

**For adults
with type 1 diabetes**

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Module 0 Introduction

Today's topics

- 🕒 How do CGM systems work?
- 🕒 What do you see on the CGM display?
- 🕒 How to interpret the information on the CGM display
- 🕒 What to heed during calibration
- 🕒 Which alarm features are there?
- 🕒 Homework



Measuring blood glucose

- Until today, control in diabetes treatment relies on periodic blood glucose measurements
- Blood glucose measurements tell you how much glucose is in your blood
- Benefits of measuring blood glucose
 - Up to date and rather accurate blood glucose level
- Drawbacks of measuring blood glucose
 - Only spot values available
 - No information on the current glucose trend
 - Requires drops of blood
 - Drawing blood is painful



Continuous glucose monitoring (CGM)

- CGM: Acronym for “continuous glucose measurement” or “continuous glucose monitoring”
- A sensor in the fatty tissue below the skin (subcutaneous) continuously measures the “tissue glucose” level
- Continuous display of the glucose levels
- Display of the direction and rate with which the tissue glucose level changes (trend arrow)
- Automatic warning whenever glucose levels are too high, too low, or changing too fast
- Possibility to prevent loss of metabolic control



Comparison: Blood glucose measurement (BGM) and continuous glucose monitoring (CGM)

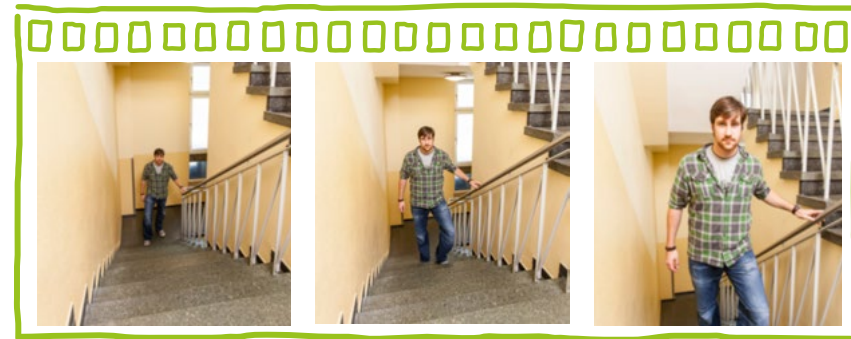
BGM



- “Sharp” as a photo
- “Spot value” of the blood glucose level
- Accurate single value

Single values

CGM



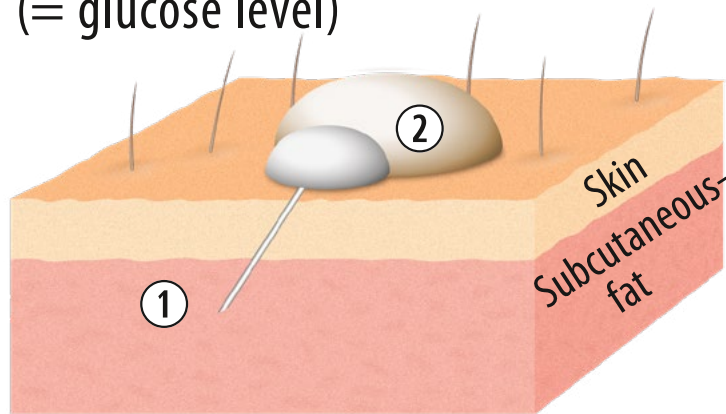
- “Dynamic” like a movie
- Chronological display of the glucose levels
- Somewhat less accurate single values

Continuous levels

How do CGM systems work?

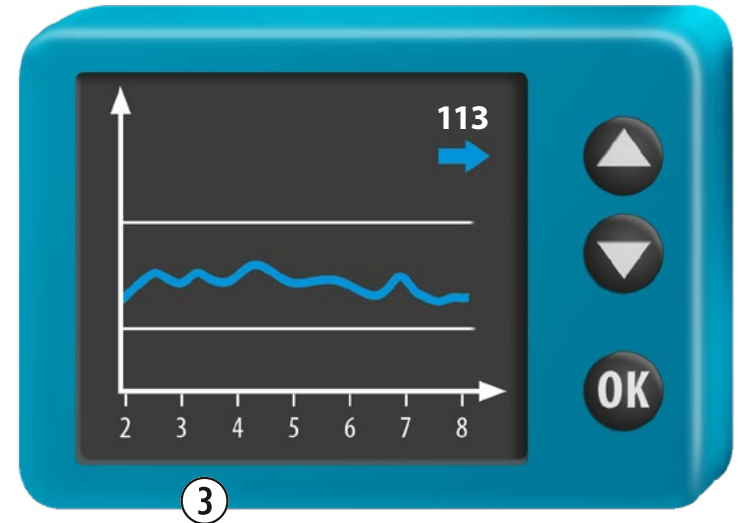
① Sensor:

- Inserted in the fatty tissue below the skin (subcutaneous)
- Measures the current tissue glucose (= glucose level)



② Transmitter:

