Continuous Subcutaneous Insulin Infusion (CSII) in Diabetes Management: Who, Why & How

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DIABETES, PREVENTION AND CONTROL PROGRAM
TELE-HEALTH CONFERENCE
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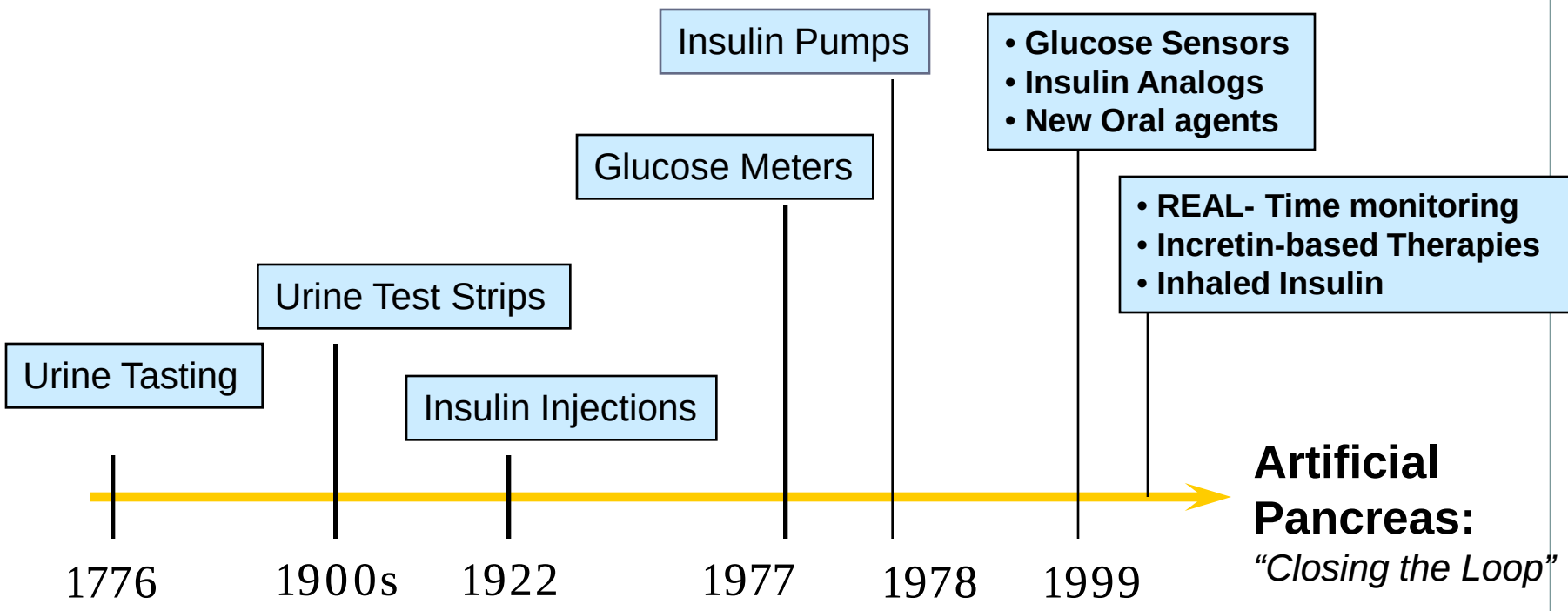
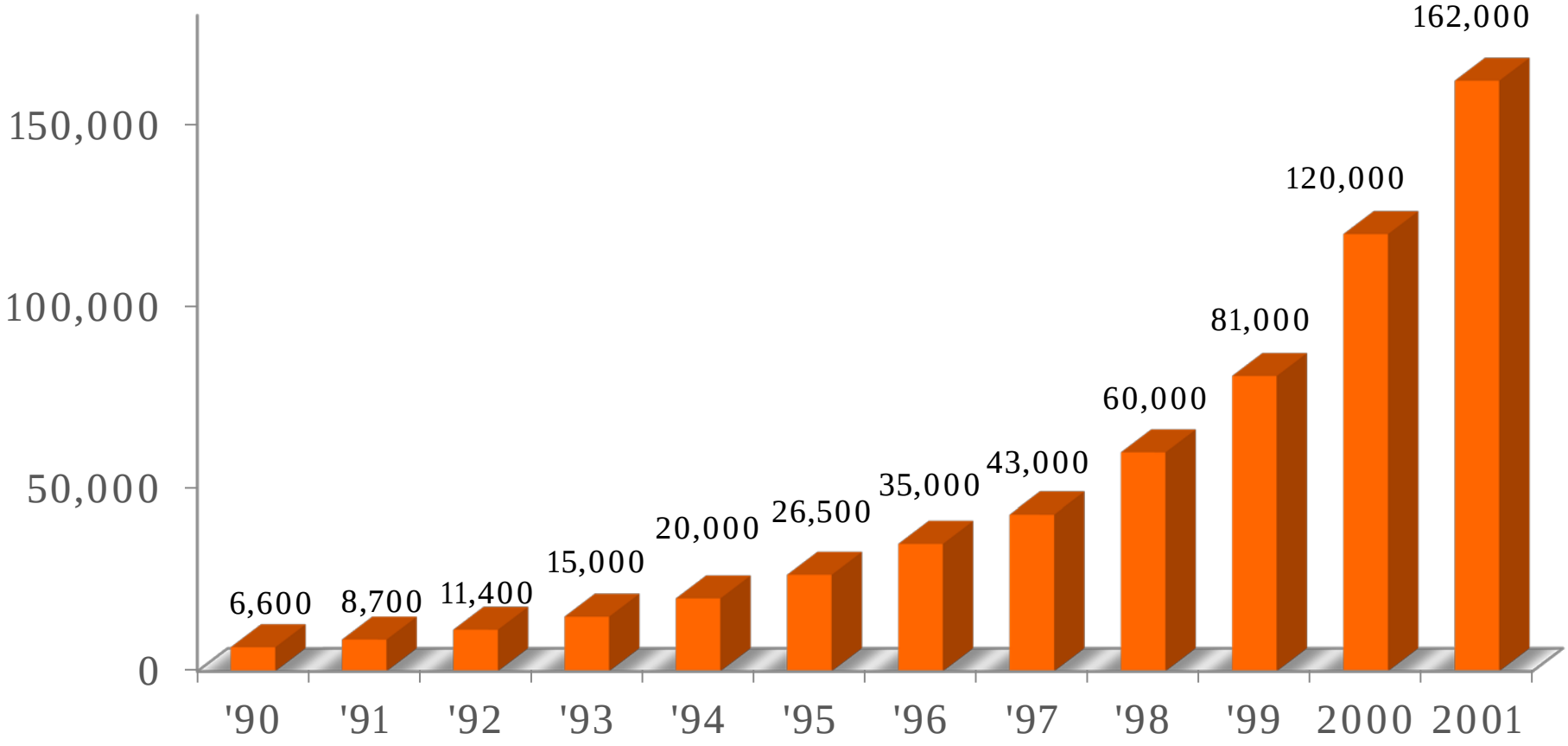
Evolution of Diabetes Technology and Treatments: Timeline

