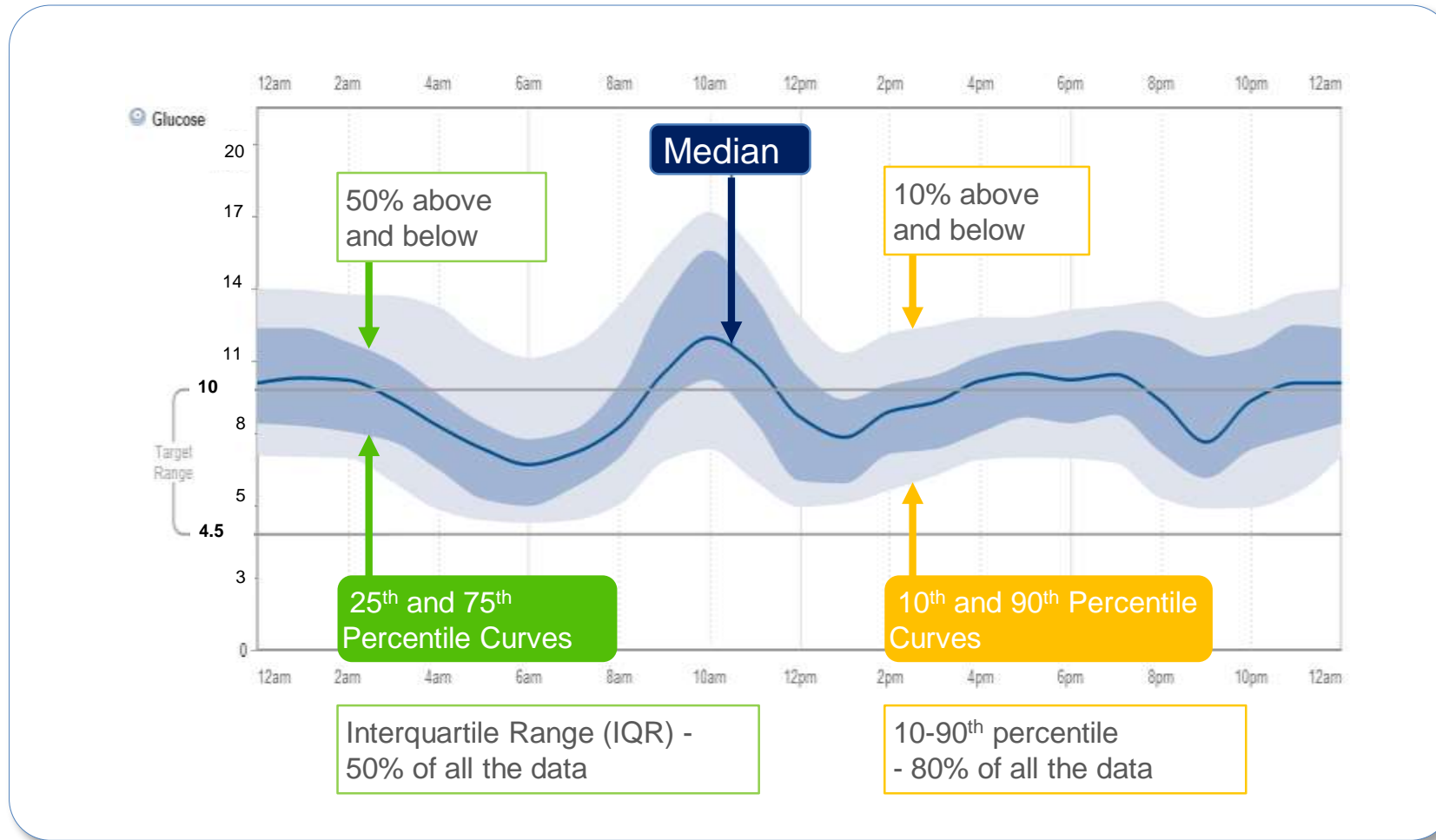
- tests results not brought(dog ate it)
- test once or twice a day
- no profile
- complicated insulin or oral agents regime
- impossible to adjust with no information
- meter has wrong date ;time and year!!!!

Ambulatory Glucose Profile (AGP)

- Algorithm developed by the IDC (International Diabetes Centre)
- Single report with statistical summary, visual display and daily views of glucose information
- Analyzes glucose data collected over days/weeks as if they occurred within a single 24-hour period
- Provides a comprehensive view of changing glucose levels/patterns over 14 days



Ambulatory Glucose Profile: 5 curves



AGP graphic interpretation

STEP 1: Are there patterns of hypoglycemia?

STEP 2: Are the readings within target range?

STEP 3: What is the shape of the median curve?

STEP 4: What is the width of the Interquartile Range (IQR)?

Consider various causes for hypoglycemia, hyperglycemia and glucose variability

Monitoring with Meaning ...

SMBG accompanied by structured educational program to facilitate behaviour change results in improved outcomes

Teach patients

1. How and when to perform SMBG
2. How to record the results
3. Meaning of various BG levels
4. How behaviour and actions affect SMBG results

Individualize Frequency of SMBG

Diabetes Canada SMBG tool - provides guidance on appropriate situations for SMBG utilization

<http://guidelines.diabetes.ca>

SMBG, self-monitoring of blood glucose

Recommendation 1

1. For most individuals with diabetes, **A1C** should be measured approximately **every 3 months** to ensure that glycemic goals are being met or maintained [Grade D, Consensus]. In **some circumstances**, such as when significant changes are made to therapy, or during pregnancy, it is appropriate to **check A1C more frequently**. Testing at least **every 6 months** should be performed in adults during periods of treatment and healthy behaviour **stability** when glycemic targets have been consistently achieved [Grade D, Consensus]



Recommendation 2

2. For individuals using **insulin more than once a day**, **SMBG** should be used as an essential part of diabetes self-management [Grade A, Level 1 for type 1 diabetes; Grade C, Level 3 for type 2 diabetes] and should be undertaken **at least 3 times per day** [Grade C, Level 3] and include both **pre- and postprandial** measurements [Grade C, Level 3]. For individuals with type 2 diabetes on **once-daily insulin** in addition to non-insulin antihyperglycemic agents, testing **at least once a day** at variable times is recommended [Grade D, Consensus].



Recommendation 4

4. **In many situations**, for all individuals with diabetes, **more frequent SMBG** testing should be undertaken to provide information needed to make health behaviour or antihyperglycemic medication adjustments required to achieve desired glycemic targets and avoid risk of hypoglycemia [Grade D, Consensus]

Recommendation 5

5. In people with **type 1 diabetes** who have not achieved their glycemic target, **real-time CGM** may be offered to improve glycemic control [Grade A, Level 1A for non CSII users; Grade B, Level 2 for CSII users] and reduce duration of hypoglycemia [Grade A, Level 1A] in individuals who are willing and able to use these devices **on a nearly daily basis**

pump patient

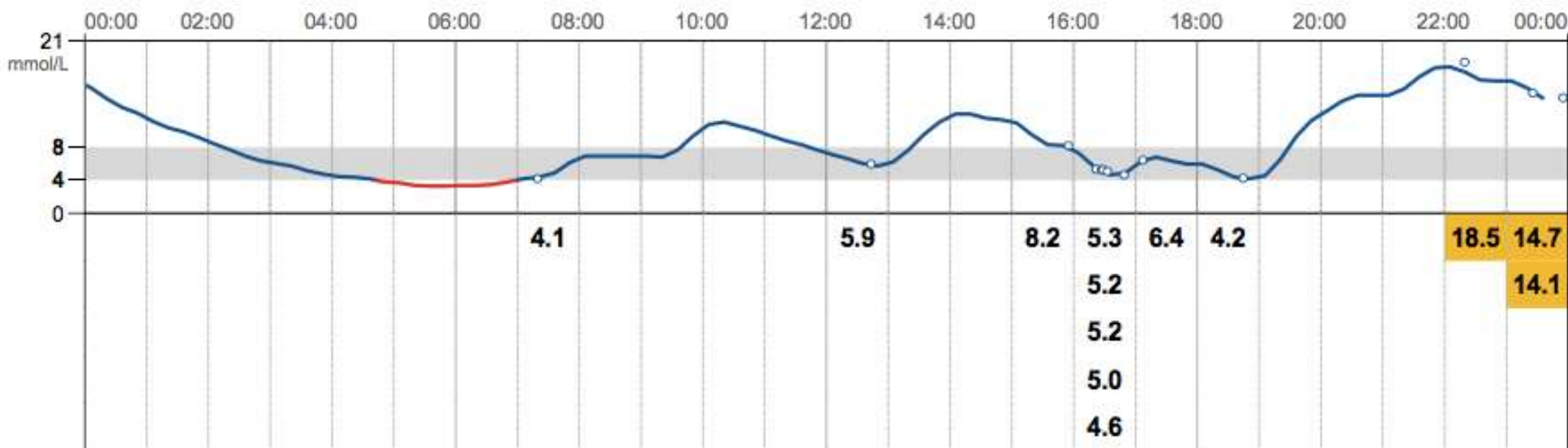
- MR R ON PUMP THERAPY
- A1C 0.074
- JUST GOT LIBRE
- WHAT CHANGES WOULD YOU MAKE

