Insulin Delivery: Pens, Pads, Pumps, and Low Glucose Suspend

Clinical Need & Technology

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Topics

- MDI vs. CSII
- Line pumps and patch pumps
- Pump components
- Infusions sets
- Alerts and alarms
- Troubleshooting the pump
- Sensor Augmented Pump
- Future solutions: Closed Loop

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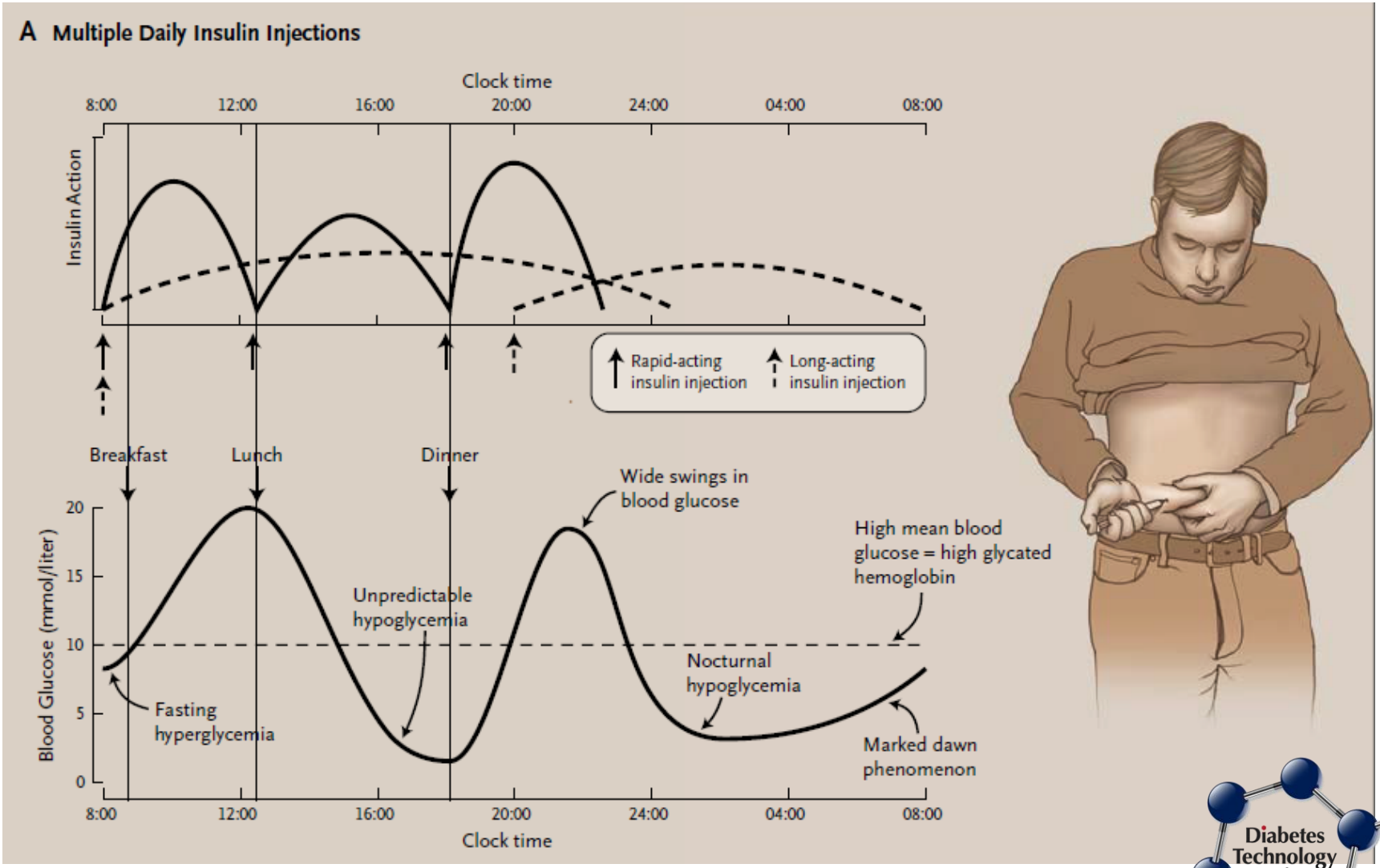
MDI vs. CSII



N Engl J Med 2012;366:1616-24.

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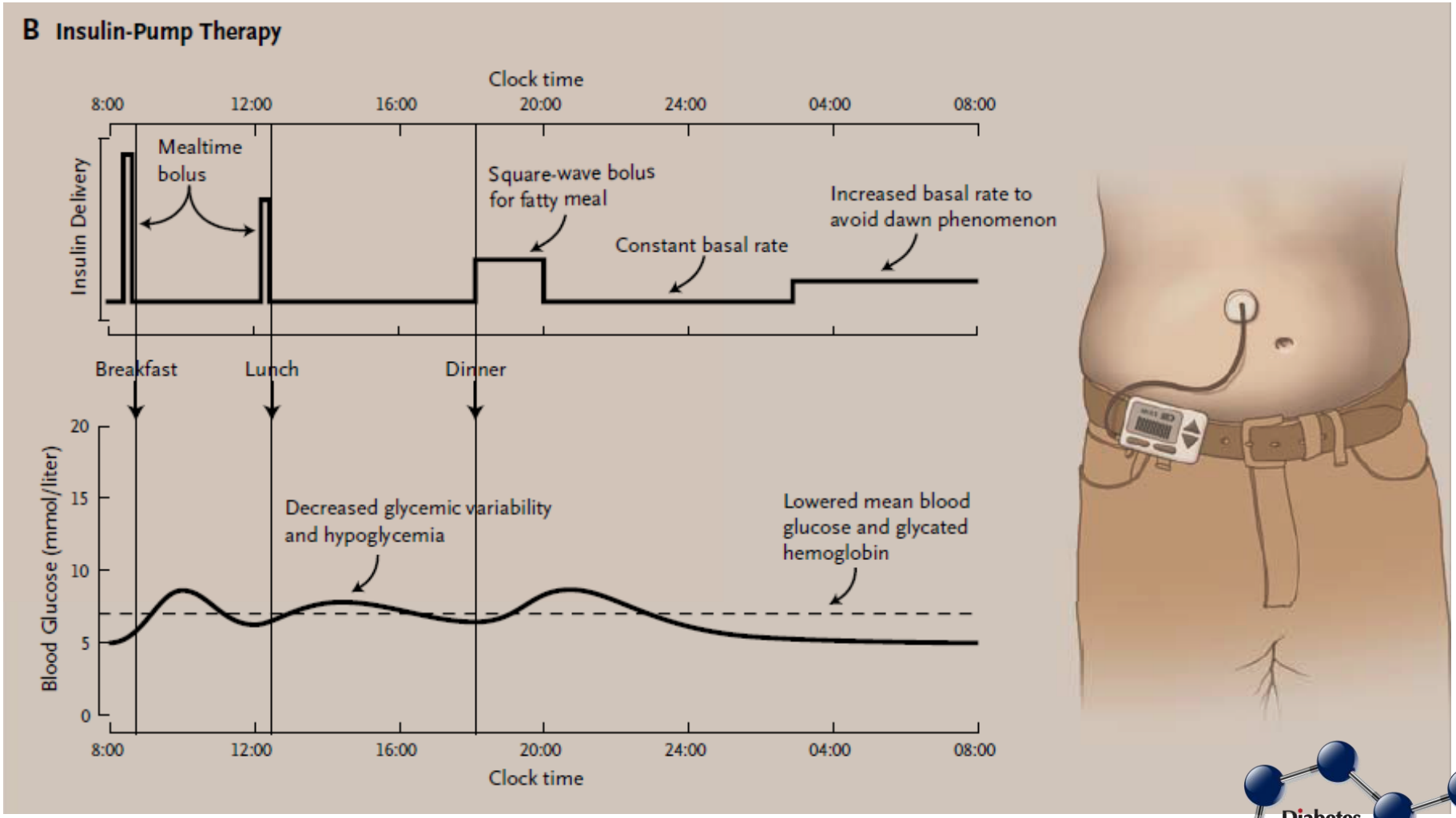

