GLUCOSE MONITORING

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Prevalence of Diabetes

- 29.1 million with diabetes in the United States
  - 21 million diagnosed
    - 8.1 million undiagnosed
- 9.3 % of the population has diabetes
- Another 86 million with pre-diabetes
- $245 billion: Total costs of diagnosed diabetes in the United States in 2012 (176 billion in direct medical costs)

Source: www.cdc.gov 2012 National Diabetes Fact Sheet

Complications

Diabetes is the 7th leading cause of death and when uncontrolled is:

- The leading cause of new cases of blindness among those age 20 - 74 years
- The leading cause of kidney failure
- The leading cause of non-traumatic lower limb amputation
- Adults with diabetes have heart disease death rates about 2 to 4 times higher than adults without diabetes.
- The risk for stroke is 2 to 4 times higher among people with diabetes.

Source: www.cdc.gov 2011 National Diabetes Fact Sheet

Controlling Blood Glucose

- *Studies show that a 1% decrease in A1c correlates to an approximately 40% decrease in complications.

- **Blood glucose targets for most non pregnant adults:
  - before meals = 80-130 mg/dl
  - post prandial = < 180 mg/dl
  - A1c < 7.0%

* Centers For Disease Control

** American Diabetes Association Guidelines

Factors to Consider

- duration of diabetes
- age/life expectancy
- comorbid conditions
- known CVD or advanced microvascular complications
- hypoglycemia unawareness
- individual patient considerations.

Hemoglobin A1c (A1c)

A1c	* **eAG** (estimated average glucose)
6.0%	126 mg/dl
7.0%	154 mg/dl
8.0%	183 mg/dl
9.0%	212 mg/dl
10.0%	240 mg/dl
11.0%	269 mg/dl

* Estimated Average Glucose = 28.7 x A1C – 46.7

Who Should Test?

- Those who take insulin
- Anyone having trouble controlling BG levels
- Those who are experiencing hypoglycemia or are hypoglycemic unaware
- People with high blood sugars and ketones
- In pregnancy – shows improved fetal outcomes