Daily Log

19 January 2018 - 15 February 2018 (28 days)

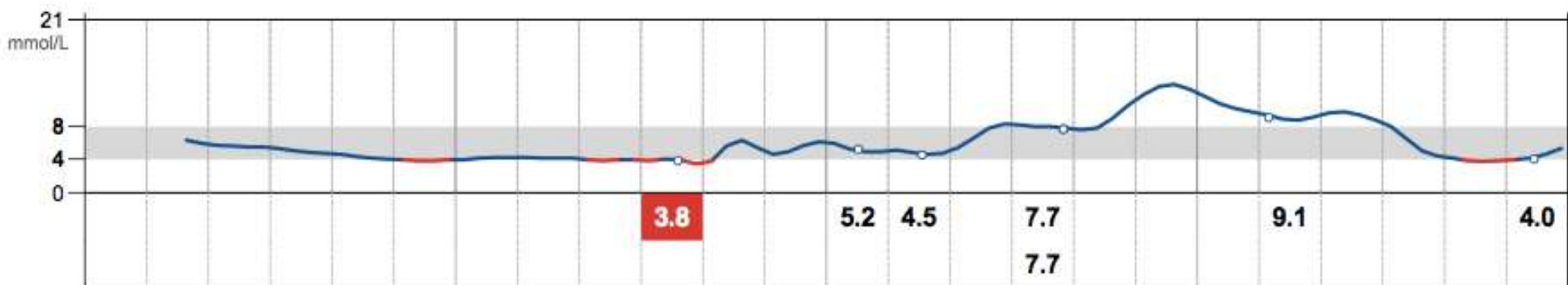
Fri 19 Jan

 Glucose
mmol/L



Sat 20 Jan

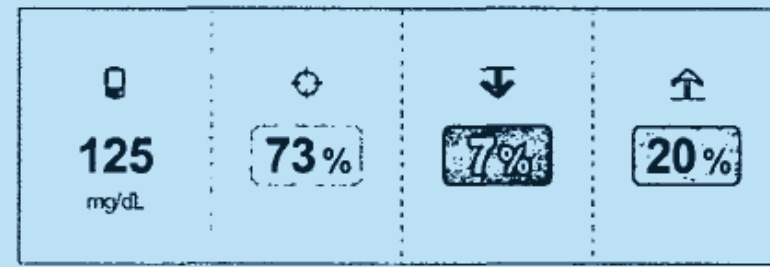
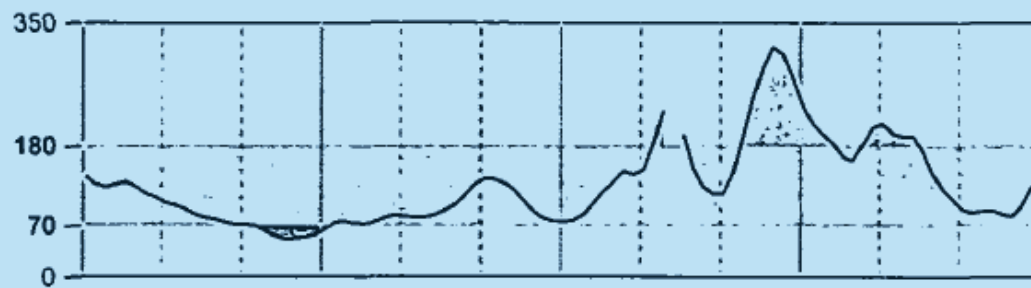
 Glucose
mmol/L



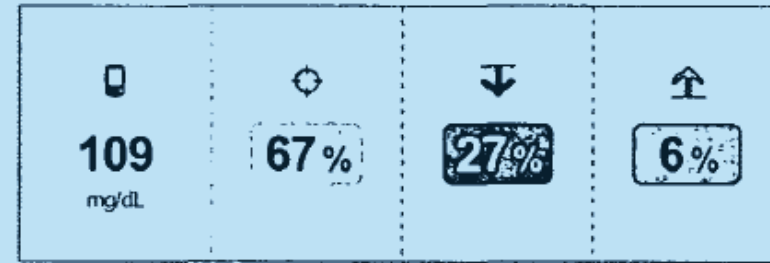
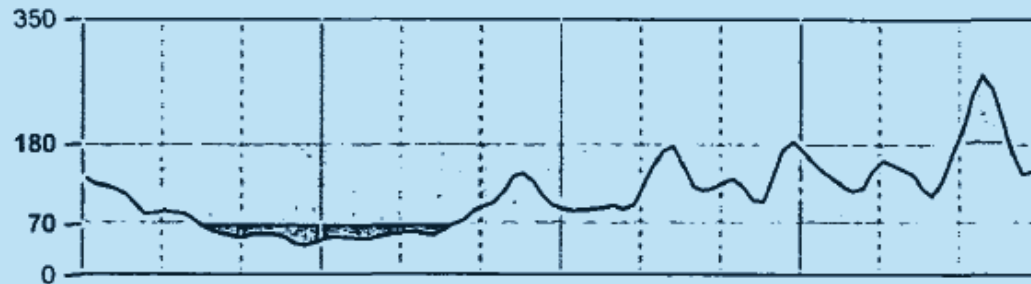
Sun 21 Jan



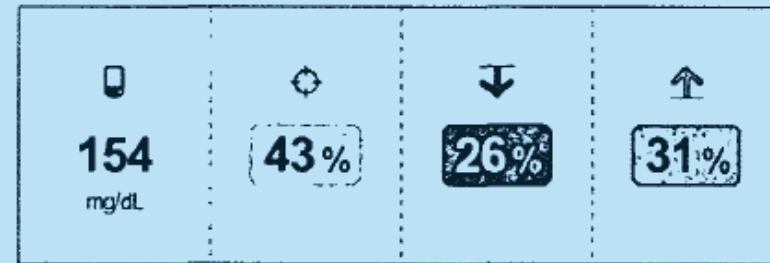
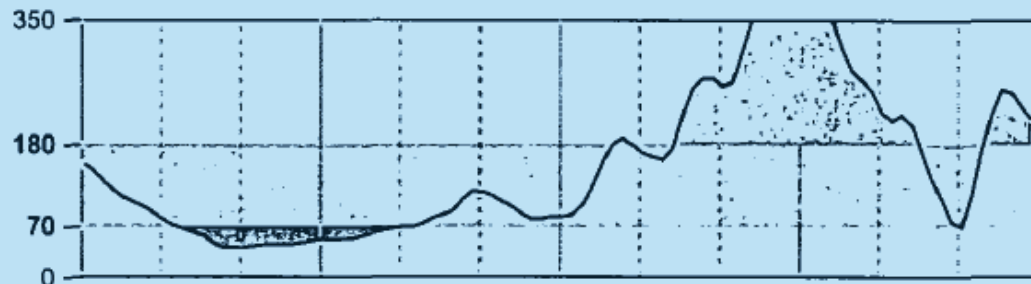
Sat
Feb 17



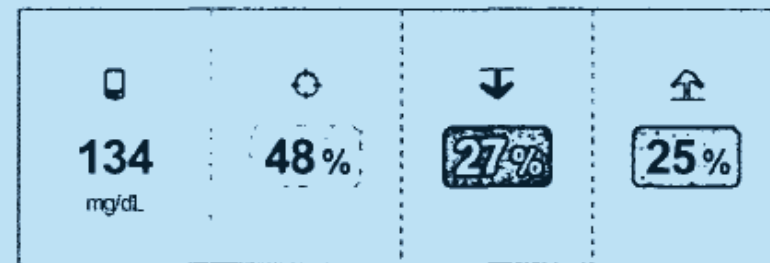
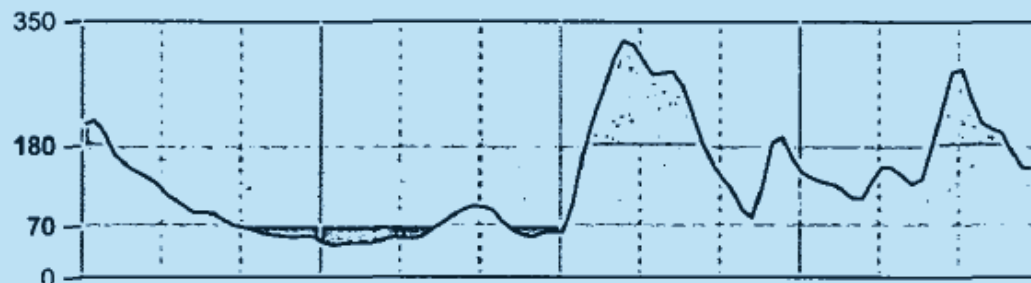
Sun
Feb 18



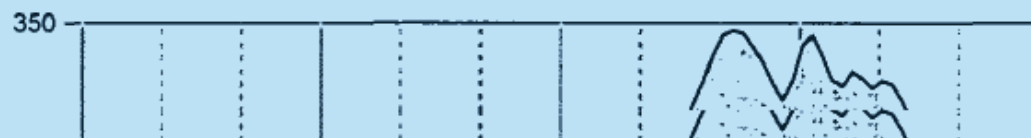
Mon
Feb 19



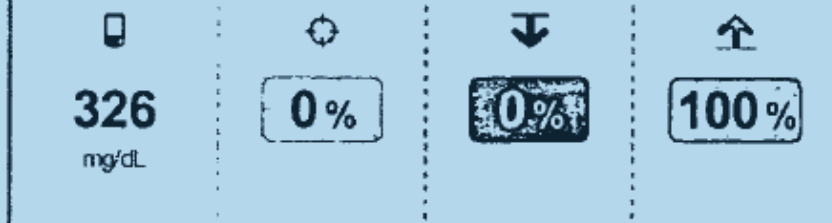
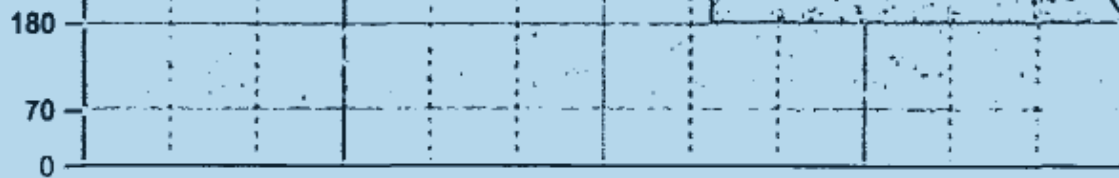
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Feb 20