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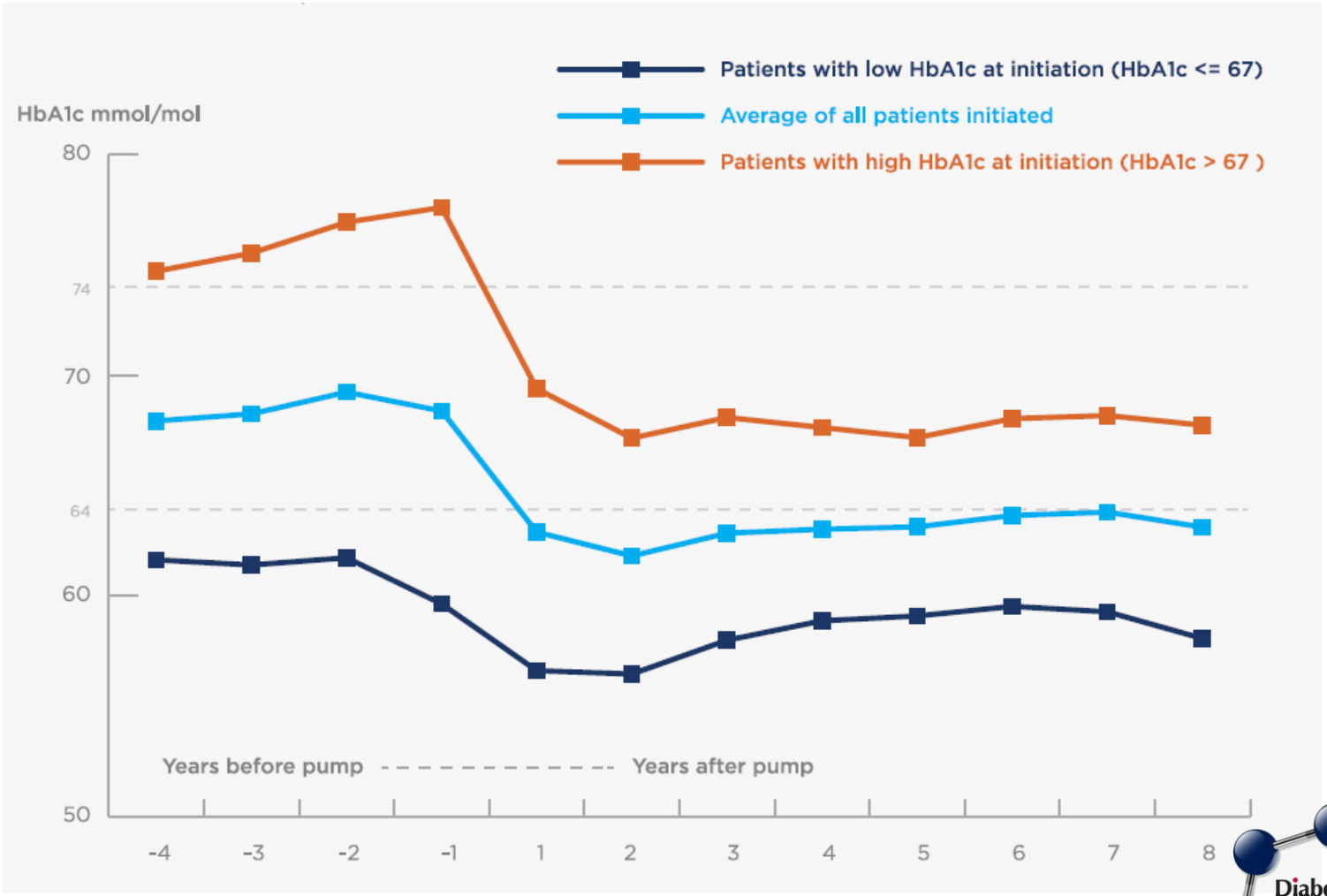
Insulin Pumps at steno