- Transmits glucose levels to the receiver

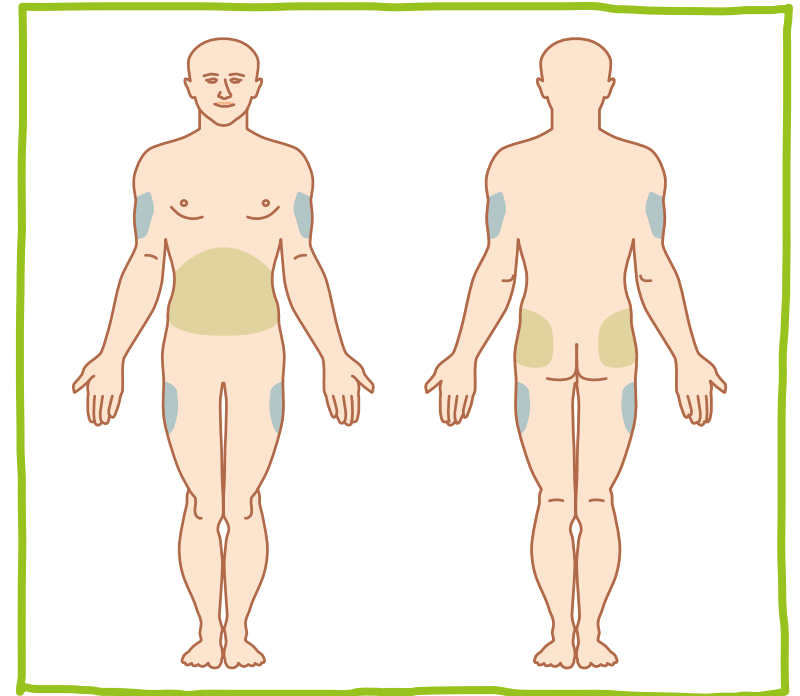


③ Receiver:

- Displays and saves the tissue glucose level and trend
- Triggers alarms, if needed
- May be read out on a computer

CGM: You wear the sensor here

- Depending on the manufacturer, you may wear the CGM sensor at different sites of the body.
- Almost painless application of the sensor
- Sensor wearing time:
5–7 days, depending on the manufacturer*

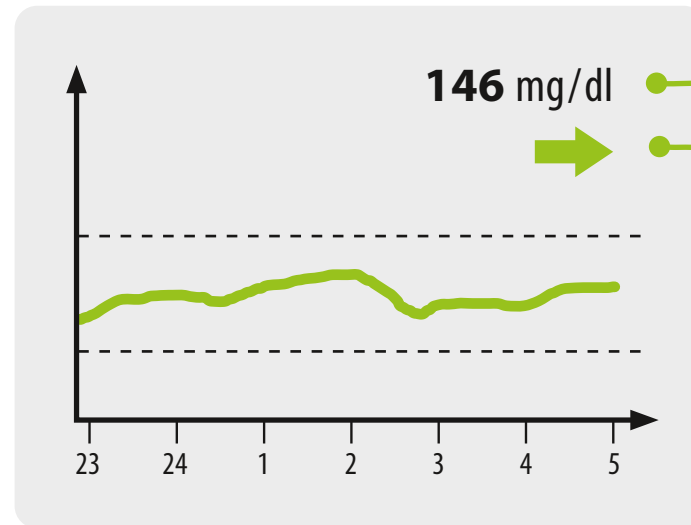


*As of: 2017

The CGM display

Receiver display

Chart of tissue glucose levels
(here: display of last 6 hours)

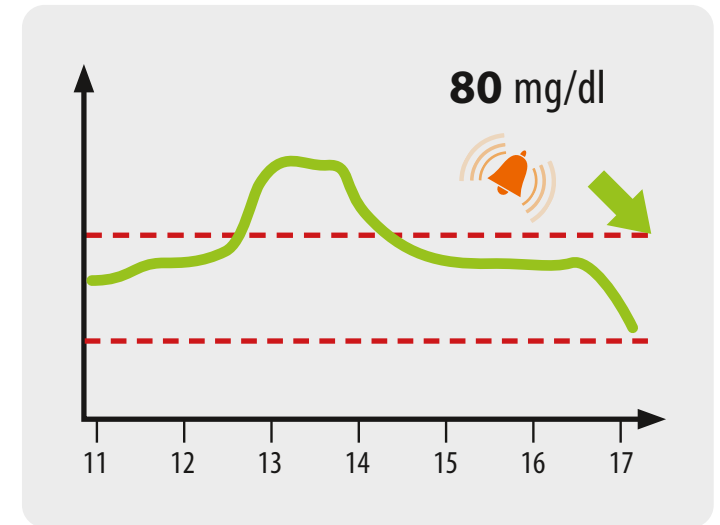


Current tissue glucose level
(example in mg/dl)

Trend arrow
(here: steady trend)

Safety through alarm features

- Alarm features alert
 - in case of **low** tissue glucose levels
(Caution: Hypoglycemia - abnormally low glucose level!)
 - in case of **high** tissue glucose levels
(Caution: Hyperglycemia - abnormally high glucose level!)
 - some time before** hypoglycemia- or hyperglycemia (pre-alert)
 - in case of glucose levels **changing too rapidly**
- Once the alarm limits are reached, the alarm is sounded (e.g., sound, vibration)
- Alarm limits must be set individually