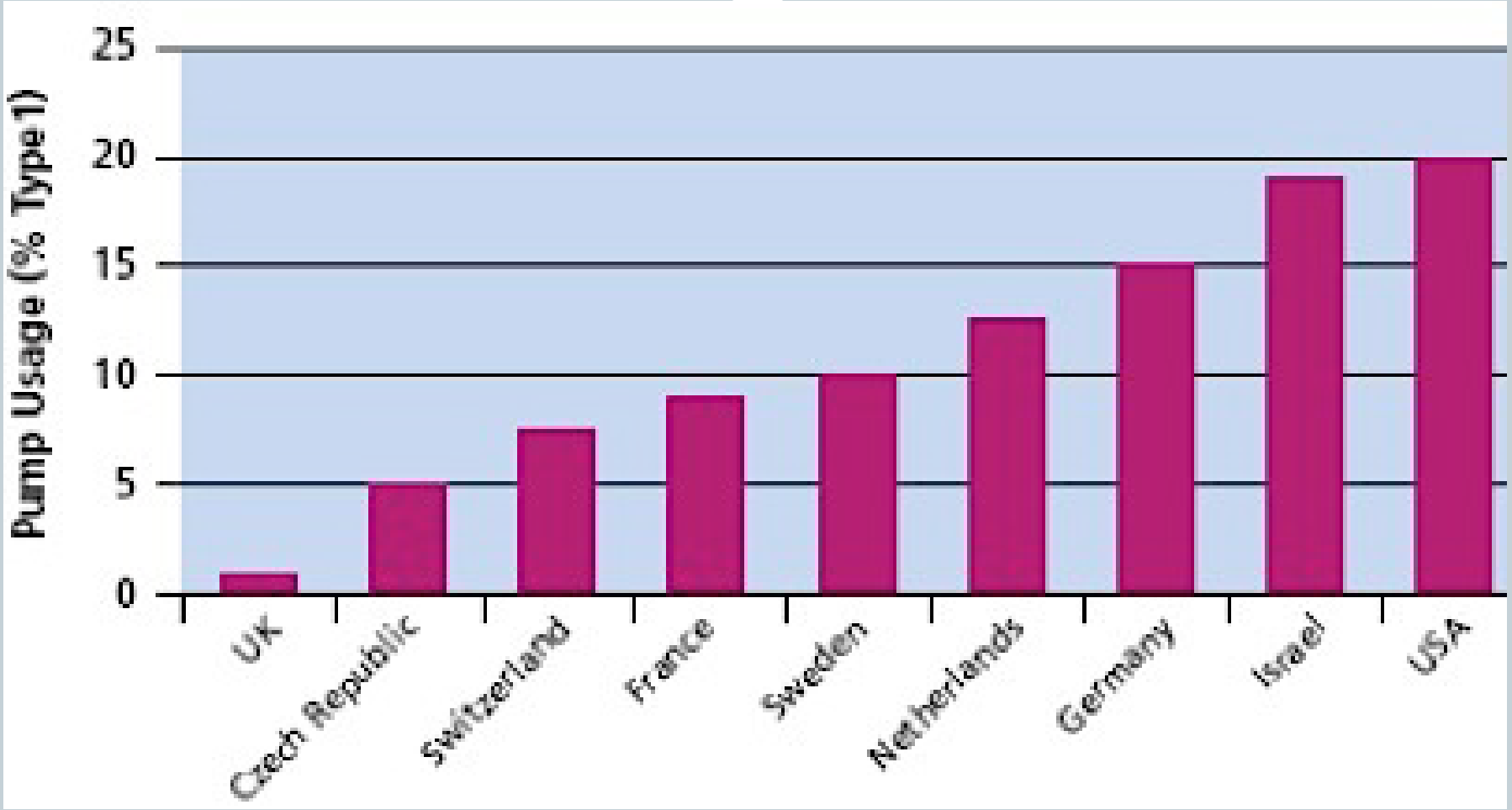


Insulin Pumps: Overview

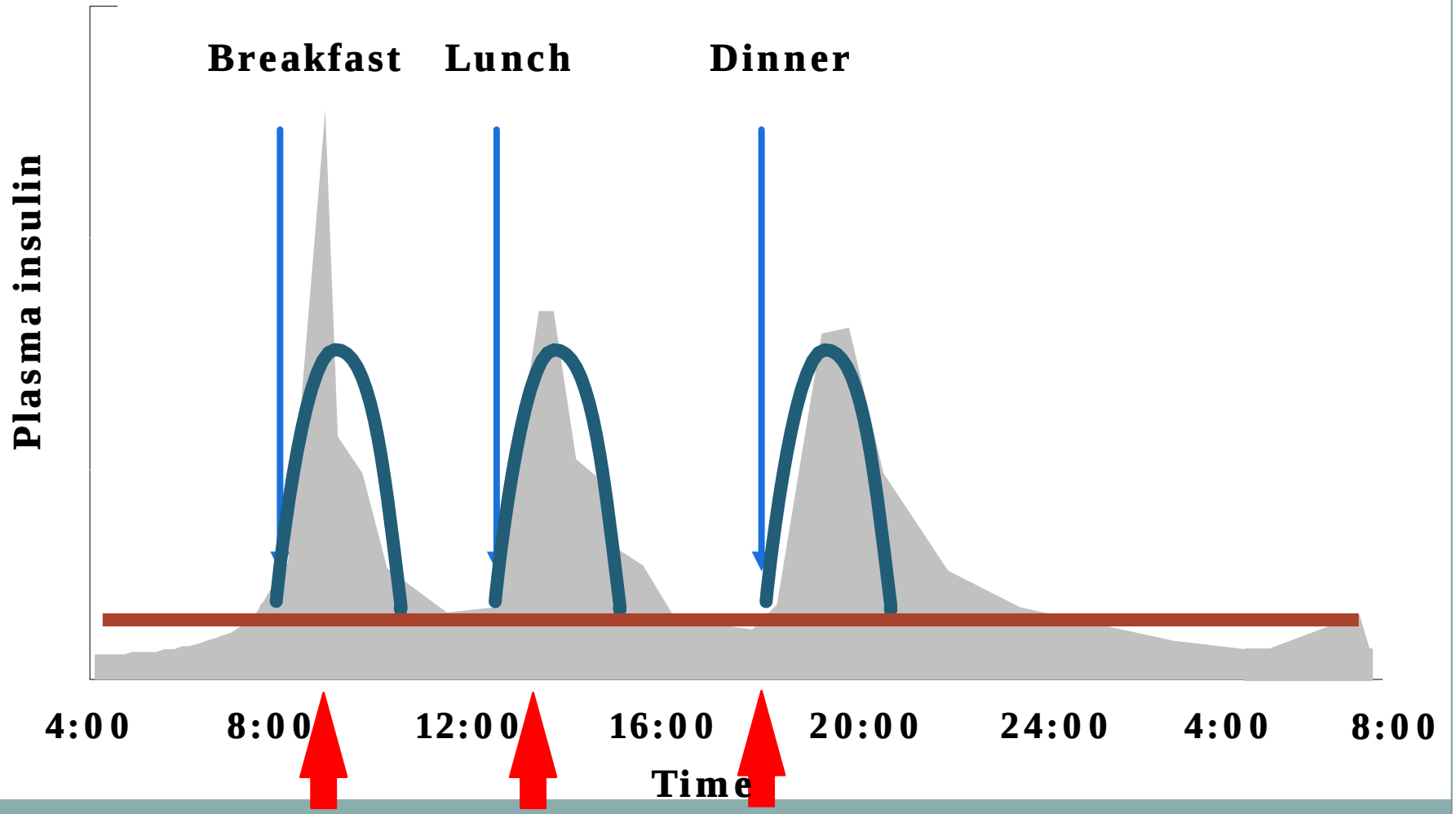
U.S. Pump Usage



Estimated Pump Use Around the World



Ideal Basal/Bolus Insulin



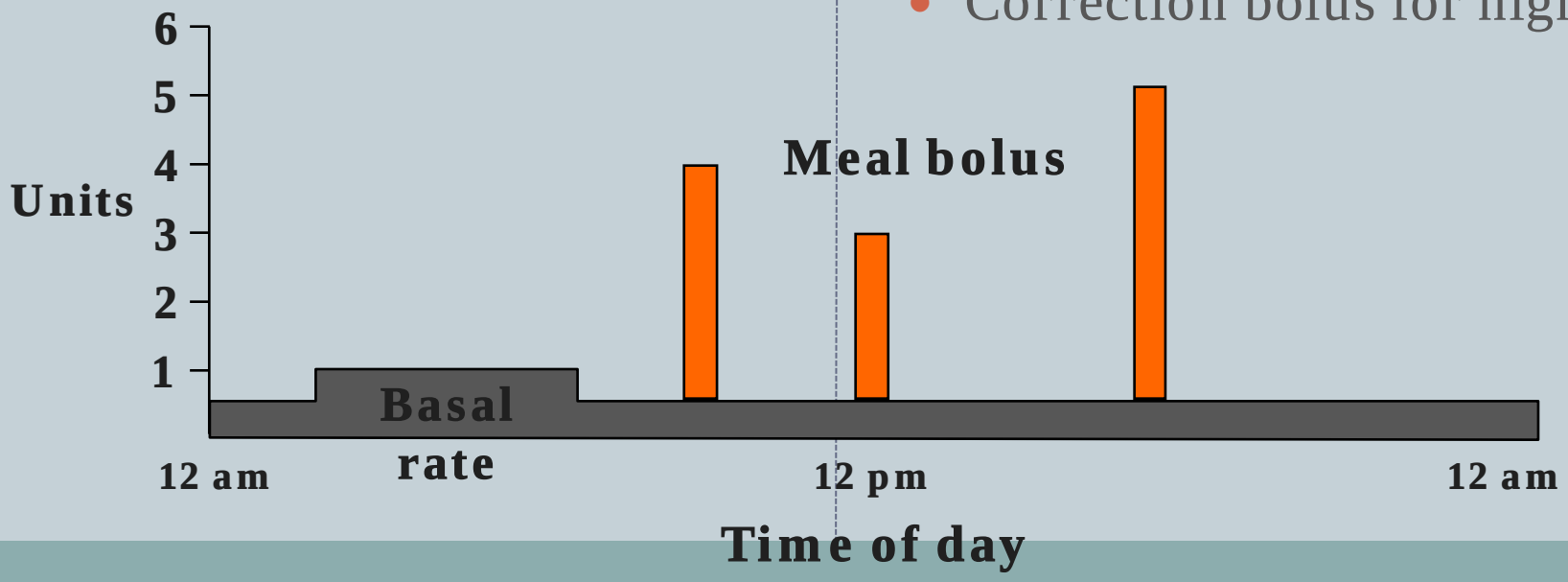
Pump Therapy