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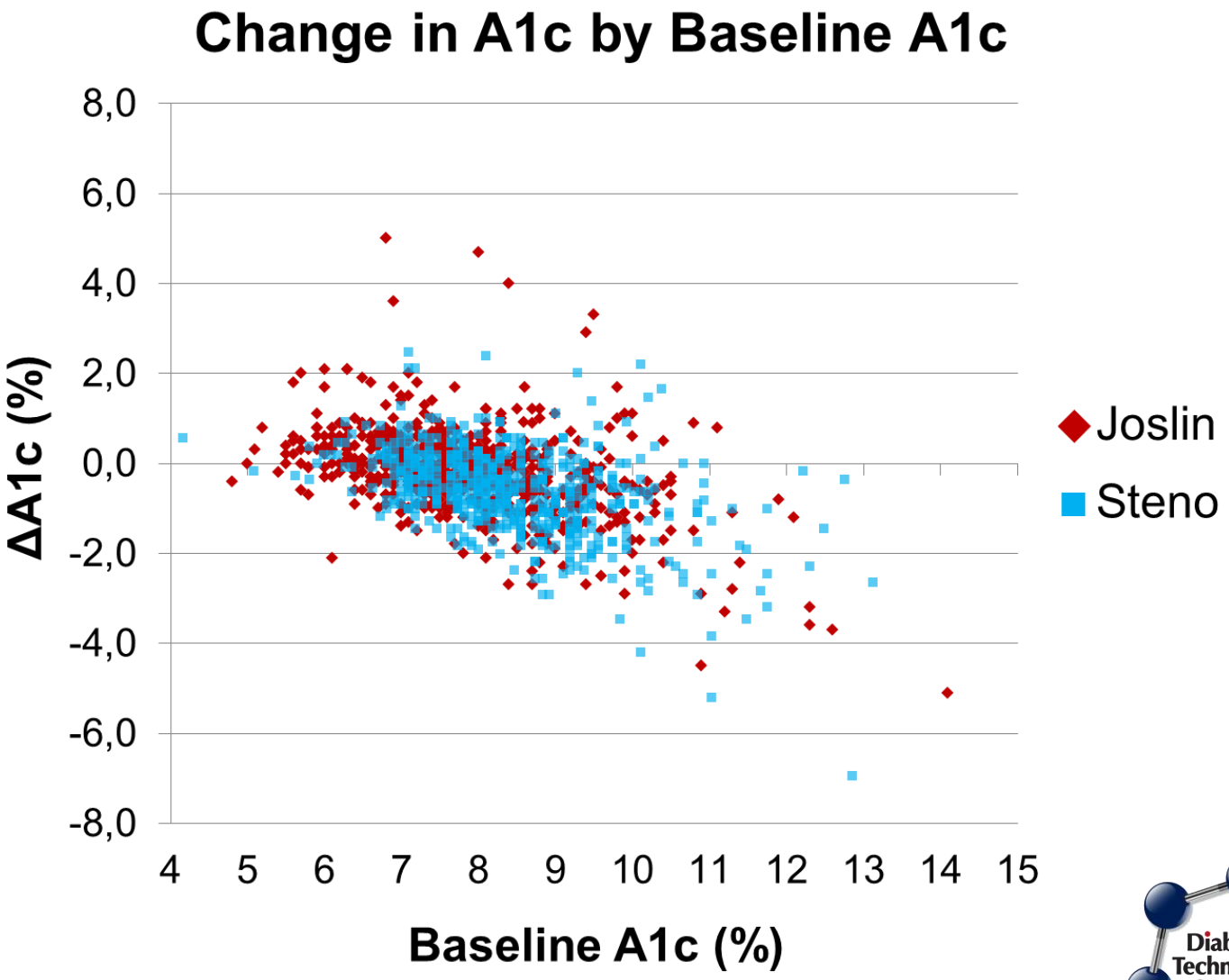
Steno Diabetes Center, data on file

Insulin Pumps at steno



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Mehta S, et al (2014) Abstract at the ADA

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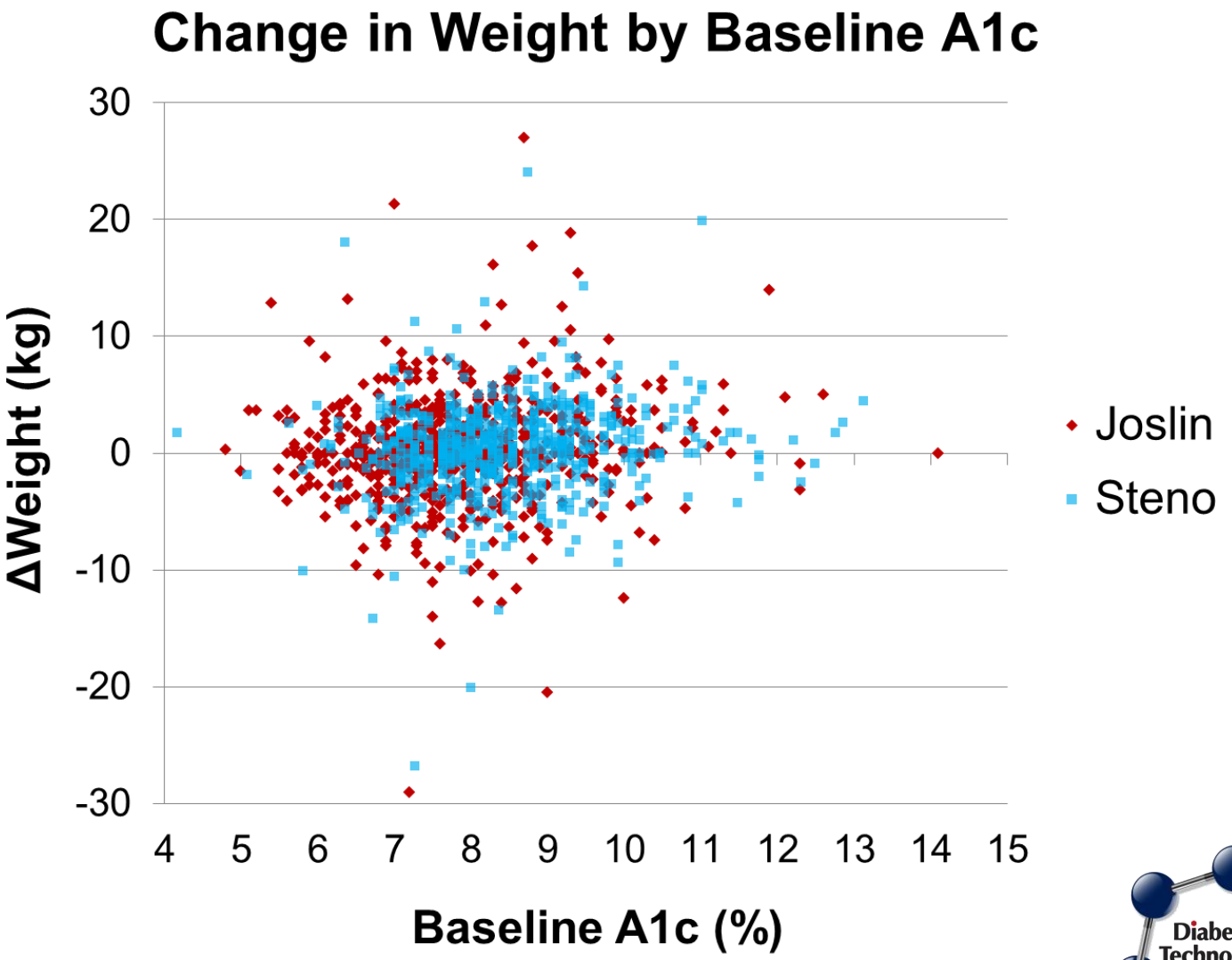

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Mehta S, et al (2014) Abstract at the ADA

Clinical Evidence

- HbA_{1c}
- Hypoglycaemia
- Quality of Life

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Who should be offered a pump?