History of Measuring Glucose

Early Meters

First meter issued

Sept. 14, 1971

by Ames

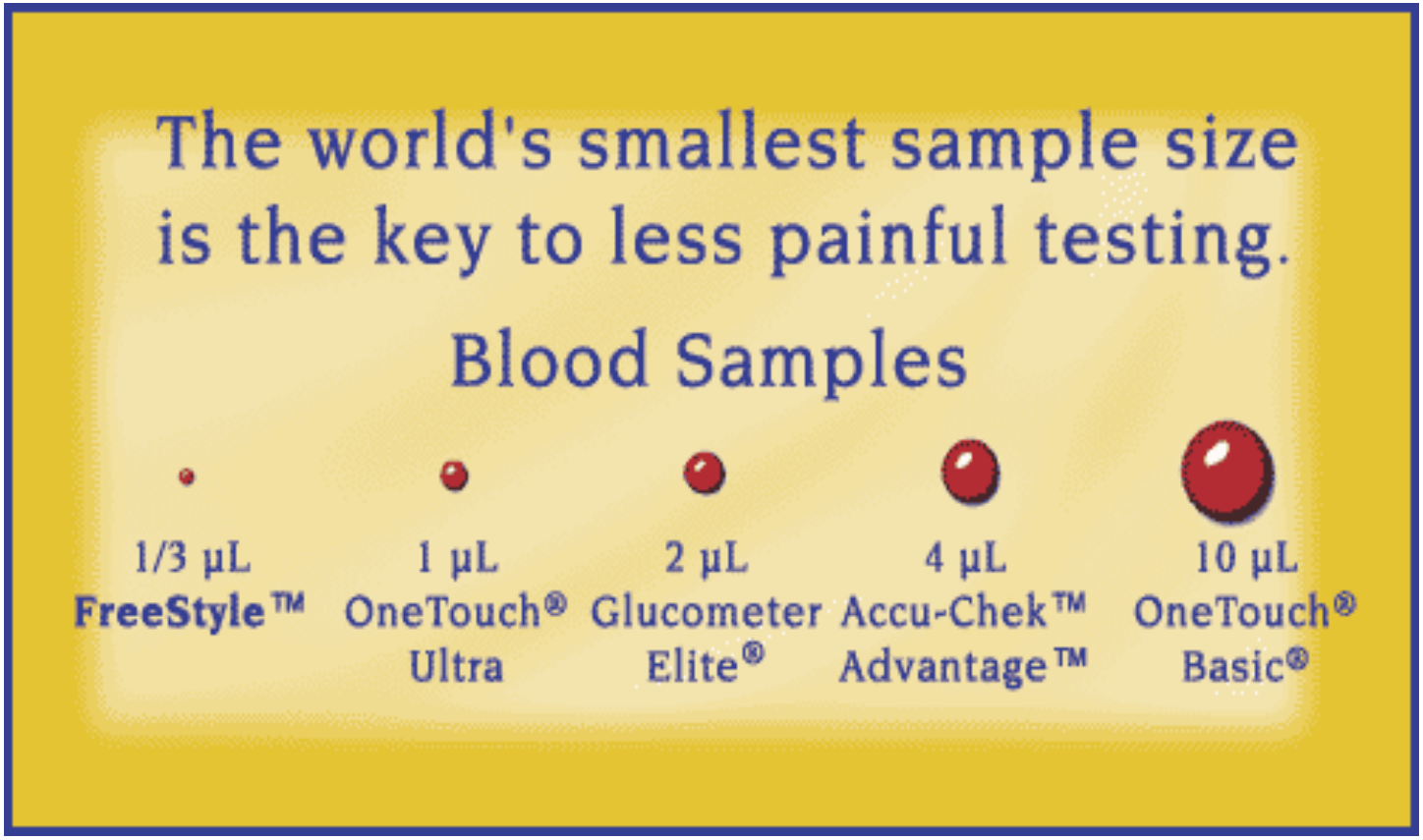
New Meters

ACCU-CHEK® Nano

New Meter Features

- Fast –results in 5 – 10 seconds
- Small – weigh about 2 ounces
- Simpler to use and more accurate
- No coding required
- Plasma correlated vs. whole blood
- No cleaning required
- Software for data management
- Lithium or alkaline batteries
- Provides blood glucose readings from 10-600 mg/dl (depending on model)
- Pattern management
- Improved screens / color / touch

Sample Size


The world's smallest sample size is the key to less painful testing.
Blood Samples
1/3 µL
FreeStyle™
1 µL
OneTouch® Ultra
2 µL
Glucometer Elite®
4 µL
Accu-Chek™ Advantage™
10 µL
OneTouch® Basic®

Alternative Site Testing

Alternative Site Testing (AST)

Use fingertips if:

- your blood sugar is changing rapidly – after a meal, after insulin or exercise

- you feel low

- you have been diagnosed with hypoglycemia unawareness or don’t feel early symptoms of low blood glucose