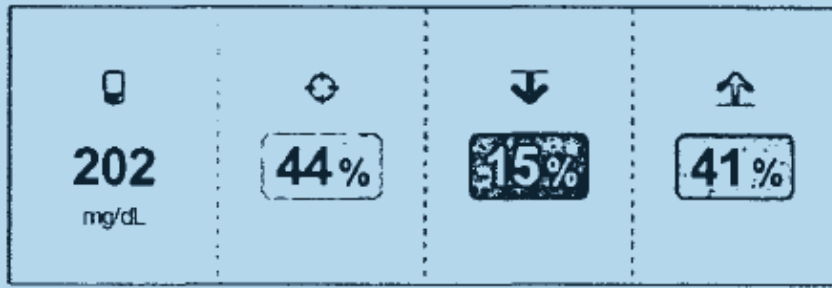
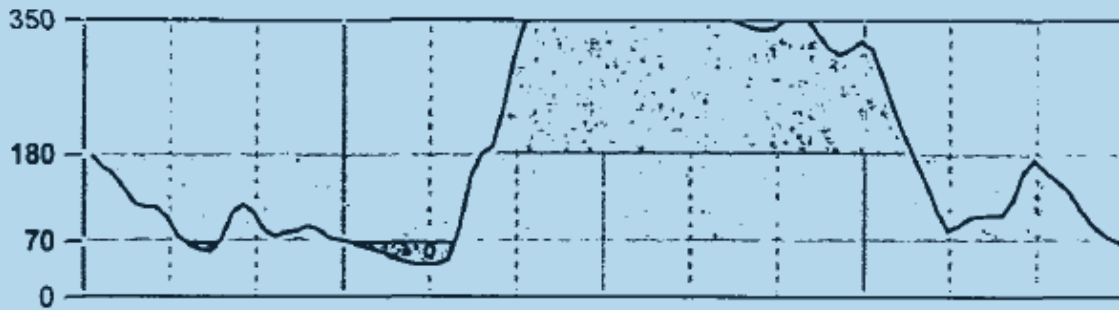
Wed
Feb 21



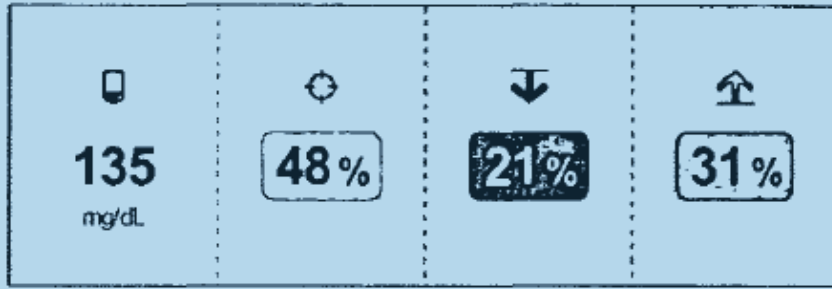
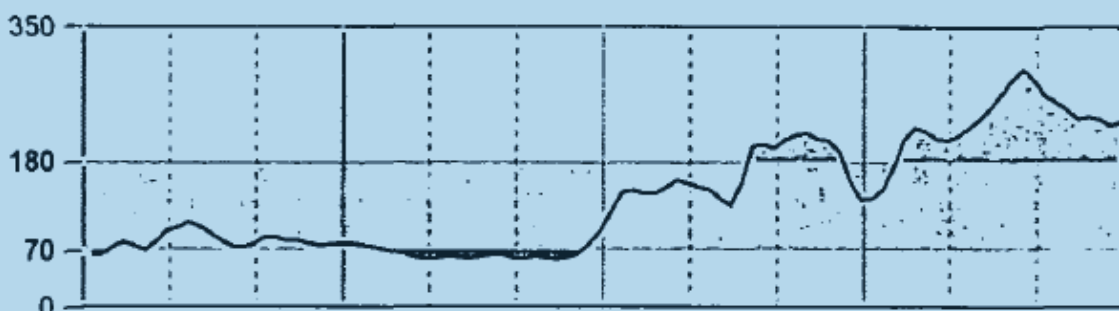
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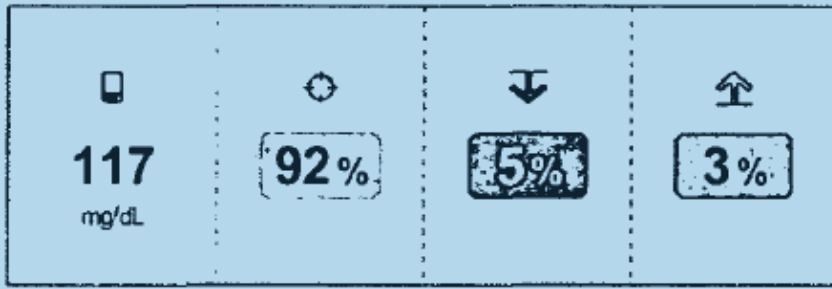
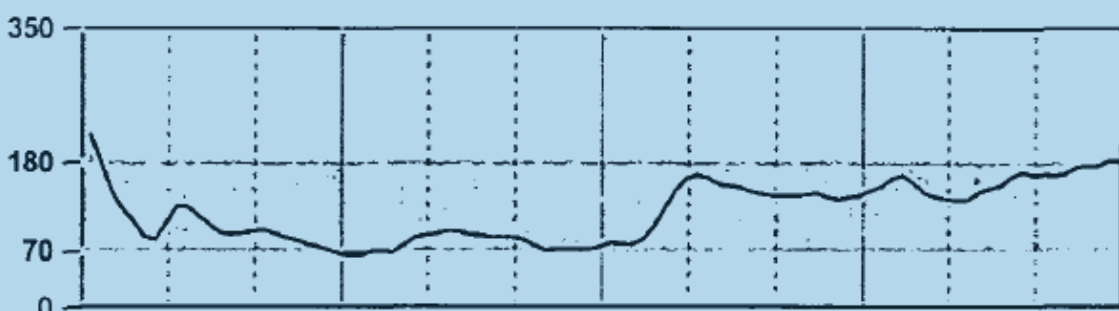
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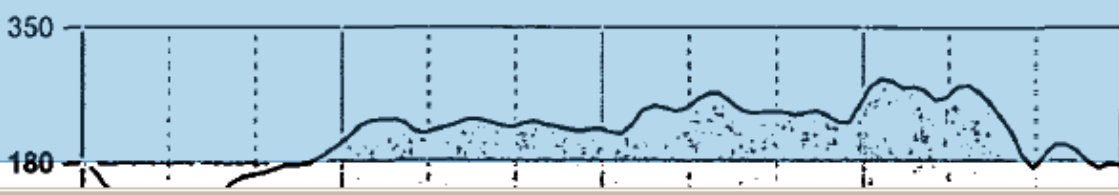
18



19



20



- MRS S
- ON TREISBA 40 UNITS IN AM/METFORMIN; GFR 30
- COMES FOR ASSESSMENT
- MORNINGS ARE ALWAYS GOOD
- SHE DOES NOT UNDERSTAND WHY A1C 0.086
- WHAT DO YOU THINK?

Glucose Pattern Insights

March 23, 2018 - April 5, 2018 (14 Days)