- Type 1 diabetes where MDI does not give sufficient control
- Labile diabetes/glycaemic excursions
- Frequent hypoglycaemia/unawareness
- Significant dawn-phenomenon/low dose
- Special populations (children, athletes, T2D)

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Line Pump Components

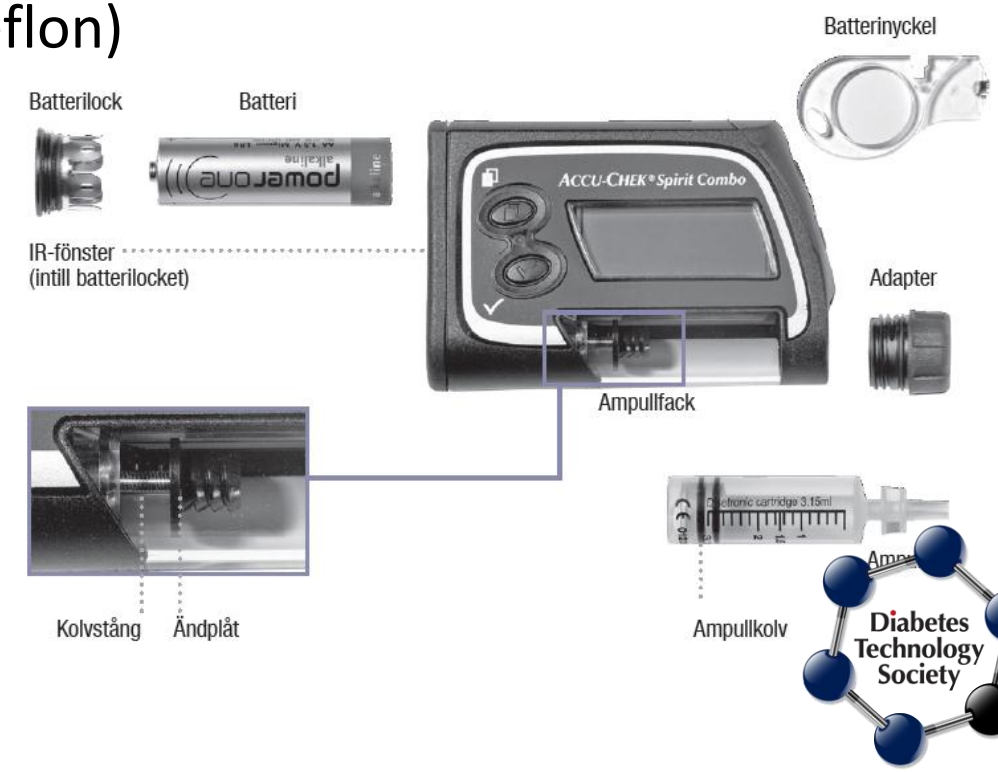
- Pump
- Reservoir/cartridge
- Infusion set

–hub (luer lock)

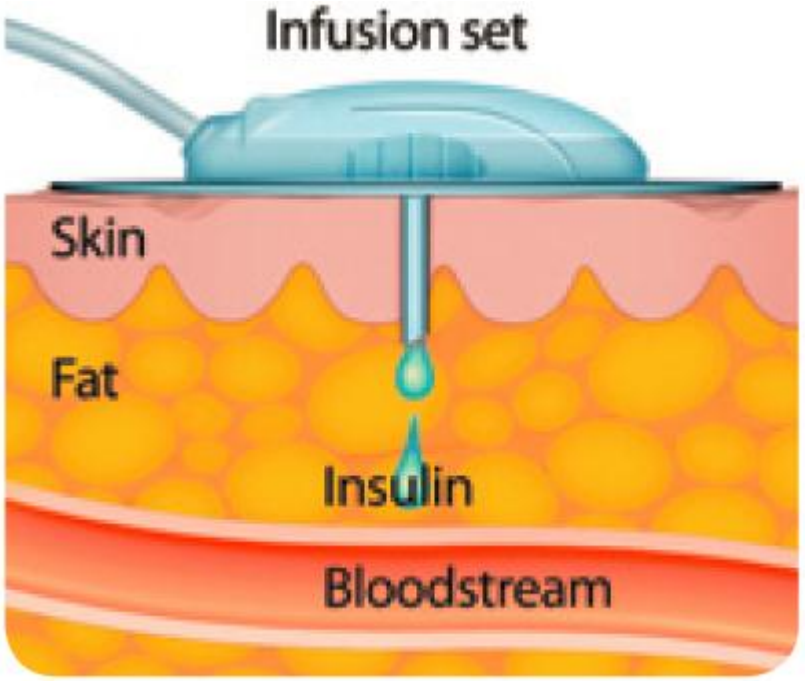
–tubing

– cannula (metal or teflon)

- Adhesive/tape



The Infusion Set Delivers Insulin



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The Infusion Set Delivers Insulin

Cannulas

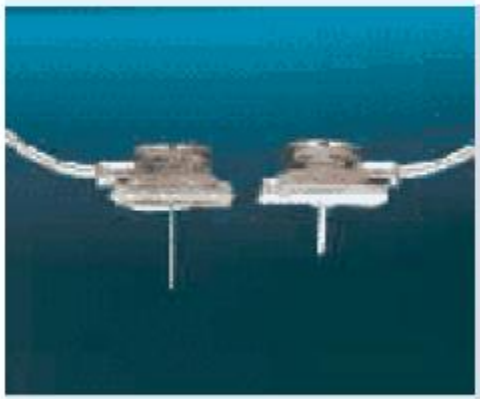
Straight

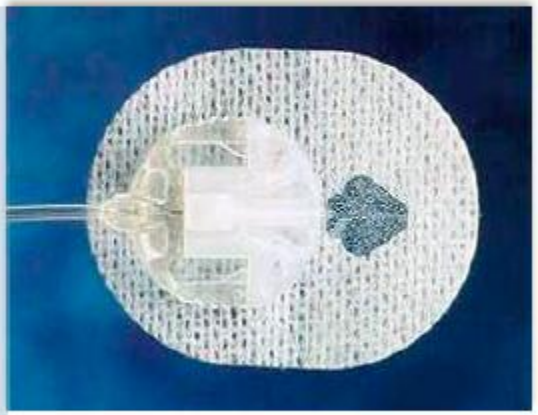
Slanted

Teflon

Metal

Teflon





6, 9 mm

4, 5, 6, 9 mm

13, 17 mm

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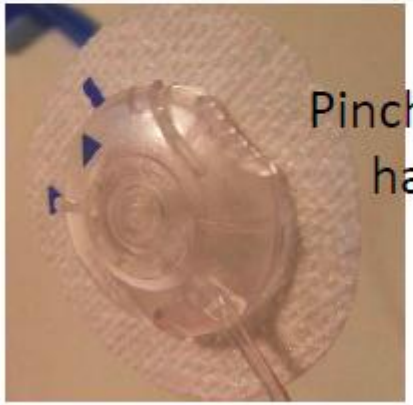
The Infusion Set Delivers Insulin