Basal rate

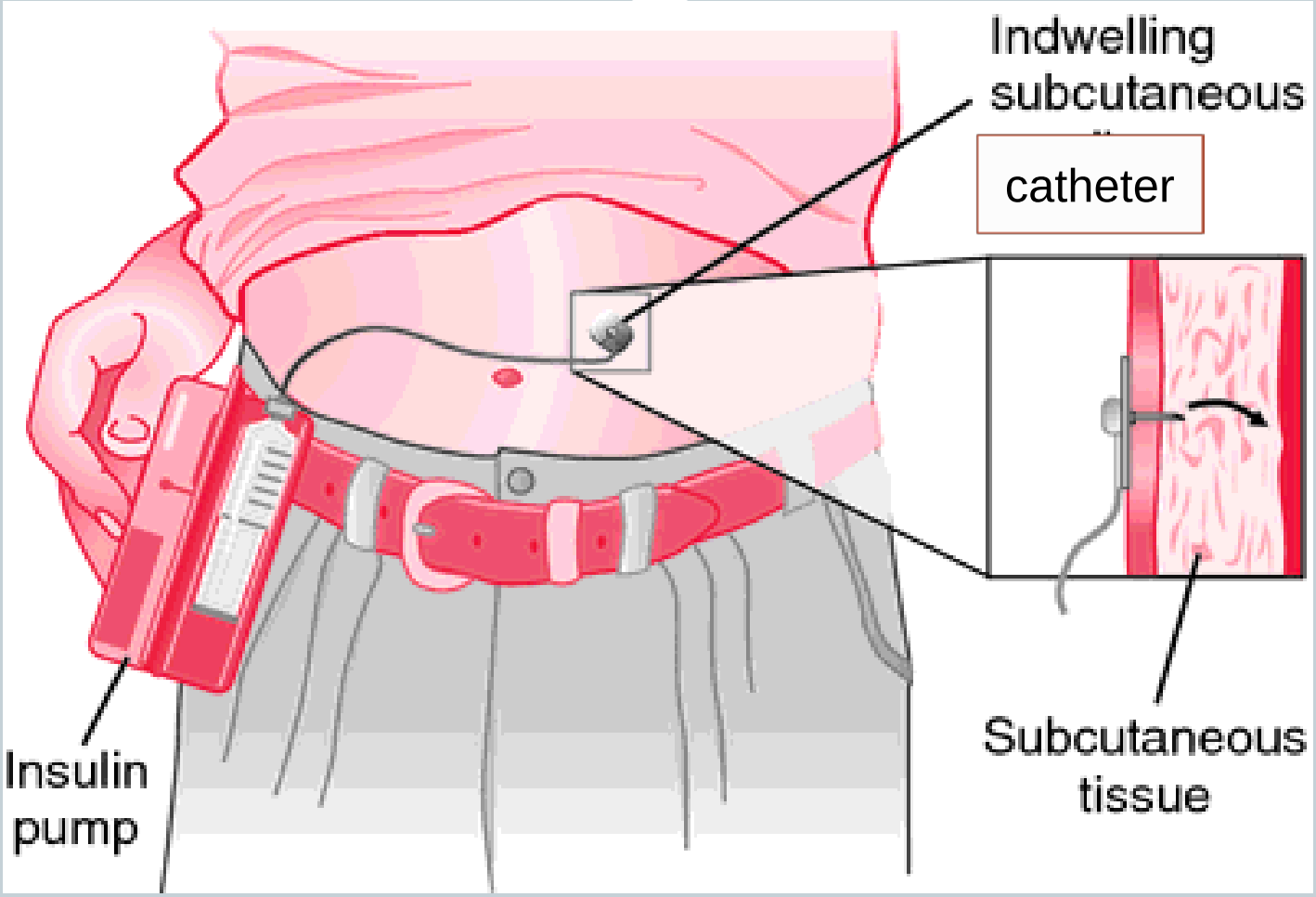
- Continuous flow of insulin
- Takes the place of glargine or detemir

Boluses

- Insulin needed pre-meal
  - Pre-meal BG
  - Carbohydrates in meal
  - Activity level
- Correction bolus for high BG