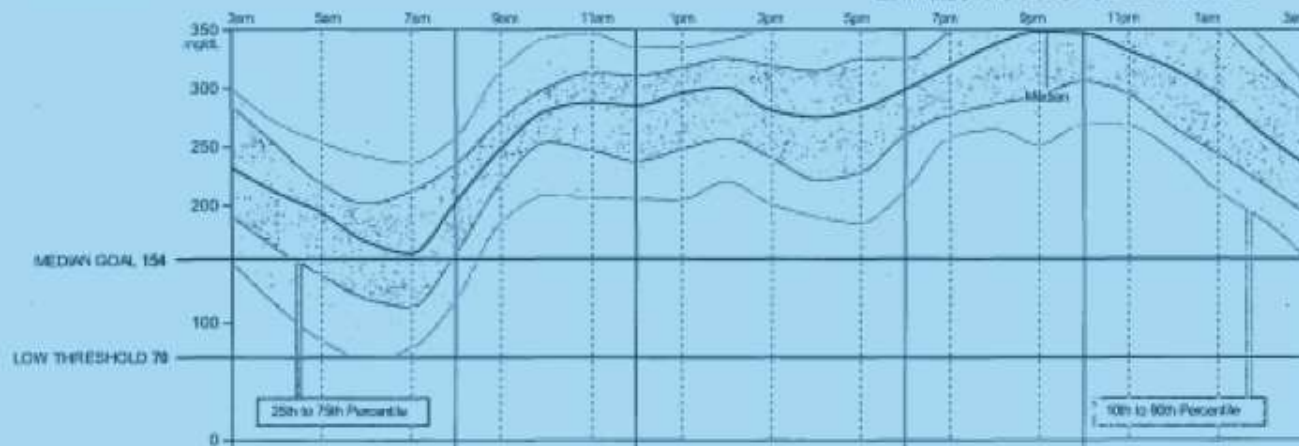
LibreView

Glucose

Estimated A1c **10.9 %** or **96 mmol/mol**

PRINTED 04/05/2018

Podiatry Phone 518-314-3460



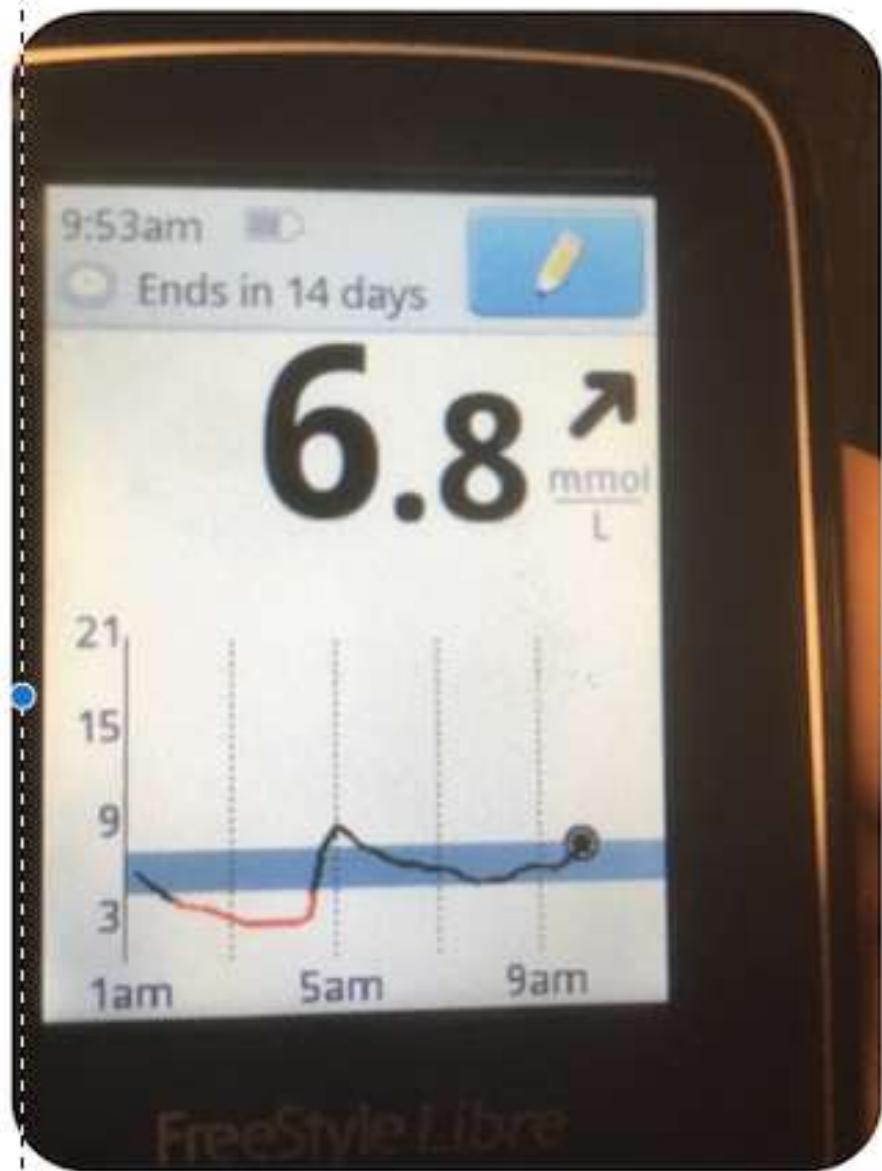
Likelihood of LOW GLUCOSE					
MEDIAN GLUCOSE Compared to goal					
VARIABILITY BELOW MEDIAN Median to 10th percentile					

VARIABILITY BELOW MEDIAN IS HIGH This makes it difficult to achieve the median glucose goal without increasing the likelihood of low glucose. Factors that could contribute to variability below median:

- Erratic diet
- Variations in activity level
- Incorrect or missed medication
- Stress
- Alcohol consumption

MY NEPHEW

- TYPE 1 ATHLETIC
- ON OMNIPOD
- HAVING A ROUGH TIME CONTROLLING
- JUST GOT LIBRE



This thing is amazing



ent from my iPhone



Mrs f

**got a spider bite
anaphylactic shake
on high dose steroids since
tapering steroids
tresiba 40 qd
novorapid 10 mealtime**

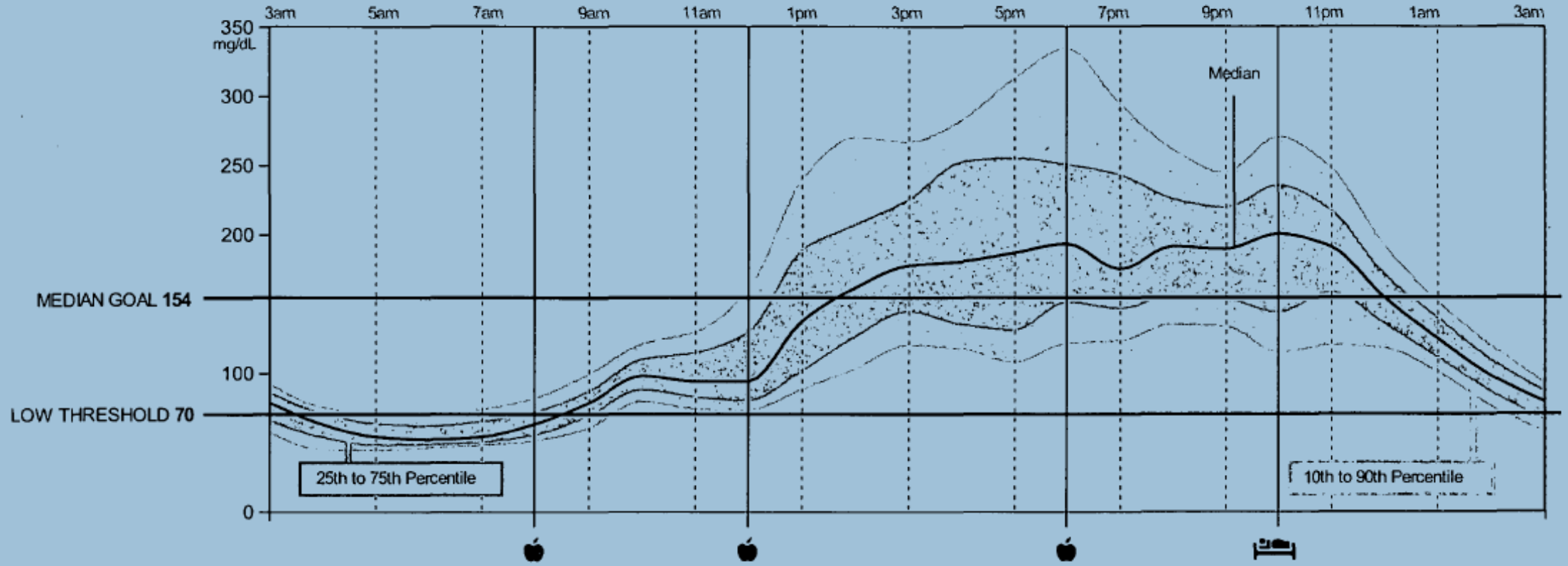
Glucose Pattern Insights

February 16, 2018 - March 2, 2018 (15 Days)

LibreView

Glucose

Estimated A1c **6.3 %** or **45 mmol/mol**



Likelihood of LOW GLUCOSE					
MEDIAN GLUCOSE Compared to goal					
VARIABILITY BELOW MEDIAN Median to 10th percentile					