Line connections

Twist & pull
easiest

Pinch & pull
easier



Pinch & twist
hardest

Separate & lift
harder

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The Infusion Set Delivers Insulin

Inserters

Inset 30

Accu-Chek Link Assist

Inset/Mio

Quick-Serter

Cleo

Spring

Omnipod

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Patch Pumps

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Patch Pump Components

- Wearable pump
  All disposable or modular
- PDA with meter
- Automated or manual catheter insertion
- Covers larger skin area

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Remote Controllers

- Discreet bolus/basal delivery
- Meter sends BG to pump
- All data in one location
- Bidirectional communication
- Required for bolus

Accu-Chek Combo

Animas Ping

Cellnovo

Omnipod

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Line Pumps and Patch Pumps

Patch Pump

- Discreet
- Easier but less versatile
- Tubeless
- Presence of PDA to bolus
- Simple versions for T1D & T2D
- Can loosen, leak, be knocked off

Line Pump

- Some are discreet
- More site options
- Many choices for needle and tubing length
- Easy pump removal for showering, sports
- Can also loosen, leak, be knocked off!!!

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Pump Patient Options

- Reservoir size (180, 200, 300 units)
- Screen type and size
- Basal/bolus delivery increament and frequency
- Bolus calculator
- Ease of use/programming steps
- Meter and CGM connections
- Data download type and speed
- Internal and downloaded history
- Software
- Safety features
- Remote control
- Cosmetic attraction
- Cases and accessories
- Green factor, battery type

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Working with the screen

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Working with the screen - bolus

Insulin-to-Carb ratio (ICR)

One unit of insulin takes care of what gram amount of carbs?

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Working with the screen - bolus

Insulin-to-Carb ratio (ICR)

One unit of insulin takes care of what gram amount of carbs?

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Working with the screen - correction

Insulin Sensitivity Factor (ISF)
One unit of insulin lowers your BG how much?

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Working with the screen - correction

Insulin Sensitivity Factor (ISF)

One unit of insulin lowers your BG how much?

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Alarms and Alerts

Alarms = **no** delivery

- Empty reservoir
- Depleted battery (no sound?)
- Occlusion
- Pump malfunction
- Auto off
- Suspension by operator

Alerts = delivery **OK**

- Low reservoir
- Low battery
- Alternate basal
- Extended bolus

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Troubleshooting the Pump

- DKA is more common with pumps; 3.4 versus 1.5 per 100 years of pump versus injection use in children*
- There is loss of both basal and bolus; required correction doses are higher than normal!

*Hanås R et al (2009) Pediatr Diabetes 10(1):33-37

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Infusion Set Failure

- Partial or complete pull-out
- Occlusion
- Bent cannula
- Loose hub connection
- Insulin leak along teflon to skin
- Line punctures
- Rash or allergies
- Infection
- Hematoma

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Check for ketones!

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Anchor the line!

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Sensor augmented pump therapy

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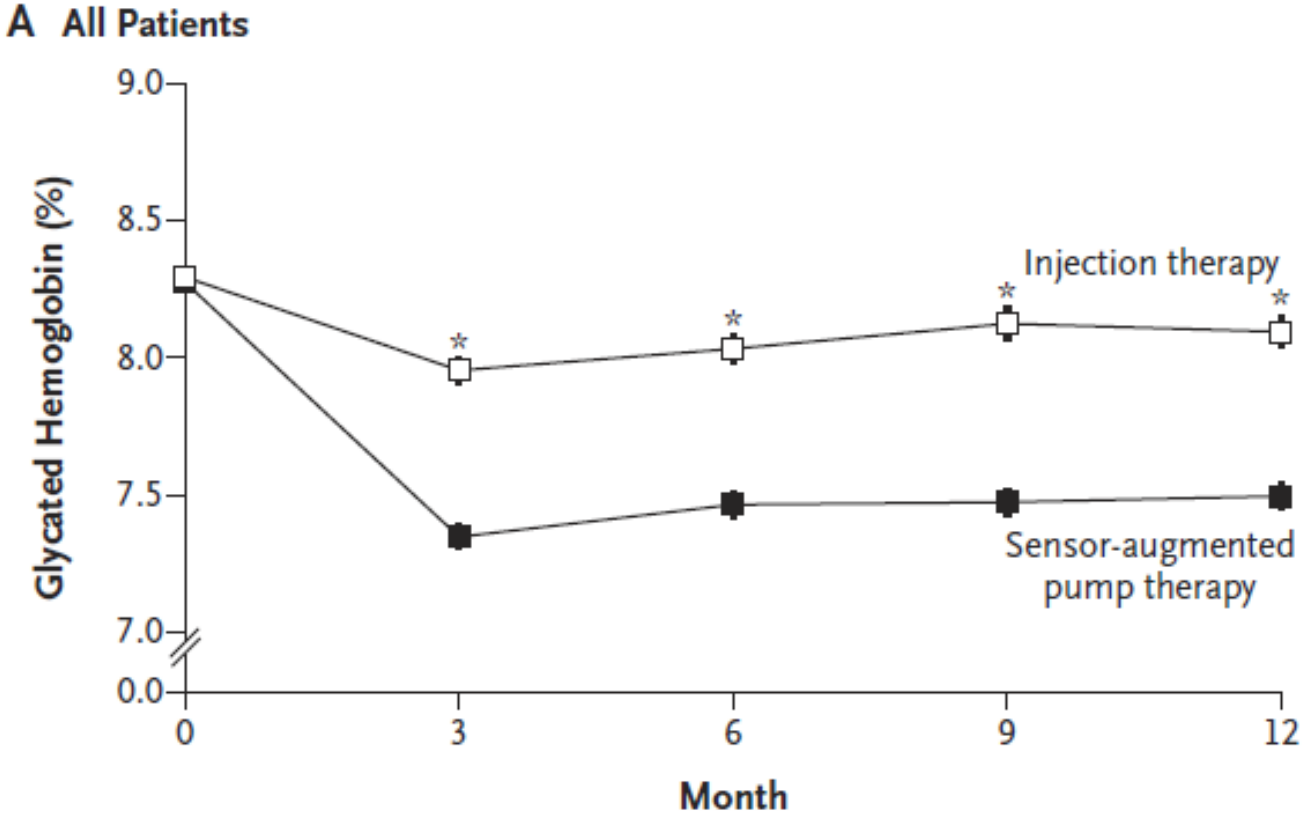
Effectiveness of Sensor-Augmented Insulin-Pump Therapy in Type 1 Diabetes