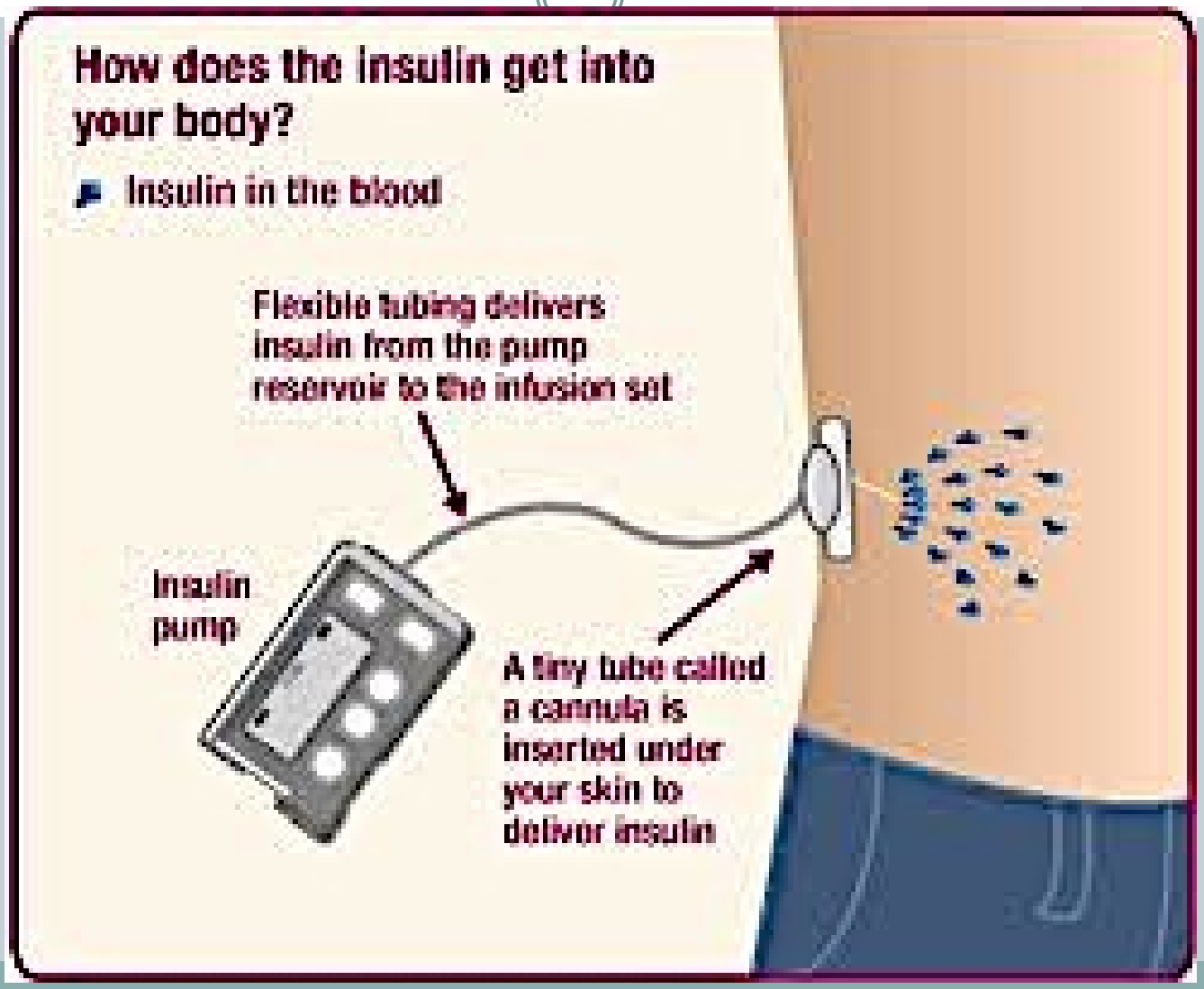


Pump Components

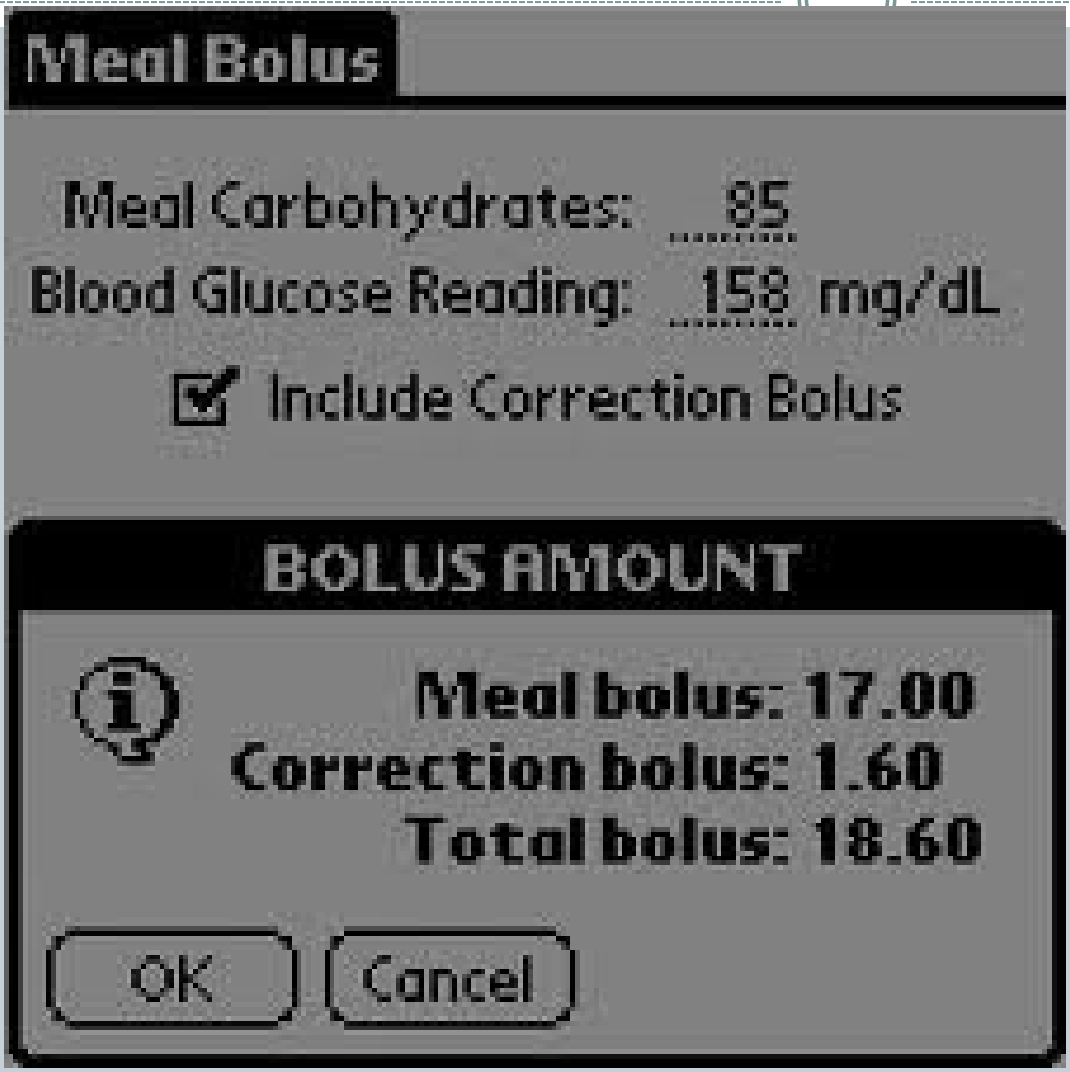


Pump Components

Pump Components



Additional Features

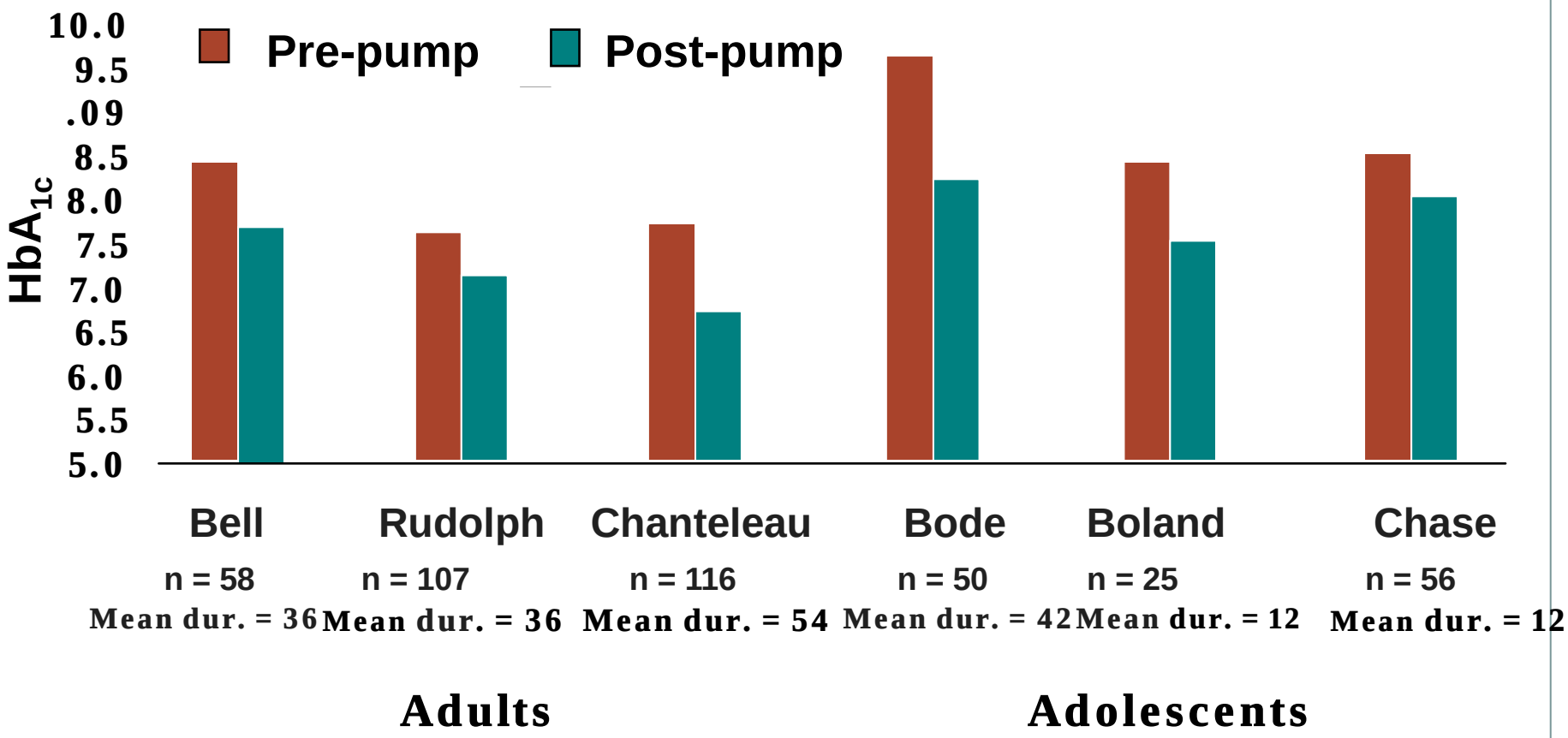