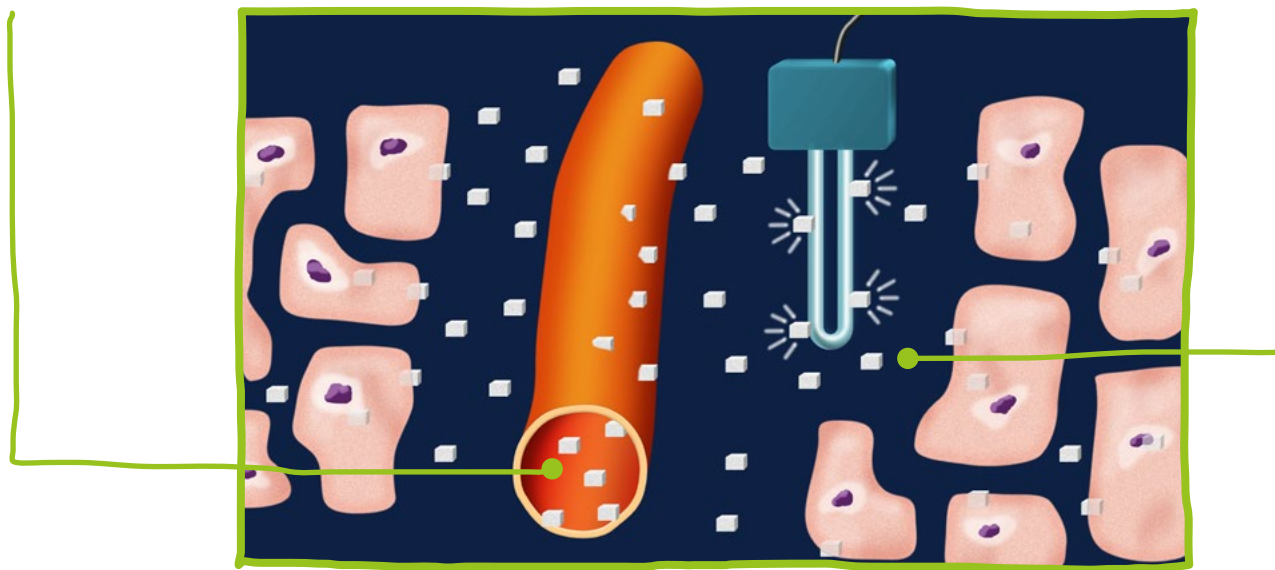
Difference between blood glucose and tissue glucose (1)

BGM:

Measures the glucose level in capillary blood

CGM:

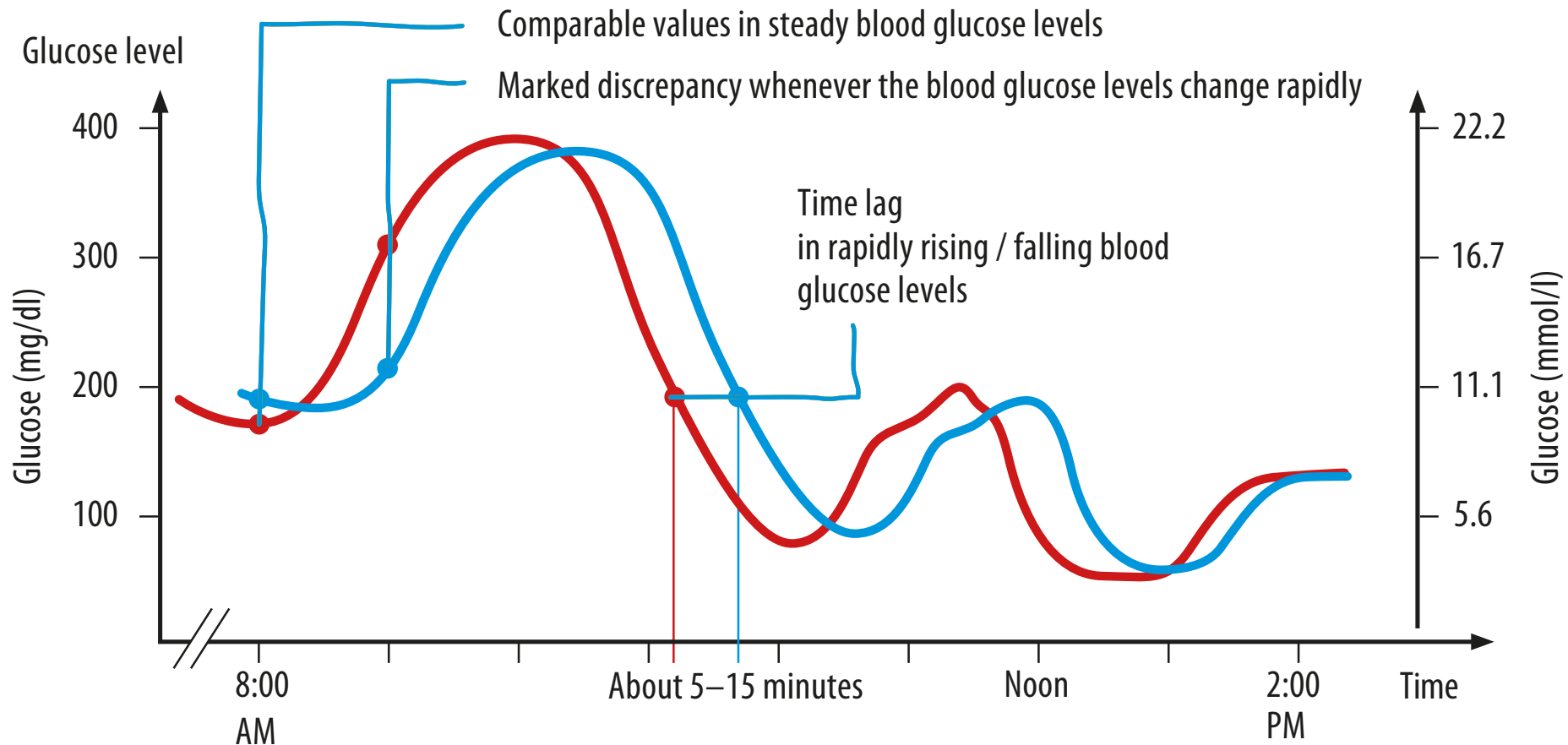
Measures the glucose level in the space between the cells ("interstitial" tissue glucose)