Richard M. Bergenstal, M.D., William V. Tamborlane, M.D., Andrew Ahmann, M.D., John B. Buse, M.D., Ph.D., George Dailey, M.D., Stephen N. Davis, M.D., Carol Joyce, M.D., Tim Peoples, M.A., Bruce A. Perkins, M.D., M.P.H., John B. Welsh, M.D., Ph.D., Steven M. Willi, M.D., and Michael A. Wood, M.D., for the STAR 3 Study Group*



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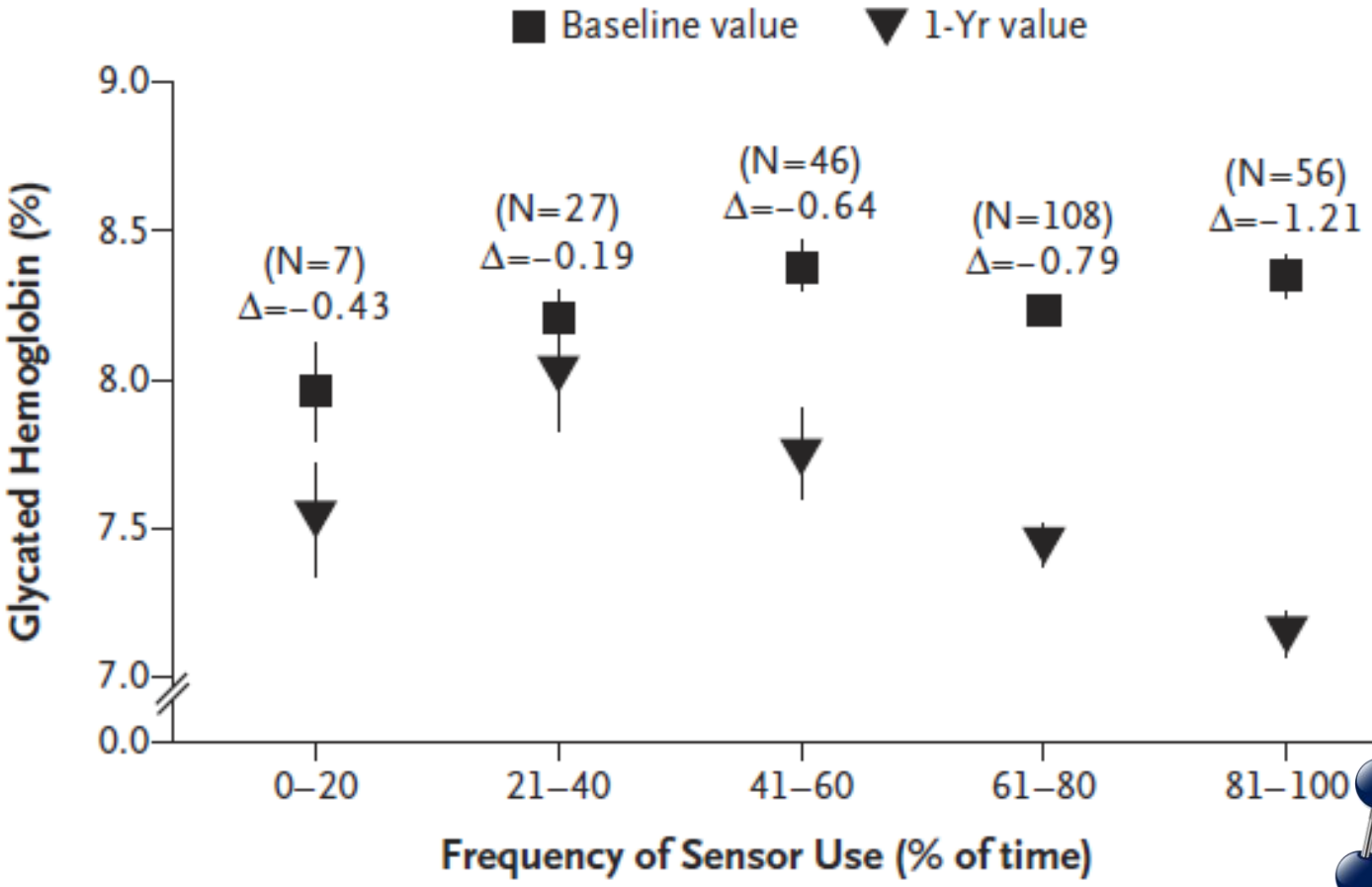

N ENGL J MED 363;4 NEJM.ORG JULY 22, 2010

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Sensor augmented pump therapy

Advantages

- One less device to carry
- All data in one location
- Improved decision making (monitor and review)
- Safety
- Path to closed loop

Disadvantages

- CGM data; not BG nor input for insulin dosing
- Pump tied to old technology
- More alarms and alerts
- Interpretation?