Bolus Calculators:

- Carbohydrates
- Blood glucose
- Insulin on board

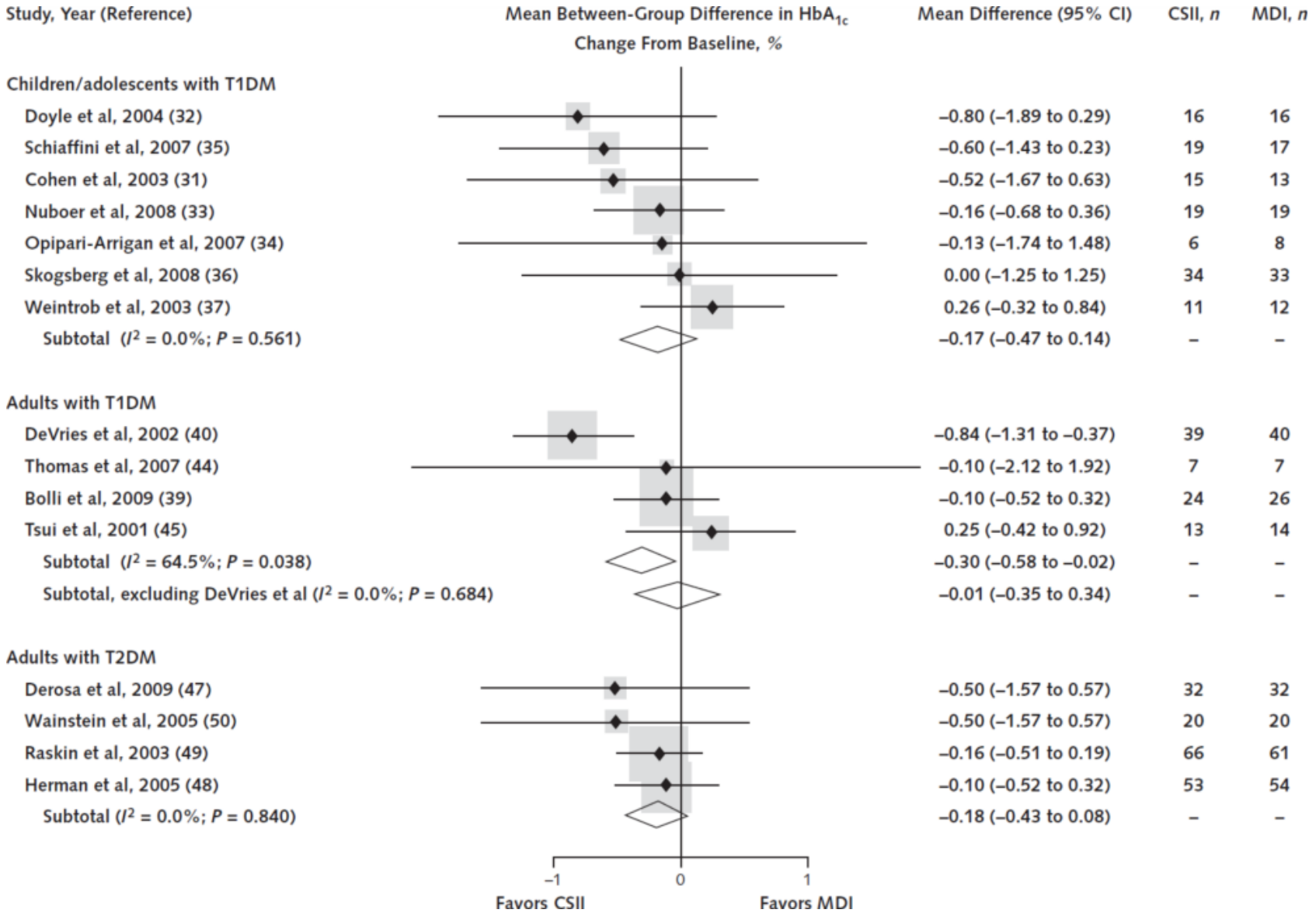
Insulin Pump Benefits

HbA_{1c} Reduction



Chantelau E, et al. *Diabetologia*. 1989;32:421–426; Bode BW, et al. *Diabetes Care*. 1996;19:324–327; Boland EA, et al. *Diabetes Care*. 1999;22:1779–1784; Bell DSH, et al. *Endocrine Practice*. 2000;6:357–360; Chase HP, et al. *Pediatrics*. 2001;107:351–356.