Blood glucose and tissue glucose levels do not always agree exactly.

Once the blood glucose level changes, it may take about 5–15 minutes until there is a corresponding change in the tissue glucose level.

Difference between blood glucose and tissue glucose (2)



Level differences between the blood glucose (**red**) and tissue glucose (**blue**) become evident particularly whenever the blood glucose level rises or falls rapidly (e.g., after meals, in sports, etc.).

CGM cannot substitute for blood glucose measurements

- For system calibration, the CGM systems require periodic blood glucose levels (about twice daily, depending on the system).*
- Please note the manufacturer's instructions regarding those situations where blood glucose measurement is still mandatory despite the CGM system.*



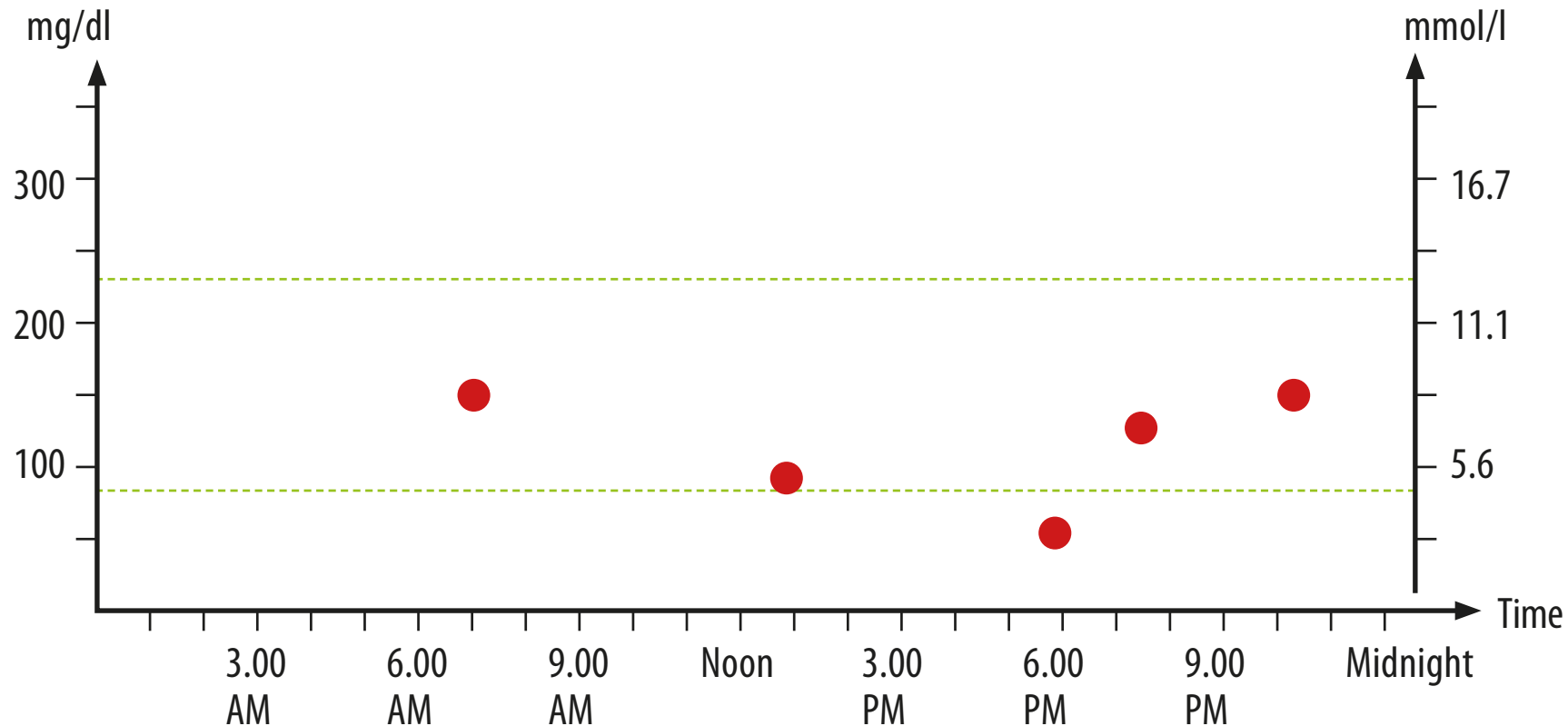
* As of: 2017

Important prerequisites for CGM

- Motivation to learn intensively about one's own diabetes
- Willingness to analyze CGM actively and periodically, and to adapt the treatment accordingly
- Realistic personal goals for using CGM