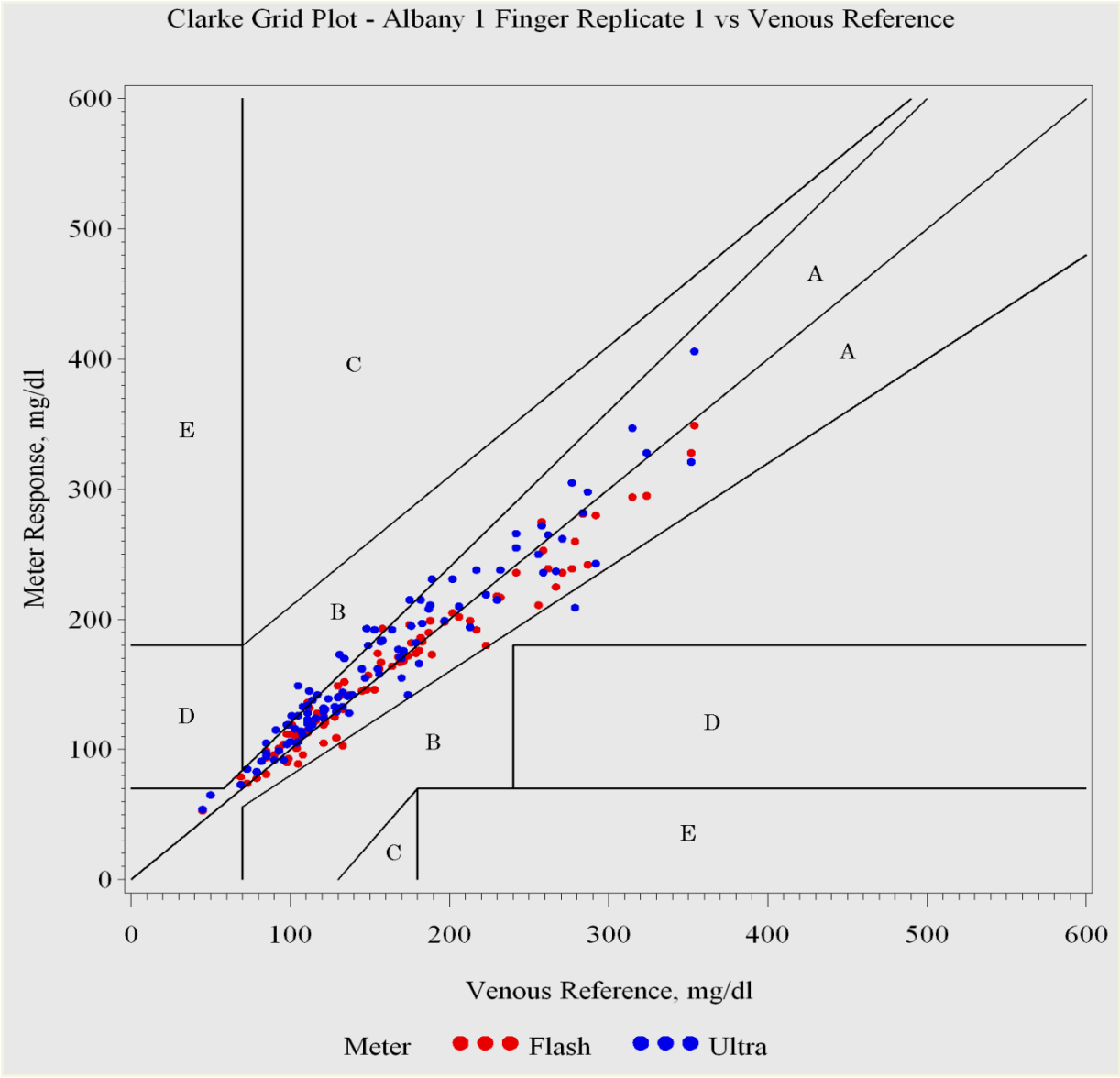
Selecting a Meter

- Medical insurance coverage - cost
- Visual acuity – screen + font size / contrast
- Dexterity – size of the test strips
- Size of blood sample needed
- Simplicity / Complexity of use
- Data Management / Downloads
- Other medical equipment being used – links – insulin pump

Skill Sets Required for SMBG

- General operation of the meter
- Obtain adequate blood sample
- Use of control solutions
- Care and storage of device and supplies
- Sharps disposal
- Documentation and ***use of results***

ACCURACY



Definitions:

A – Clinically accurate

B – Benign error

C – Could result in an over correction

D - A dangerous failure to detect and treat errors

E – An erroneous treatment zone

Accuracy

- Current FDA standards:

- for results at or above 75 mg/dl
  - 95% of results must be within +/- 20% of actual
- for results below 75 mg/dl
  - 95% of results must be within +/- 15 points of actual

October 2016 update for new meter approval:

- 95% of results must be within 15% of actual
- 99% of results must be within 20% of actual

Accuracy

- Hand washing
- Test strips out dated or exposed to light and air
- Temperature range

When in doubt – test don’t guess!