Change from Baseline HbA1c: Comparing CSII with MDI



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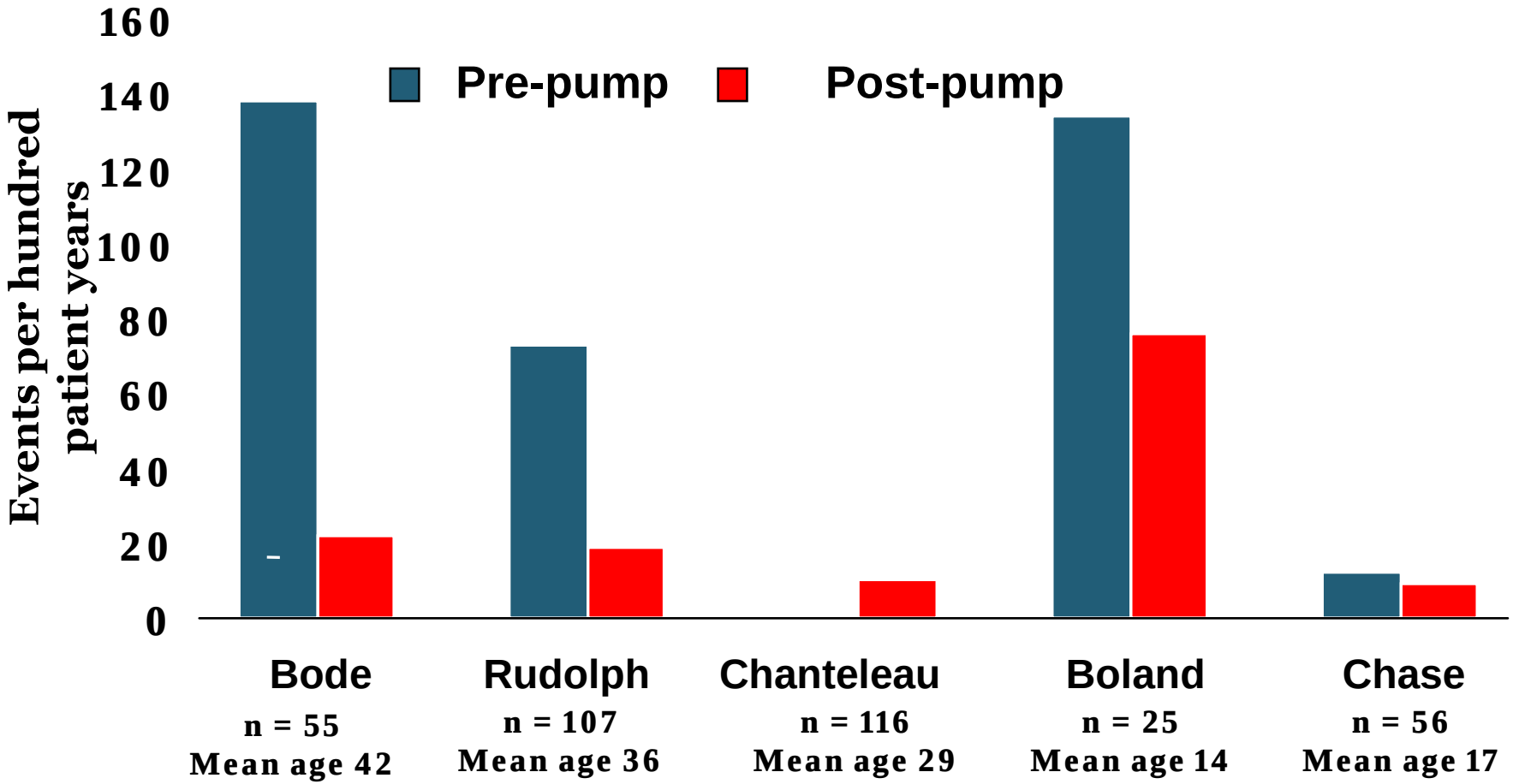
Reduces Hypoglycemia



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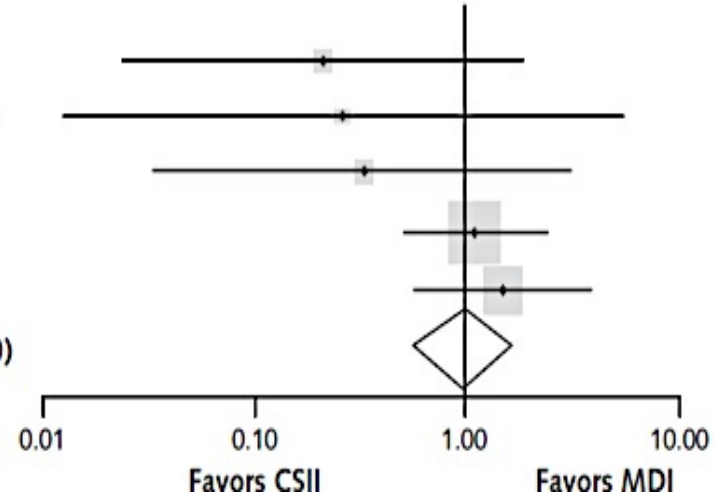
Incidence Rate Ratio Severe Hypoglycemia: CSII vs MDI



Study, Year (Reference)	IRR for Severe Hypoglycemia, *events/person-year*	IRR (95% CI)	Total Events, *n*		Person-Years	
			CSII	MDI	CSII	MDI
Cohen et al, 2003 (31)		0.22 (0.02–1.94)	1	4	6.0	6.0
Opipari-Arrigan et al, 2007 (34)		0.27 (0.01–5.55)	0	2	3.0	4.0
Weintrob et al, 2003 (37)		0.33 (0.03–3.21)	1	3	6.7	6.7
Skogsberg et al, 2008 (36)		1.12 (0.52–2.41)	13	12	76.0	78.0
Schiaffini et al, 2007 (35)		1.50 (0.58–3.88)	11	7	38.0	34.0
Overall (I^2 = 6.5%; P = 0.370)		0.99 (0.57–1.71)	–	–	–	–