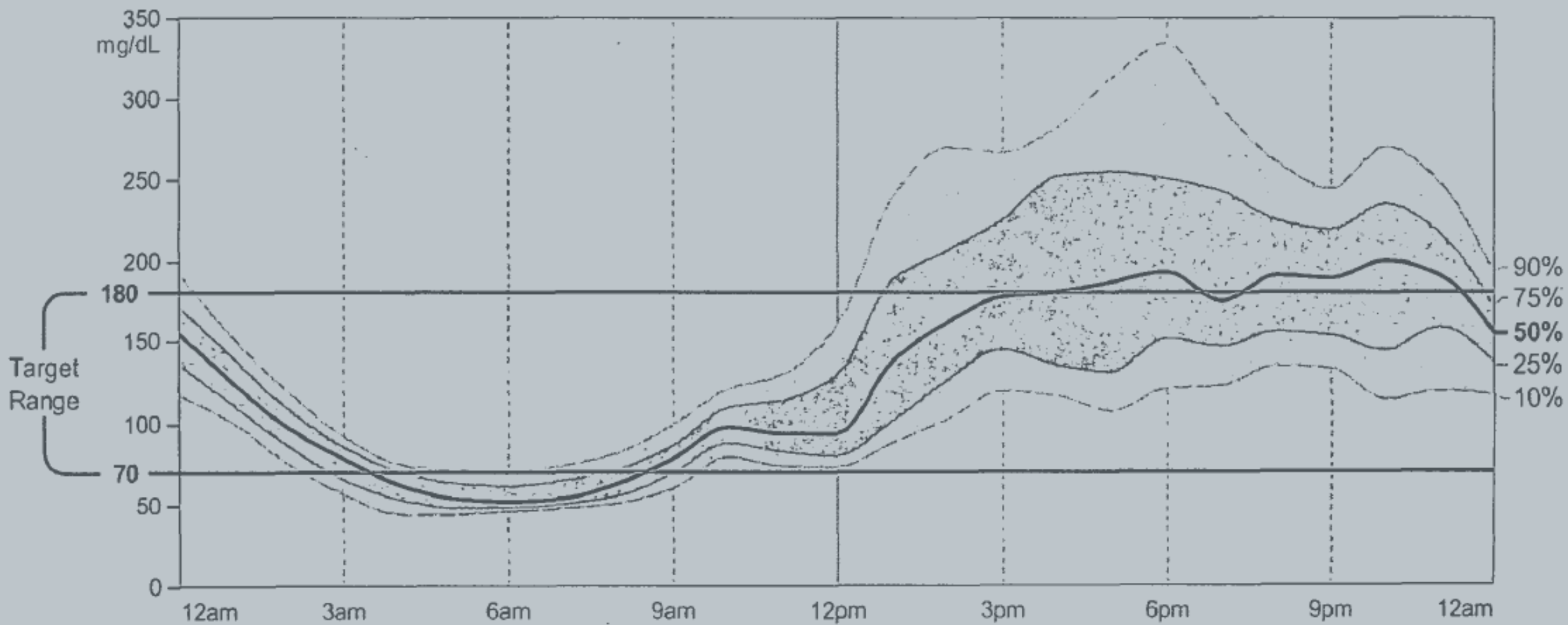
VARIABILITY BELOW MEDIAN IS HIGH This makes it difficult to achieve the median glucose goal without increasing the likelihood of low glucose.

PRINTED 03/02/2018 10:00

Practice Phone 316-314-3400

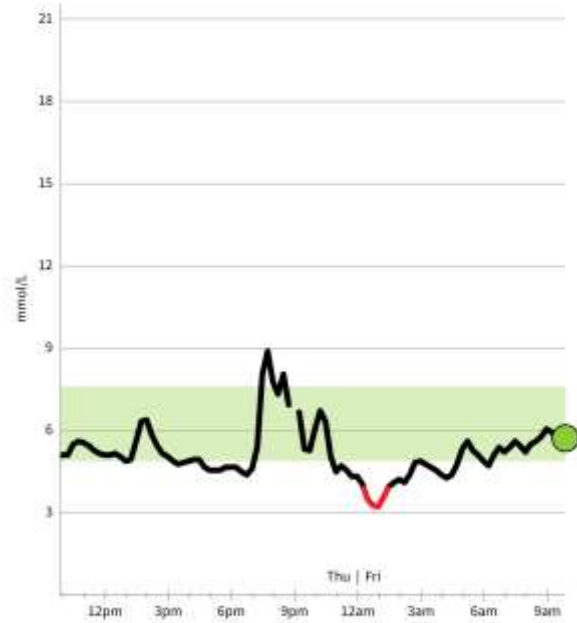
ambulatory Glucose Profile

curves/plots represent glucose frequency distributions by time regardless of date



LAST 24 HOURS

TIME IN TARGET	LAST SCAN	AVERAGE
58 %	5.7 mmol/L	5.2 mmol/L

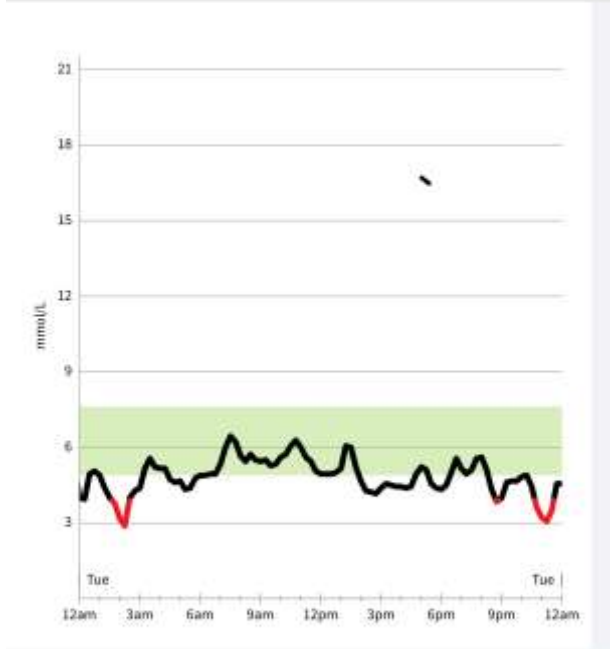


CHECK GLUCOSE

SENSOR ENDS IN: 10 DAYS

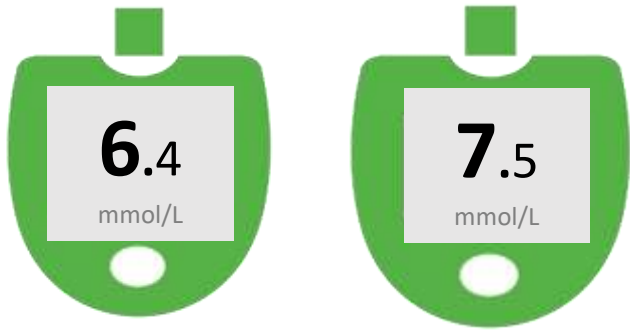
DAILY GRAPH

April 16, 2019

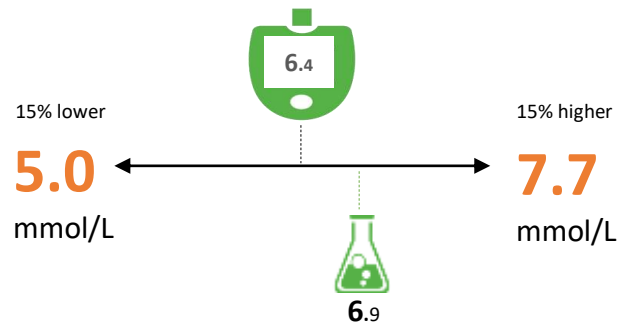


Acceptable difference between meter and sensor?

Readings approximate actual laboratory measured glucose



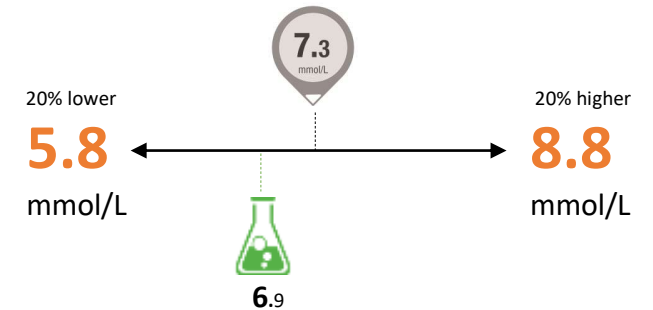
When an accurate meter reads 6.4, **actual** laboratory glucose should be within a 15% range:



Actual laboratory glucose test



When an accurate sensor reads 7.3, the **actual** laboratory glucose should be within a 20% range:



*If glucose alerts and readings from the G6 do not match symptoms or expectations, use a blood glucose meter to make diabetes treatment decisions

**Dexcom US G6 CGM System User Guide 2018; SSED Abbott US FreeStyle Libre, July 2018; Medtronic US 670G User Guide 2017

HT

- TYPE 2 DIABETES LONGSTANDING
- HYPOFEAR
- A1C 11 PERCENT ON MDI
- CHRONIC FOOT INFECTIONS
- STARTED ON VICTOZA
- WANTED ABSOLUTELY TO PREVENT LOWS



8.1 %

Estimated A1C

10.2

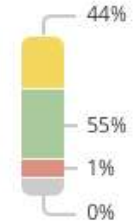
mmol/L
Average glucose
(CGM)

3.6

mmol/L
Standard
deviation
(CGM)