Frequency of Testing

1) Frequency and timing should be determined by the needs and goals of the patient.
2) For those on multiple daily insulin doses – at least– prior to meals & snacks, occasional post meal, at bedtime, prior to exercise, if they suspect hypoglycemia, have treated hypoglycemia until ok and pre critical tasks – i.e. driving.
3) Type 2 – non insulin treated – evidence is mixed – optimal frequency of SMBG unknown – use of data is crucial.

* American Diabetes Association Clinical Practice Recommendations (Jan 2017)

Interpreting Results

- Identify trends
- Identify factors that may raise or lower blood glucose
- Evaluate the impact of food, activity and medications
- Identify where changes in the treatment plan could be of benefit
- Rule in or out diabetes as a cause of symptoms you may be having

Date	MN		6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Glucose mg/dl				179	265	230			47	140				33	150	60		190		45
CHO grams																				
CHO Bolus																				
HI BG Bolus																				
Basal Rate	0.4 U/h	→	0.5 U/h	→	→	→	→	→	→	→	0.2 U/h	→	→	→	→	→	→	→	0.6 U/h	→
Ketones/ exercise																				

Date	MN		6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Glucose mg/dl				179	265	230			47	140				33	150	60		190		45
CHO grams									30g	45g				45	45	30g				
CHO Bolus										5H					3H Lasagna					
HI BG Bolus					5H	3.5H									1H			1H		
Basal Rate	0.4 U/h →		0.5 U/h →								0.2 U/h →			Bike 50'					0.6 U/h →	
Ketones/ exercise														—						

Insulin Regimen: AM:1H/10g CHO; Lunch: 1H/12g CHO; Supper: 1H/12-15g CHO
Hi BG correction: 1H/ 40 mg/dl>120 mg/dl

Tips

- Patients often don’t know what brand of meter they are using
- Store test strips in original container at temp. >59 and <86F
- Check expiration dates on patient test strips
- Some lancet brands use specific lancets – i.e. Accu Chek Multiclix, Softclix or One Touch Delica

- Call customer service # provided with each meter for technical support and directions for use

Control Solution

Control Solution

- When?
  - new meter
  - if you think the reading is not accurate
  - if you drop your meter
- How?
  - use solution provided by meter manufacturer – usually offered at no charge by the manufacturer
  - be sure to check expiration date