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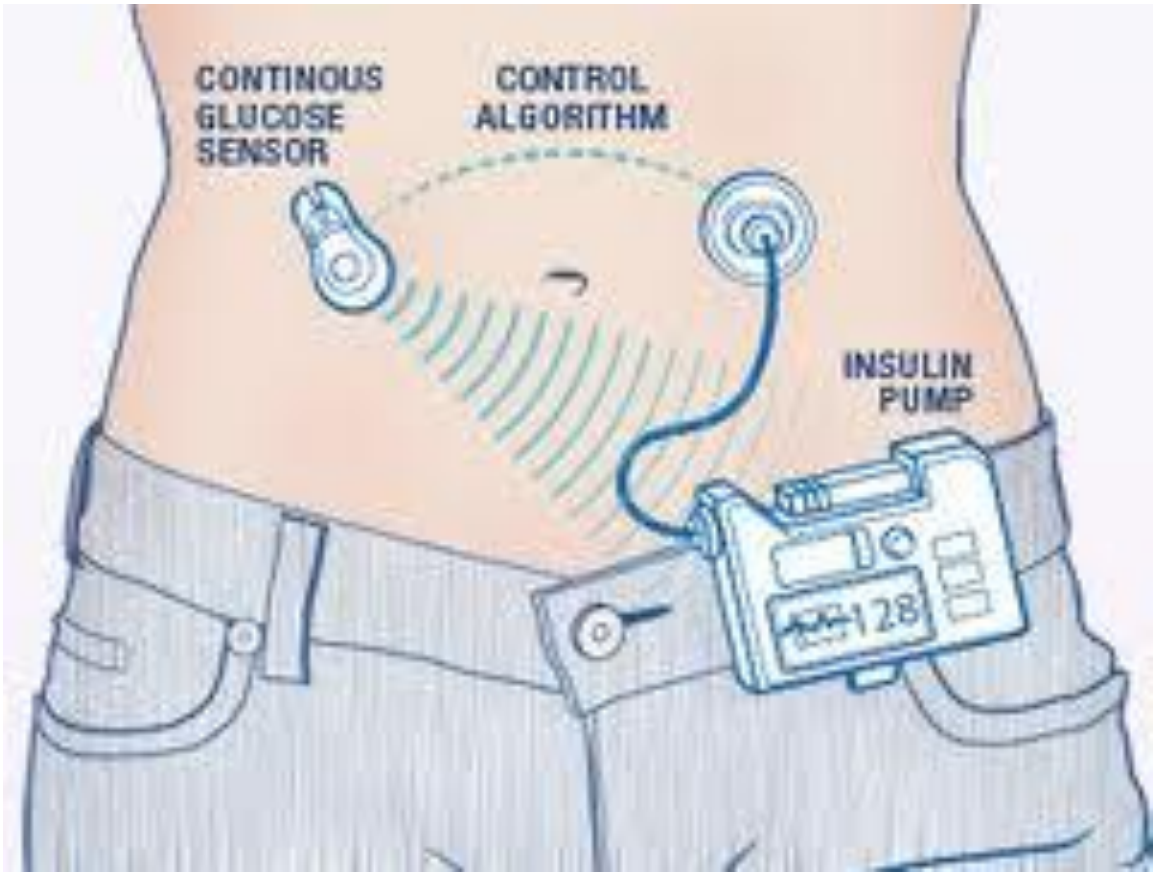
Closed Loop



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Closed Loop

- Low glucose suspend (LGS)
- 6 day Enlight sensor suspends basal for 2 hrs when BG < 70 mg/dL
- User can reactivate basal if alarm is heard
- May reduce length and severity of hypoglycemia

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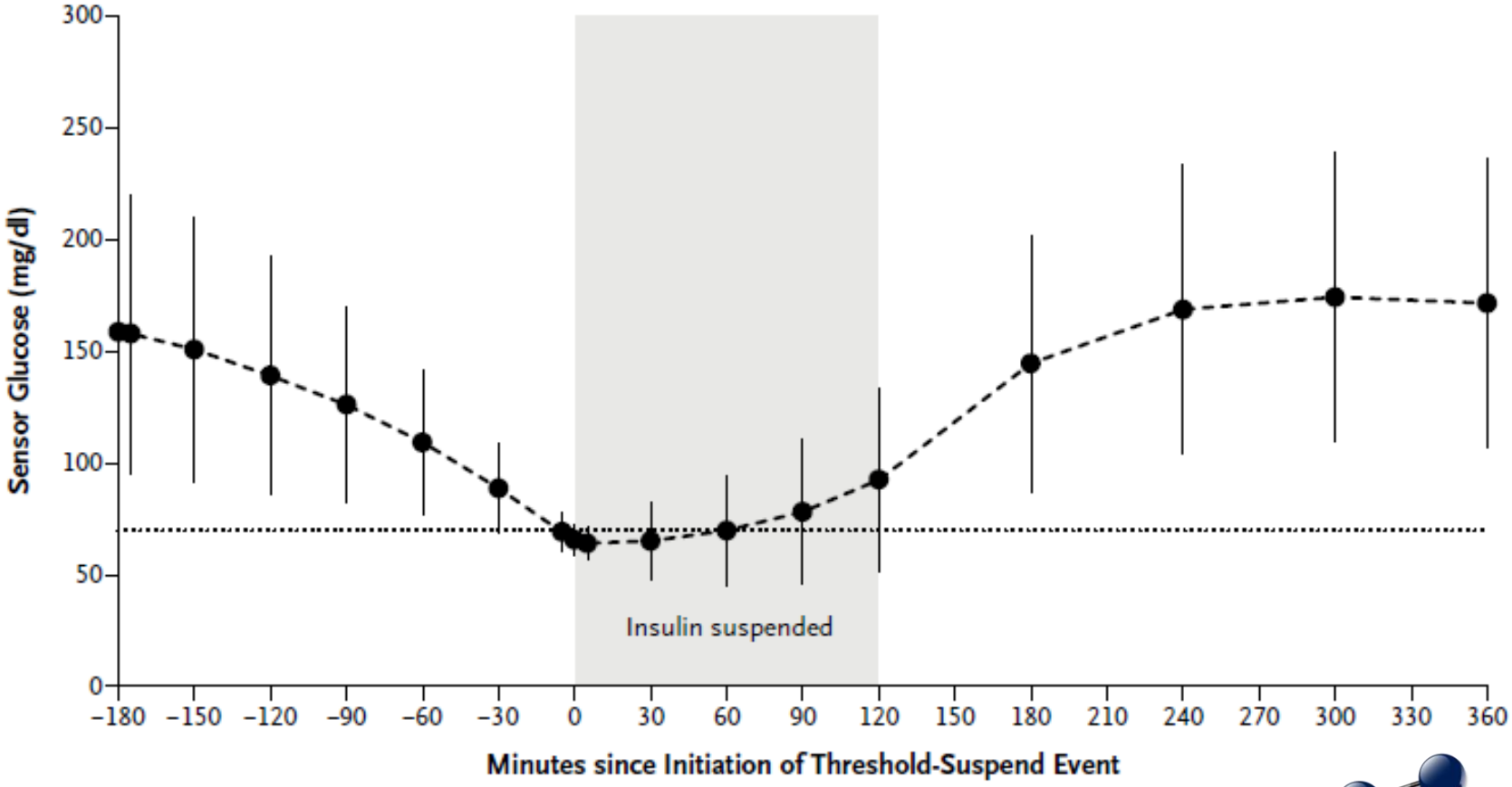
Low Glucose Suspend



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Threshold-Based Insulin-Pump Interruption for Reduction of Hypoglycemia