Hypoglycemia
risk



Time in range

Days with
CGM data 93%
13 / 14

Avg.
calibrations 0.0
per day

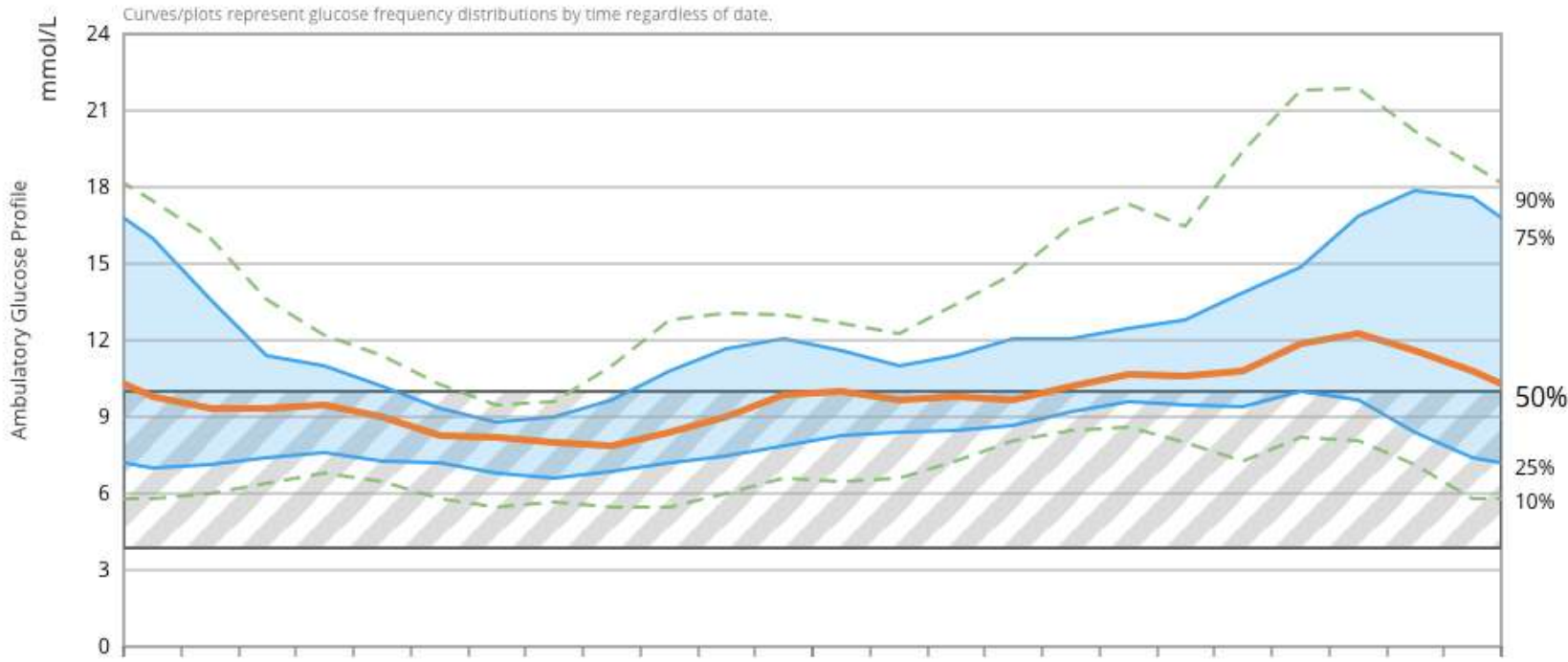
Sensor usage

**We found 1 pattern during this date range.
The best day was October 18, 2019.**

14 days | Sat Oct 5, 2019 - Fri Oct 18, 2019

Glucose Statistics	Avg Glucose mmol/L	Estimated HbA1c	Very Low < 3.0 mmol/L	Low < 3.9 mmol/L	In Target Range 3.9 - 10.0 mmol/L	High > 10.0 mmol/L	Very High > 13.9 mmol/L	Coefficient of Variation	SD mmol/L	% Time CGM Active
	10.2 Glucose Exposure	8.1%	0.5%	1.1%	54.8% Glucose Ranges	44.1%	12.9%	35.4% Glucose Variability	3.6	95.9% Data Sufficiency

CGM | 50% - Median | 25/75% - IQR | 10/90% | Target Range



[Click here to return to your clinic's Patient List.](#)

Print Reports Download Reports Export Help



Overview Patterns Data Compare Statistics AGP Settings

14 days | Sat Oct 5, 2019 - Fri Oct 18, 2019

1 Nighttime Highs 2 Best Day

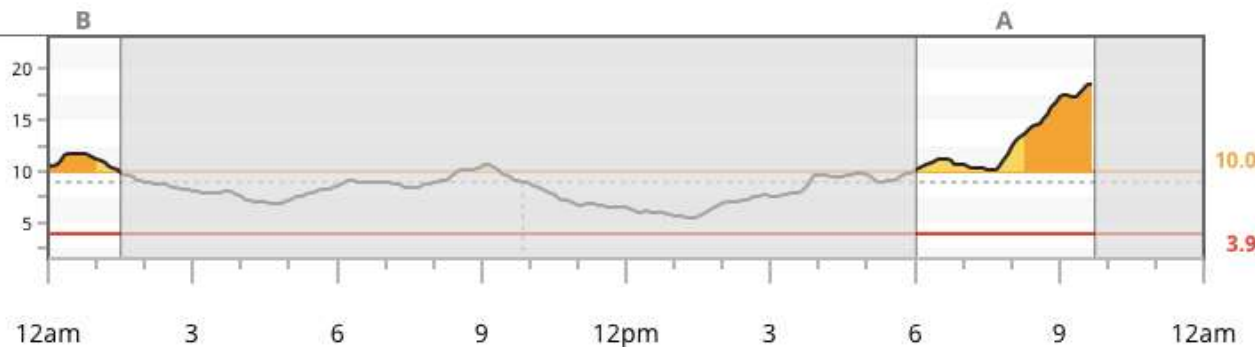
1 Harlan had a pattern of nighttime highs

Harlan had a pattern of significant highs between 8:15 PM and 1:05 AM. 13 high events contributed to this pattern. None of the contributing events were rebound highs.

Fri, Oct 18, 2019

Glucose (mmol/L)

A: 6:00 PM-9:45 PM
B: 12:00 AM-1:30 AM



Thu, Oct 17, 2019

B

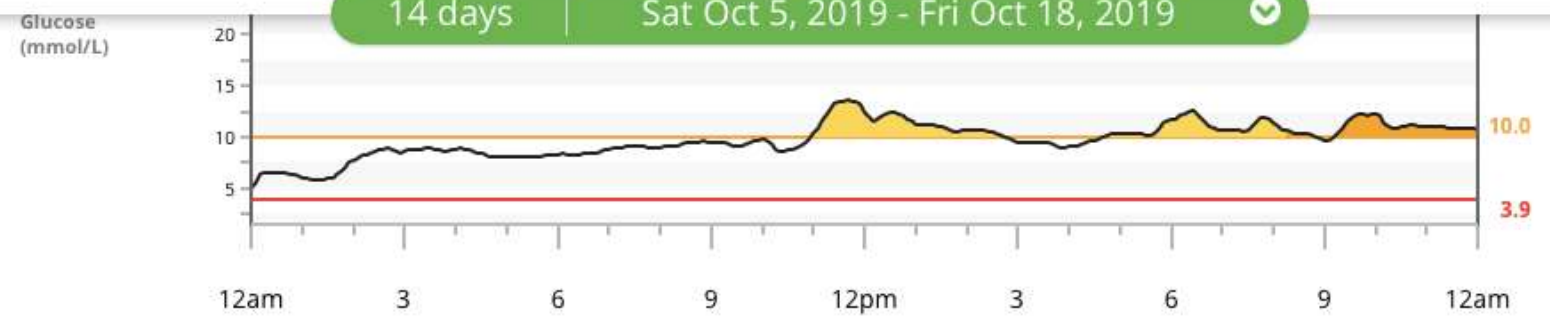
[Click here to return to your clinic's Patient List.](#)

Print Reports Download Reports Export Help



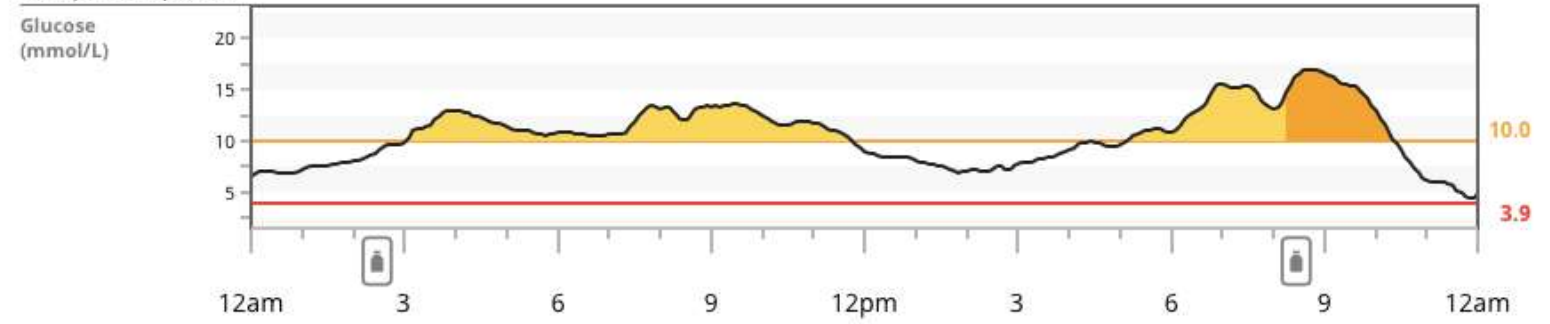
Overview Patterns **Data** Compare Statistics AGP Settings

14 days | Sat Oct 5, 2019 - Fri Oct 18, 2019



- 9:56 AM Signal Loss
- 3:51 PM Signal Loss
- 6:46 PM Signal Loss
- 10:36 PM Signal Loss

Wed, Oct 16, 2019



- 2:49 AM Fast-Acting
- 3:46 PM Signal Loss
- 4:51 PM Signal Loss
- 8:42 PM Fast-Acting
- 11:50 PM Low

2018 Diabetes Canada Clinical Practice Guidelines

Flash Glucose Monitoring may be offered to people with diabetes to decrease time spent in hypoglycemia **B**

In those who are willing and able to use devices on a nearly daily basis **Real-time CGM*** may be offered to:

- improve glycemic control in people with **T1 on MDI** who have not achieved their glycemic target **A**
- improve glycemic control in people with **T1 on CSII** who have not achieved their glycemic target **B**
- reduce duration of hypoglycemia in people with T1 **A**