Blood Ketone Testing

Precision Xtra
Abbott

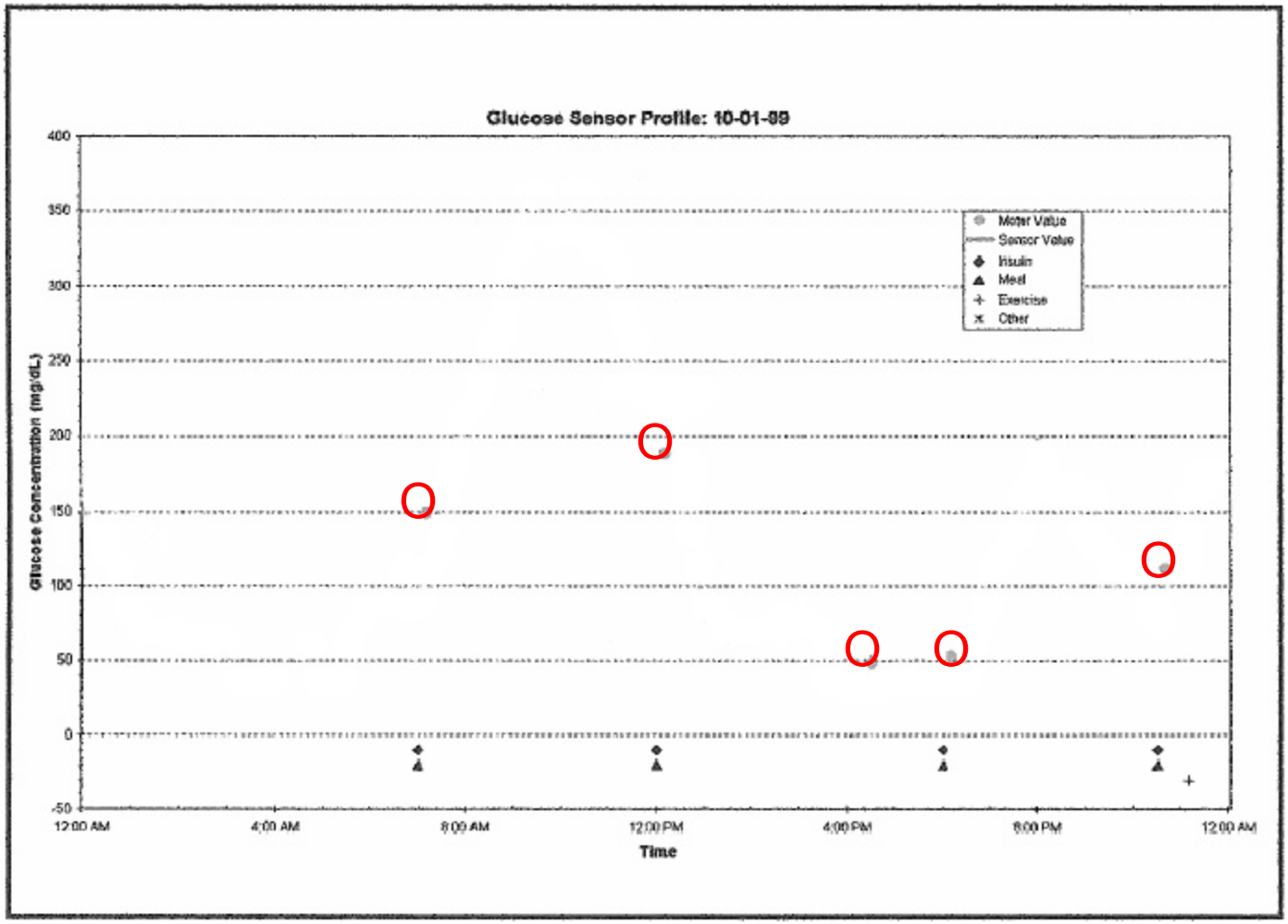
Nova Max Plus
Nova Diabetes Care

-tests blood glucose
and blood ketones

Continuous Glucose Monitoring

Sensor containing glucose oxidase is placed subcutaneously. In the presence of oxygen and glucose an electric current is created. The magnitude of this current is converted into a glucose reading.