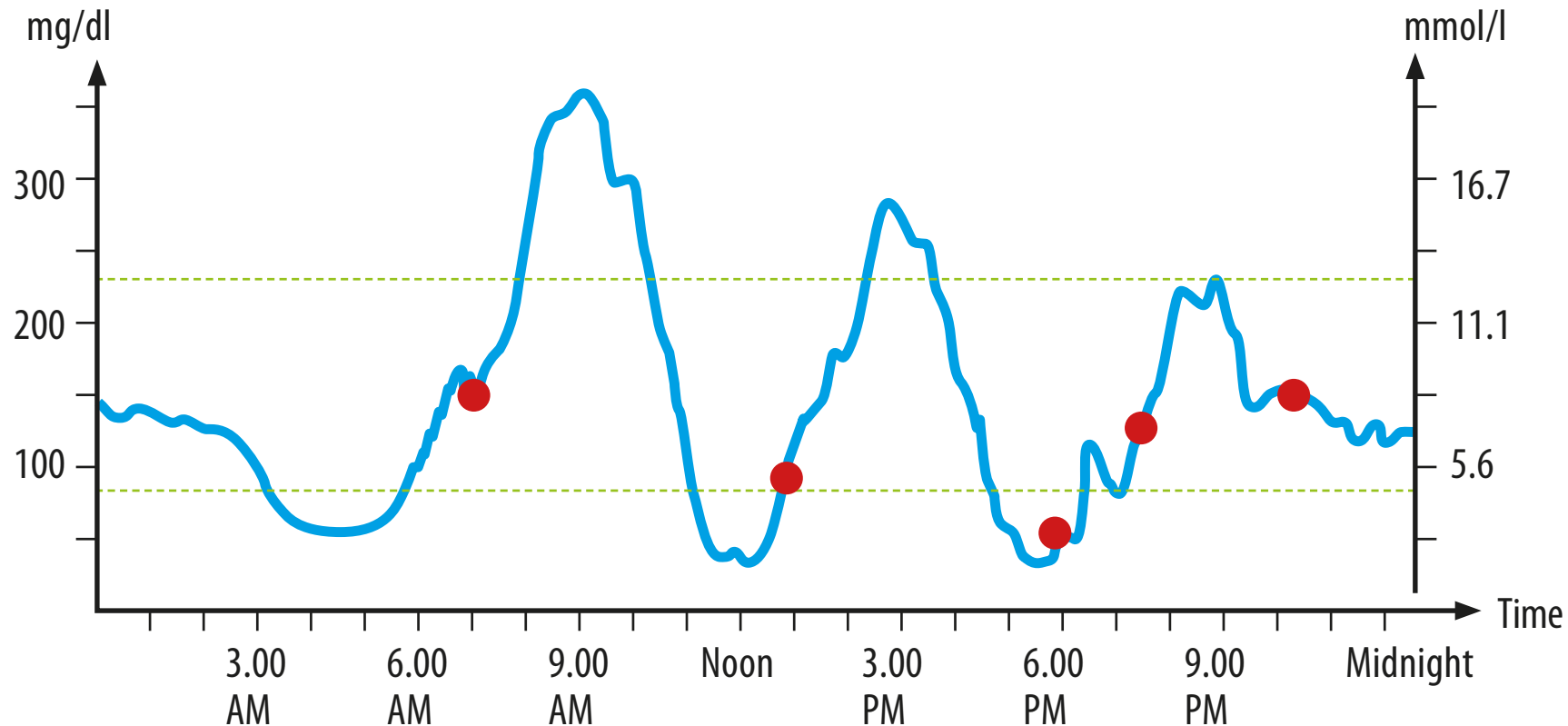
Measuring blood glucose: Only rough estimate of glucose behavior



Single “snap-shots”