*In Canada real-time Continuous Glucose Monitoring refers to Medtronic or Dexcom systems

2019 ADA

Standards of Medical Care for rtCGM use

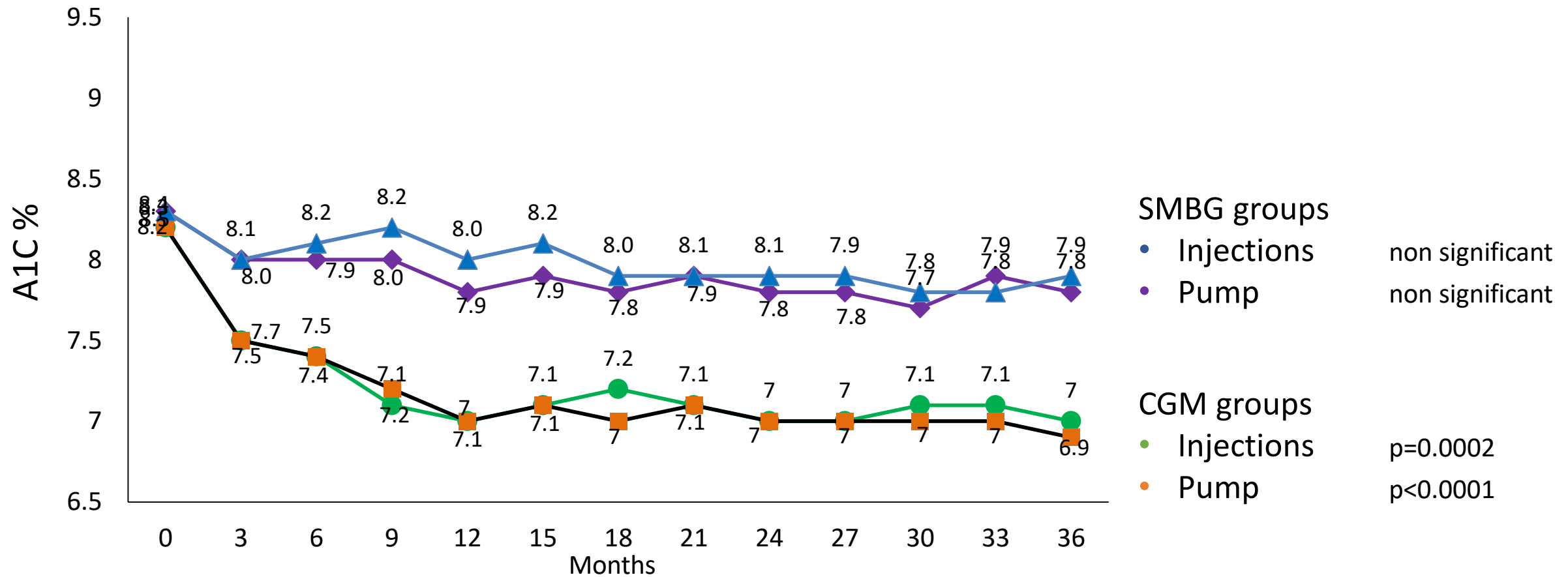


Intermittently scanned CGM (isCGM) is not included in rtCGM recommendations.

ADA recommends isCGM be used only as a substitute for SMBG in adults that require frequent glucose testing **C**

- **Real-time CGM** in conjunction with intensive insulin regimens is a useful tool to lower A1C in adults with T1 who are not meeting glycemic targets **A**
- **Real-time CGM** may be a useful tool in those with hypoglycemia unawareness and/or frequent hypoglycemic episodes **B**
- **Real-time CGM** should be used as close to daily as possible for maximal benefit **A**
- **Real-time CGM** may be used effectively to improve A1C levels and neonatal outcomes in pregnant women with T1 **B**
- **Real-time CGM** should be considered in children and adolescents with T1, whether using MDI or CSII, as an additional tool to help improve glucose control and reduce the risk of hypoglycemia **B**

A1C is similar in T1 with CGM irrespective of insulin delivery method



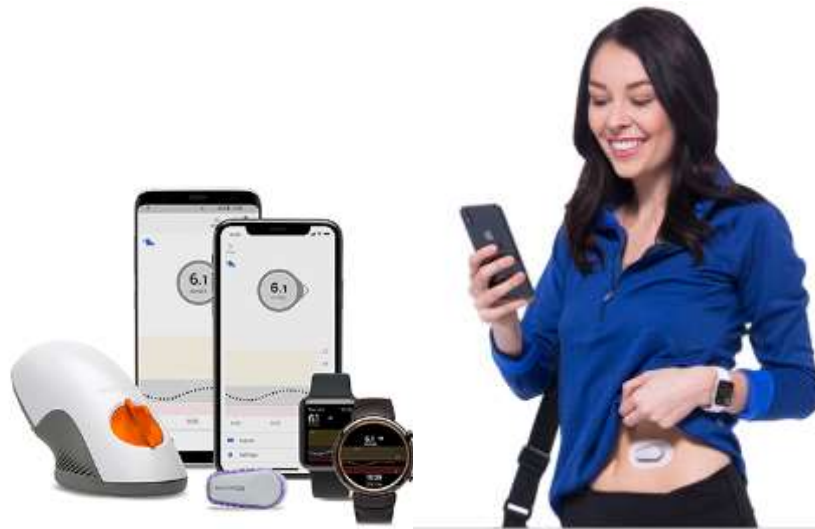
Available in Canada

Glucose Sensor Systems

Intermittent Abbott FreeStyle Libre



Continuous Dexcom G5/G6

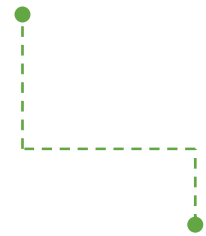


Continuous Medtronic Enlite 2/Guardian 3



Medtronic continuous rtCGM

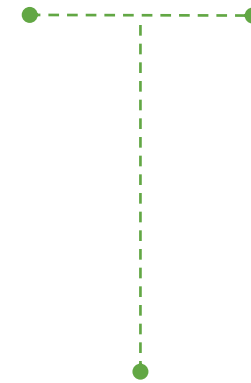
Use with MDI, manual entry or connected to pump



Sensor



Transmitter



Display Device

Medtronic 670G
insulin pump

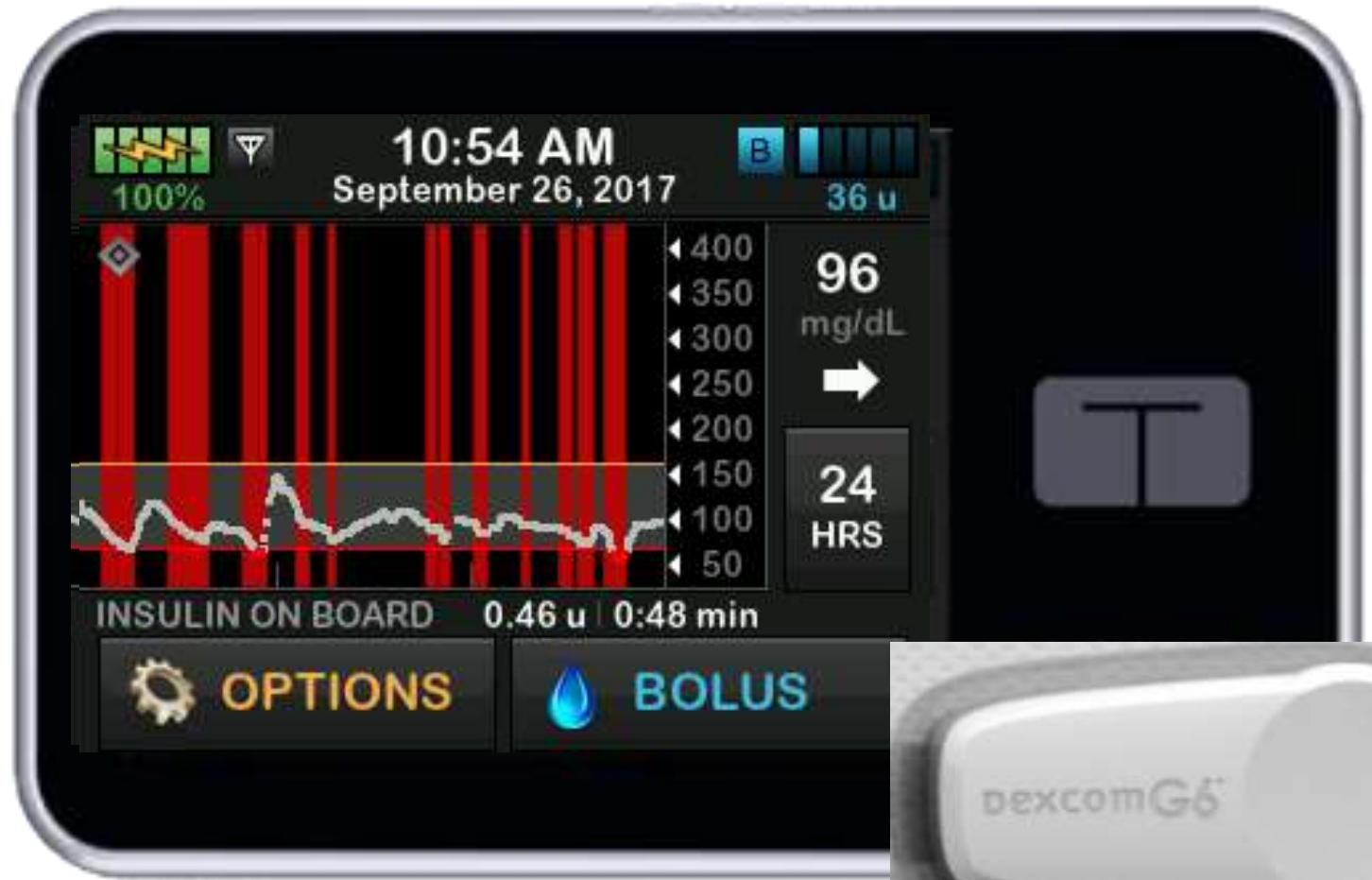


Not approved in
Canada



Tandem PLGS System (Basal IQ)