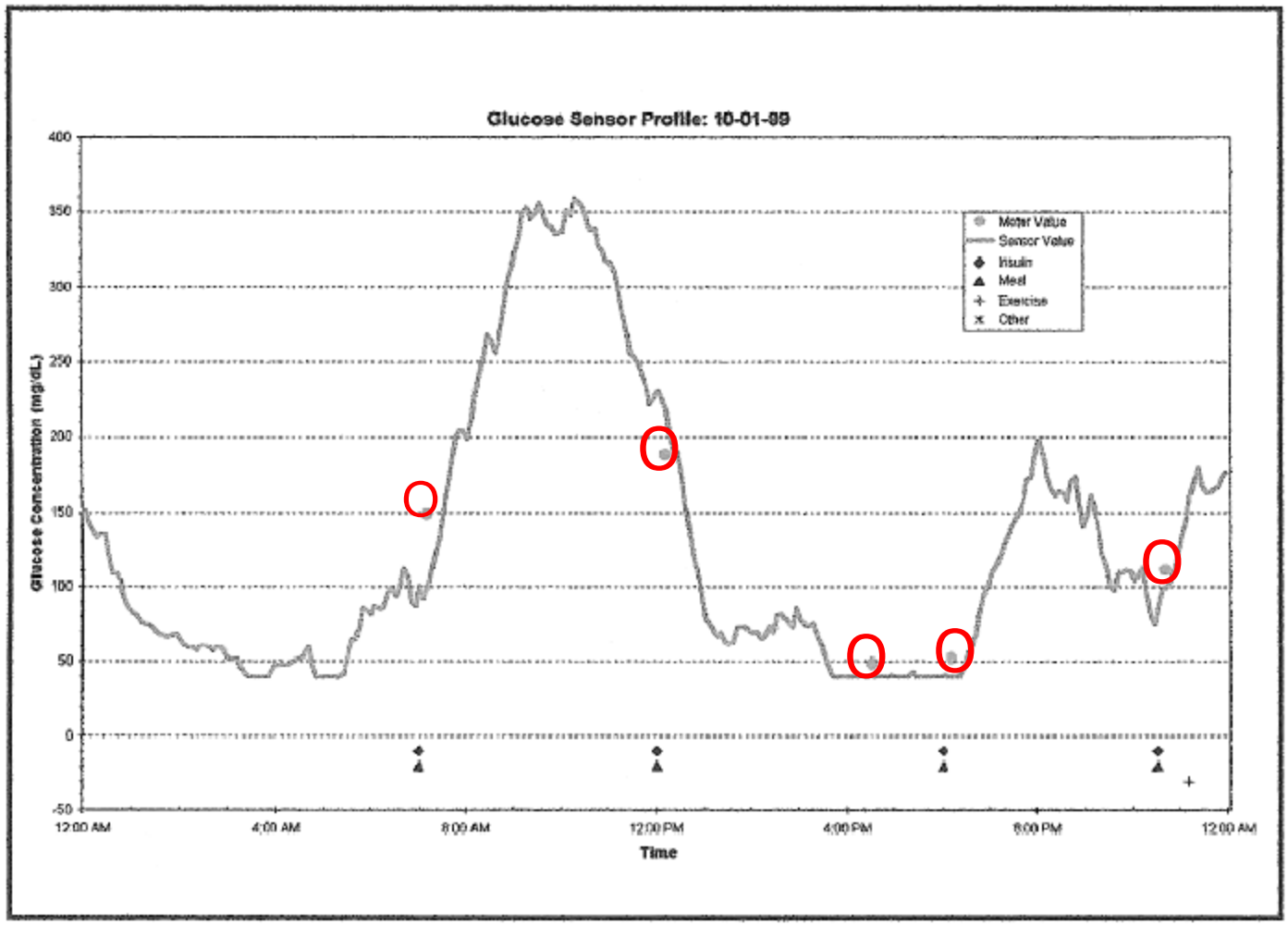
B



Gross, Diabetes Technology & Therapeutics 2:49, 2000

Benefits of CGMS: BG checks every 5 mins allows for visualization of glucose changes between fingerstix checks

B



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Continuous Glucose Monitoring