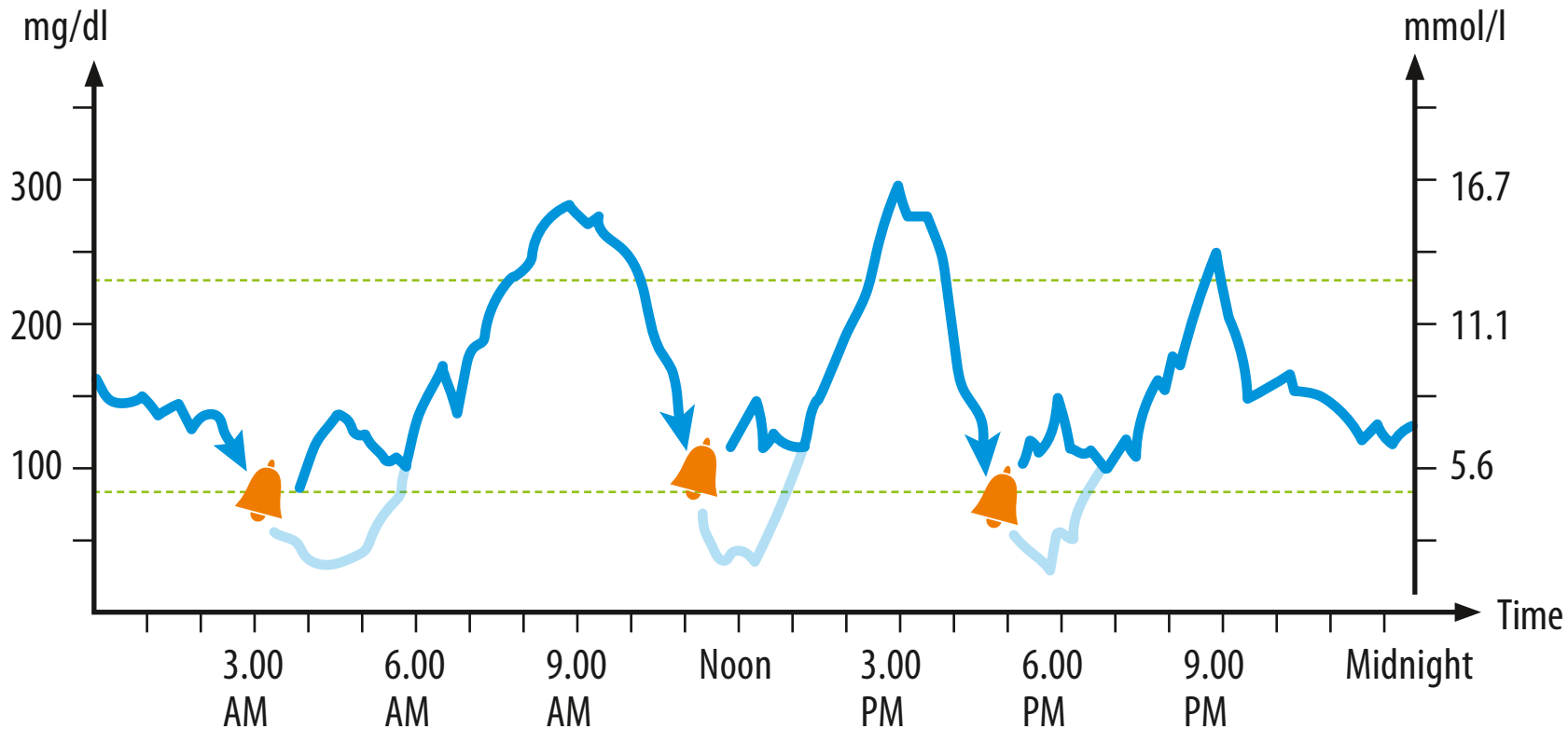
Seemingly good blood glucose control, hypoglycemia