- Tandem t:slim X2 pump with Basal-IQ
- Technology integrated with Dexcom G6 sensor and PLGS algorithm
- No Alarms with suspensions
- Automatic restart of basal rates once above low threshold



PLGS: Predictive low glucose suspend

Closer look

Dexcom G6 System Components

1

Auto-Applicator

- Simple, auto-applicator inserts the sensor just beneath the skin

2

Sensor

- Measures glucose levels for up to 10 days
- Accurate glucose readings even when taking acetaminophen*



3

Transmitter

- Affixed to the top of sensor, sends data wirelessly to a display device

4

Display Device

- Compatible smart device or Dexcom receiver (optional)
- Displays glucose readings in real-time

* G6 readings can be used to make diabetes treatment decisions when taking up to a maximum acetaminophen dose of 1,000mg every 6 hours. Taking a higher dose may affect the G6 readings. www.Dexcom.com for list of compatible devices

Dexcom G6

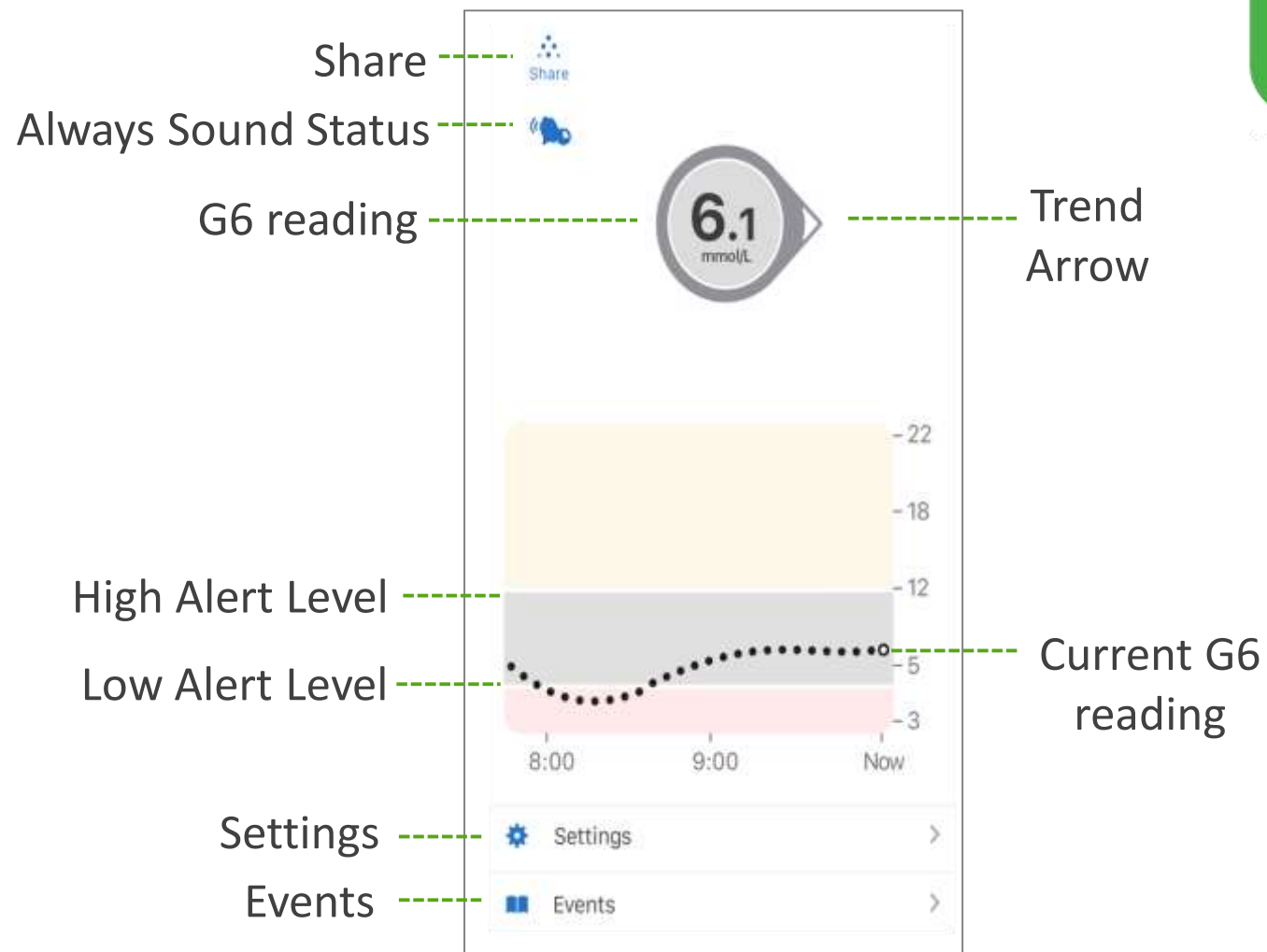
G6 App



Currently **38** iOS and Android Dexcom G6 compatible smart devices*

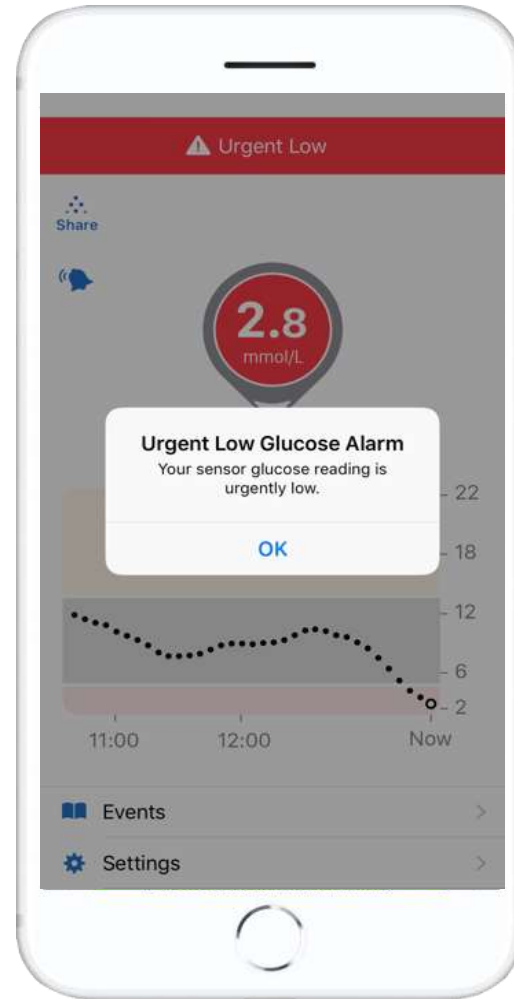


Apple

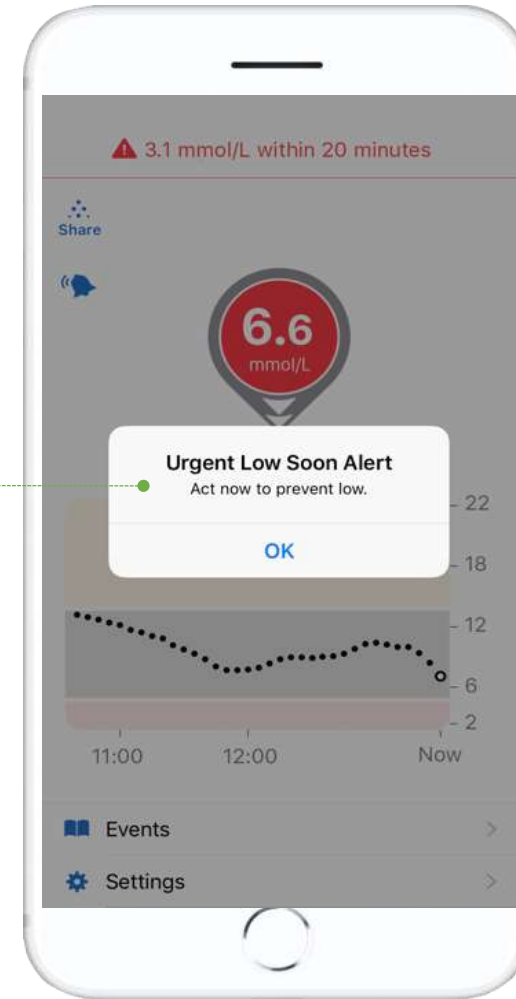


* Count as of August 15, 2019. List of devices continuously updated: <https://www.dexcom.com/dexcom-international-compatibility>

Dexcom G6 Predictive alert



New
for G6 •



iOS and
Android

In US since August 2018

Tandem Basal-IQ™ + Dexcom G6

Not approved in
Canada