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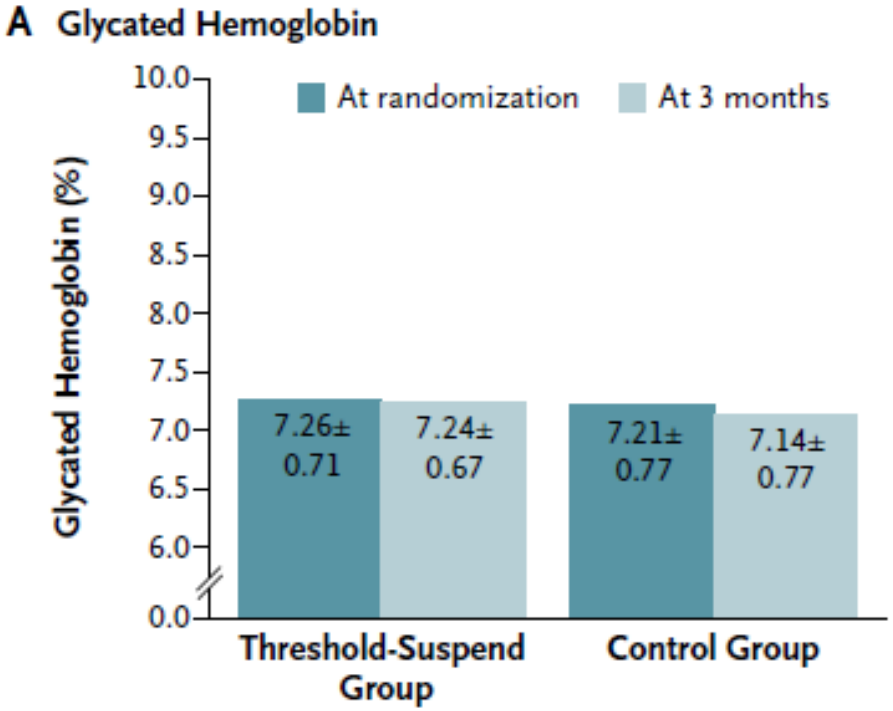

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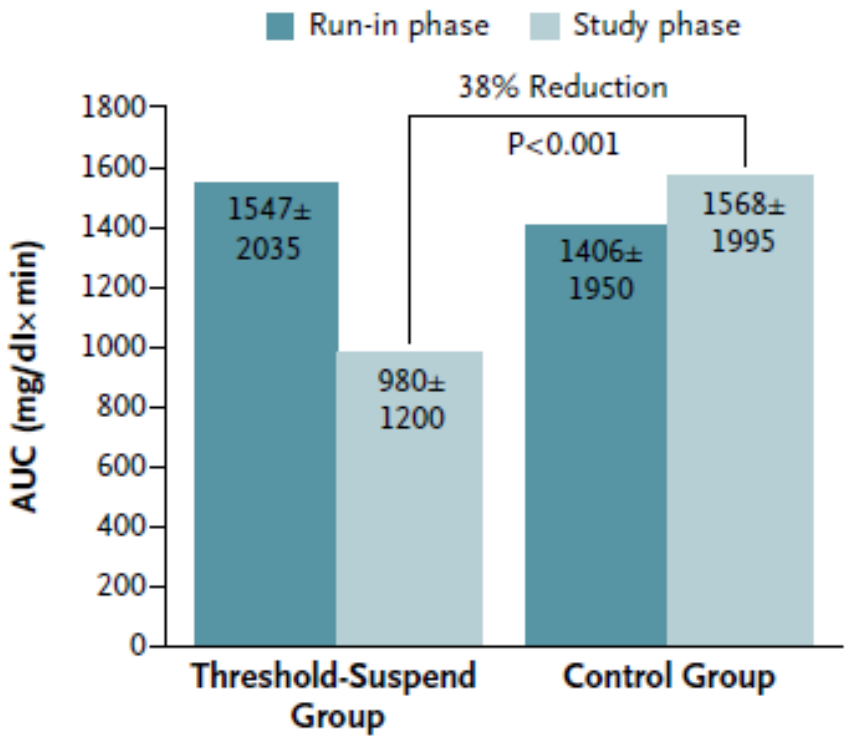
B Mean AUC for Nocturnal Hypoglycemic Events



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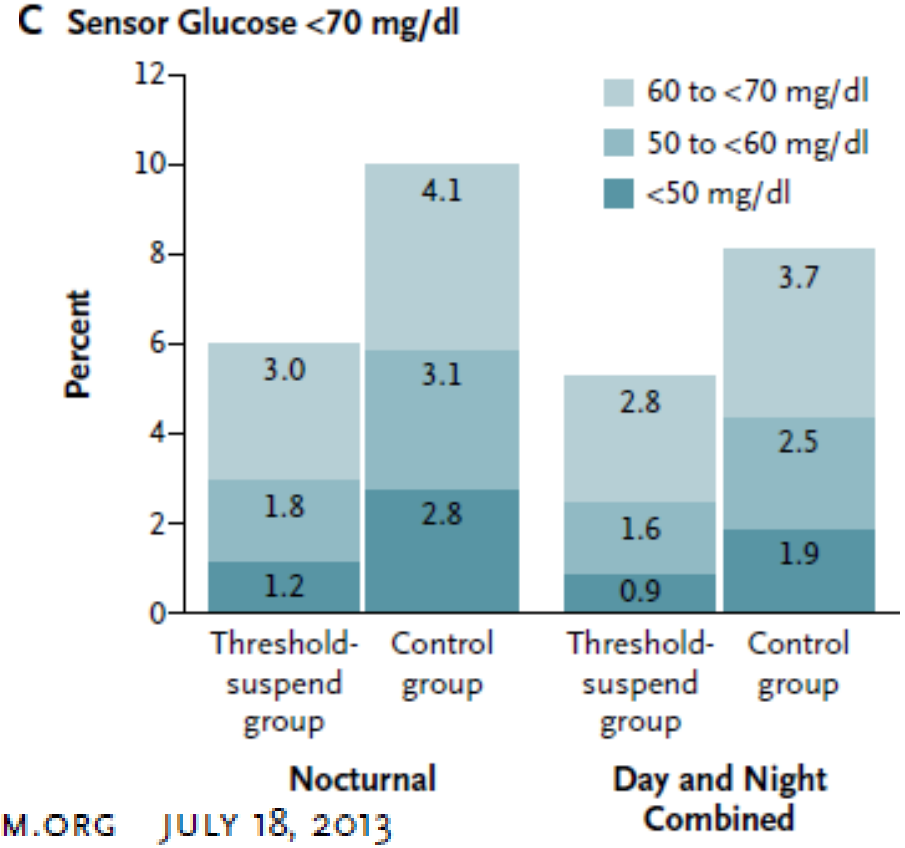

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