CGM: More accurate representation of the glucose behavior



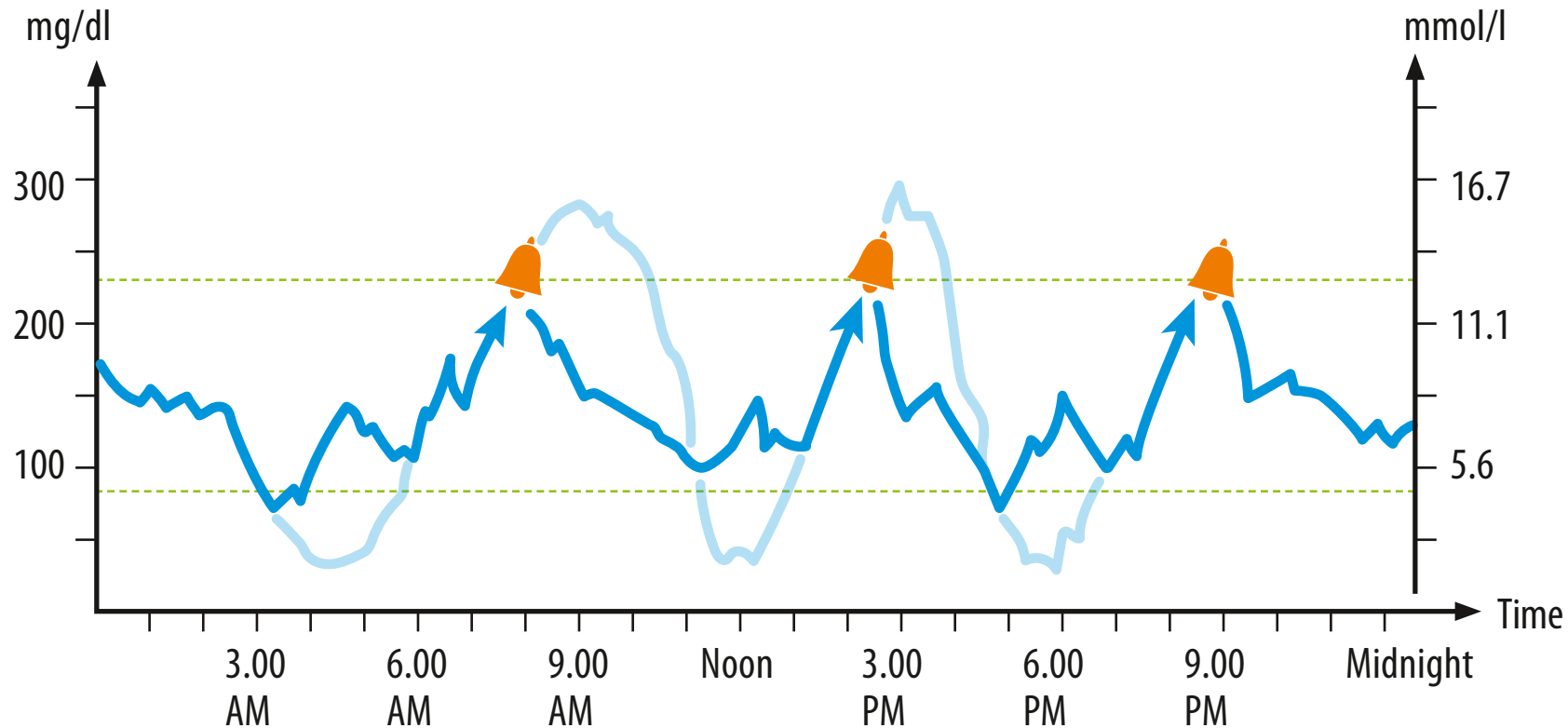
- Availability of more glucose measurements, glucose behavior becomes evident
- Better understanding of how various factors influence the glucose behavior (e.g., nutrition, physical activity, insulin corrections, stress)

Lower-limit alarm: Permits more rapid treatment of hypoglycemia



- Alarm whenever the value drops below the preset level of hypoglycemia
- Rapid feedback on the success of the treatment steps taken
- When combined with an insulin pump, it is possible to stop the insulin delivery automatically

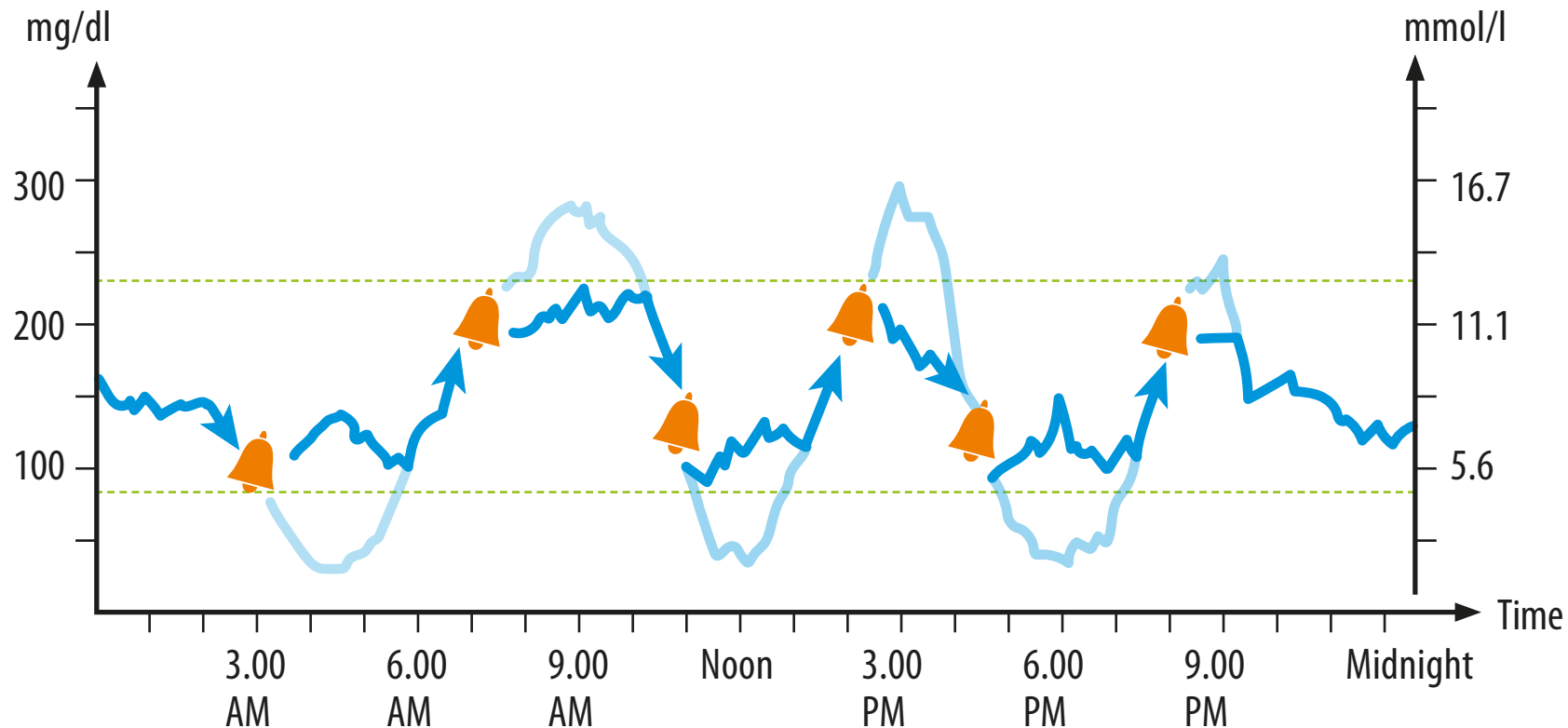
Upper-limit alarm: Better analysis and prevention of hyperglycemia possible