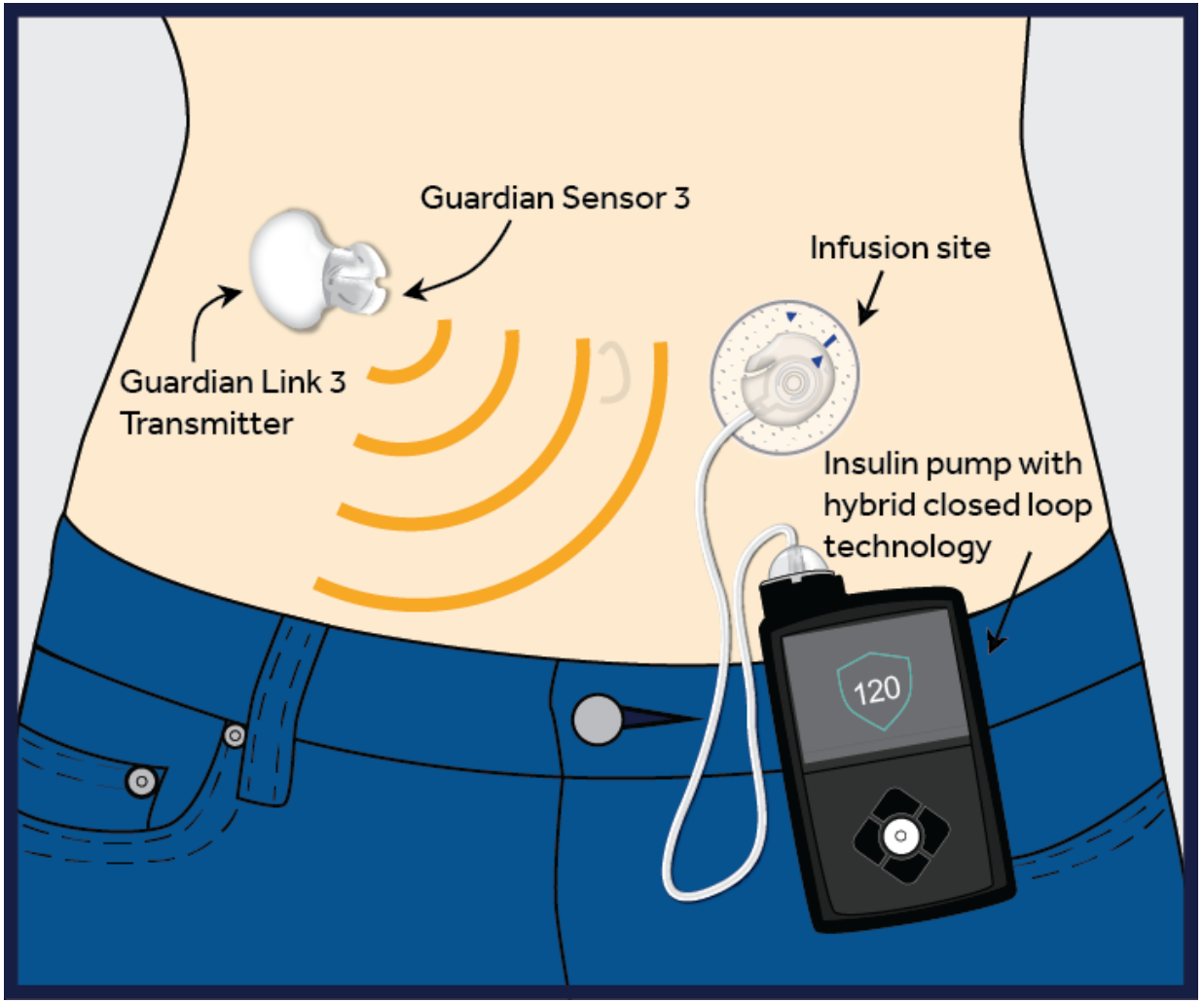
Medtronic CGMS – Continuous Glucose Monitor System) – approved by FDA 6/99

Continuous Glucose Monitoring

DexCom – approved by the FDA 3/05

DexCom Mobile G5 Share & Follow

Closed loop automated pump



Resources

- www.deo.ucsf.edu
- www.diabetes.org
- http://www.diabetesforecast.org/2016/mar-apr/consumer-guide-2016.html
- http://care.diabetesjournals.org/content/40/Supplement_1/