- Alarm whenever the upper limit of the target corridor is exceeded
- Rapid feedback on the success of the treatment steps taken

Pre-alarms:

Proactive warning of hypoglycemia and hyperglycemia



- Alarm whenever the continued current glucose trend can be expected to trigger the high/low-level alarm within a given time period
- Earlier countermeasures possible

CGM benefit: What is important for you personally?



"With CGM, my family and I are less worried about hypoglycemia".

"I do a lot of sports, and thanks to CGM I always know my glucose levels".



"My HbA1c value has improved significantly since I started wearing my CGM".



"Finally, I was able to reduce the marked swings in my blood glucose level".



"Thanks to CGM, I am feeling much safer, especially when driving a car".

Wrong expectations of CGM systems

❏ Not all blood glucose measurements can be substituted by monitoring the tissue glucose level. Blood glucose measurements are still needed for system calibration and, depending of the manufacturer's instructions, possibly before each treatment decision.*

❏ CGM still requires active personal commitment.



* As of: 2017

Possible drawbacks of CGM

- Possible discomfort by sensor and/or transmitter.
- The numerous glucose levels may become too much for the patient.
- Constant preoccupation with diabetes in everyday life might be regarded as a nuisance.
- The patient and others might regard alarms as annoying (particularly at night, false alarms).
- Reimbursement may prove to be difficult.



Are there any reasons against using CGM?

"Actually, I do not really want to become that involved with my diabetes - there are more important things in life for me."



"Isn't that rather cumbersome?"



"Do CGM systems definitely prevent hypoglycemia and hyperglycemia?"



"If my health insurance provider does not reimburse me for CGM, it is just too expensive for me."



"I don't know, maybe the many values are just too much for me."



Criteria for selecting a CGM system

Criteria to be considered when selecting a CGM system

1. Receiver as stand-alone unit or insulin pump doubling as receiver?
2. Technical features, such as:
 - Technical features and wearing time of the sensor
 - Range of the radio signal
 - Availability of various alarm features
 - Automatic / predictive shutdown in hypoglycemia
 - Analysis software
 - Design, size, weight, waterproofness
 - Cost



CGM receiver as stand-alone unit



*As of: July 2015

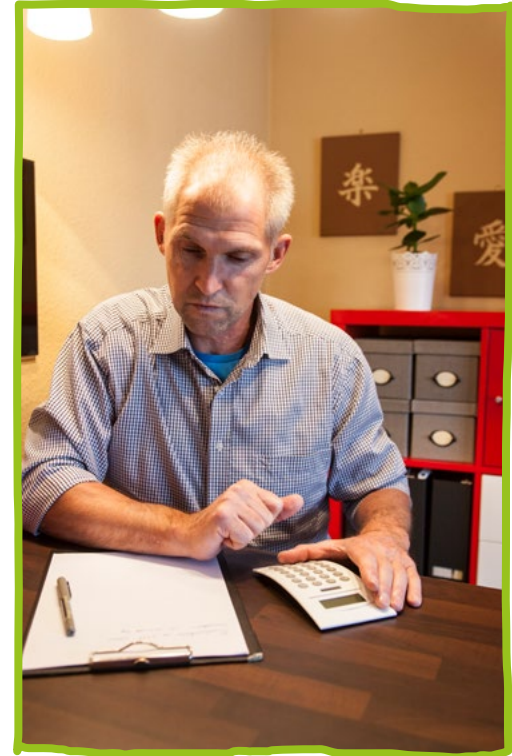
Insulin pumps with integrated CGM receiver



*As of: July 2015

How much does continuous glucose monitoring cost?

- Cost of investment: About 1,500 to 3,000 EUR
- Cost of sensor: About 10 EUR per day*
- Reimbursement by the health insurance provider may become difficult.
- Frequently, the patient has to pay by him-/herself



What will happen next?

Talk to your diabetes team

- Decide in favor of or against CGM.
- Settle the issue of possible reimbursement.
- CGM is started as part of specialized training: SPECTRUM.



SPECTRUM training modules

1. CGM basics (about 1 week before the start)
2. CGM start
3. CGM display and alarms (about 1 week after the start)
4. CGM analysis I (about 2 weeks after the start)
5. CGM analysis II (about 4 weeks after the start)
6. Advanced CGM training (about 6 weeks after the start)