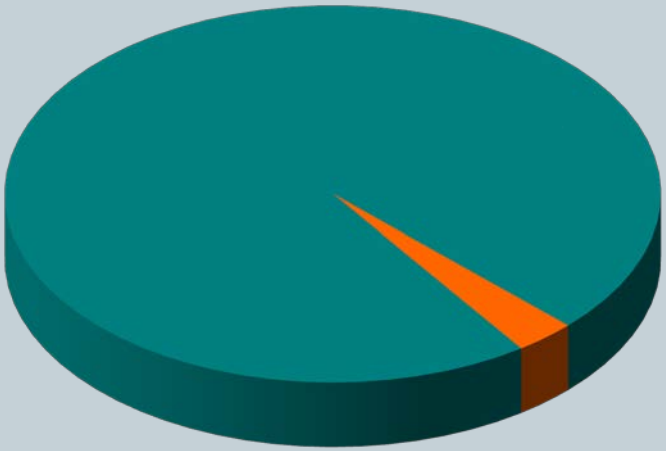
Ann Intern Med. 2012;():E-508. doi:10.7326/0003-4819-157-5-201209040-00508

Quality of Life

- Liberalization of diet — timing & amount
- Increased control with exercise
- Able to work shifts & through lunch
- Less hassle with travel — time zones
- Weight control
- Less anxiety in trying to keep on schedule

Continuation Rate

Continued
97%



Discontinued
3%

N = 165
Average Duration = 3.6 years
Average Discontinuation <1%/yr

Bode BW, et al. *Diabetes*. 1998;47(suppl 1):392.

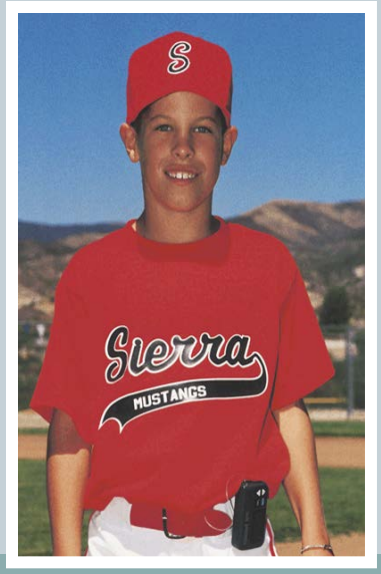
Pros and Cons of Pump Therapy

	Pros	Cons
Insulin Pump Therapy	Slightly better glycemic control	Cost
	Fewer injections	Superficial infection
	Less variable insulin absorption day to day	Pump failure → DKA
	Lifestyle flexibility, improved QOL	Inconvenience of wearing device 24/7
	Capability to store history of bolus/basal: clinicians can assess adherence	
	Decreased frequency of hypoglycemia (in peds)	
Multiple Daily Injections	Lower cost	Multiple injections
	Freedom from wearing pump	Inferior glycemic control
		Less flexible

Insulin Pumps: Indications

Pump Therapy Indications

- HbA_{1c} >6.5%
- Frequent hypoglycemia
- Dawn phenomenon
- Exercise
- Pediatrics
- Pregnancy
- Gastroparesis
- Hectic lifestyle
- Shift work
- Type 2???



Marcus. *Postgrad Med*. 1995.

PUMP INDICATIONS

- "Ideal CSII candidate is a patient with T1DM or absolutely insulin-deficient T2DM who. . ."
  - Performs 4+ injections daily
  - Is motivated to achieve tighter glycemic control
  - Is willing & intellectually/physically able to comply with initiation and maintenance of pup therapy
  - Is emotionally mature with stable life situation
  - Maintains frequent contact with health care provider
- Eligible patients should be capable of
  - Frequent SMBG and/or use of CGM
  - Carb counting and insulin correction
  - Troubleshooting problems

Target Populations

- Young children, especially infants and neonates
- Adolescents with eating disorders
- Children and adolescents with pronounced dawn phenomenon
- Children with needle phobia
- Pregnant women (before conception)
- Ketosis-prone individuals
- Competitive athletes

When to Consider

- Recurrent severe hypoglycemia
- Wide fluctuations in blood glucose levels regardless of A1C
- Suboptimal diabetes control
- Microvascular complications and/or risk for macrovascular complications
- Good metabolic control but insulin regimen compromises lifestyle
- Gastroparesis

Remember: The Smart Pump Arrives Dumb

- Glycemic control depends on
  - An accurate total daily dose
  - Appropriate basal rate (~50$ of total daily dose)
  - Accurate carb ratio
  - Accurate insulin sensitivity factor
  - Appropriate insulin on board
  - Appropriate correction target

Insulin Pumps: Available Options

Patch Pump vs Infusion Set

- Patch Pump (Omni-Pod)
  - Worn on body
  - No external tubing
  - Can loosen, leak, be knocked off
  - Lower start-up cost, greater monthly cost
- Infusion set (tubed)
  - More site options
  - Variety of needle and tubing lengths
  - Easy pump removal for showers, sports
  - Can loosen, leak, get ripped off

Omni-Pod

- **Patch pump (no tubing)**
- Watertight up to 25 feet for 60 minutes
- Color screen
- “Meter remote”
- Built-in FreeStyle blood glucose meter
- Food library
- Future integration with CGM (?)

MiniMed Paradigm Revel

- Tubed pump
- **2 different size options available (523/723)**
- **Only available pump with integrated CGM**
- Meter communicates to pump (not remote)
- No food database
- No color screen
- Low basal rate increment up to 1 unit
- Splash resistant (not waterpoof)

Animas OneTouch Ping

- Tubed pump
- **Waterproof**
- Color Screen
- **Meter remote**
- Integrated food database
- Future integration with Dexcom CGM (Animas Vibe)
- **Durable**

Tandem t:slim

- Tubed pump
- Water resistant (3 feet 30 minutes)
- **Color touch screen**
- **Smallest dimensions**
- No integrated meter
- **Rechargeable battery**
- No returns
- Occlusion shuts off pump
- Cannot tolerate extreme temperatures

Accu-Check Combo

- Tubed pump
- Water resistant
- Color screen on meter
- Meter remote
- ? Food database
- Must program basal rate for each hour
- No bolus calculator on pump
- Complicated programming

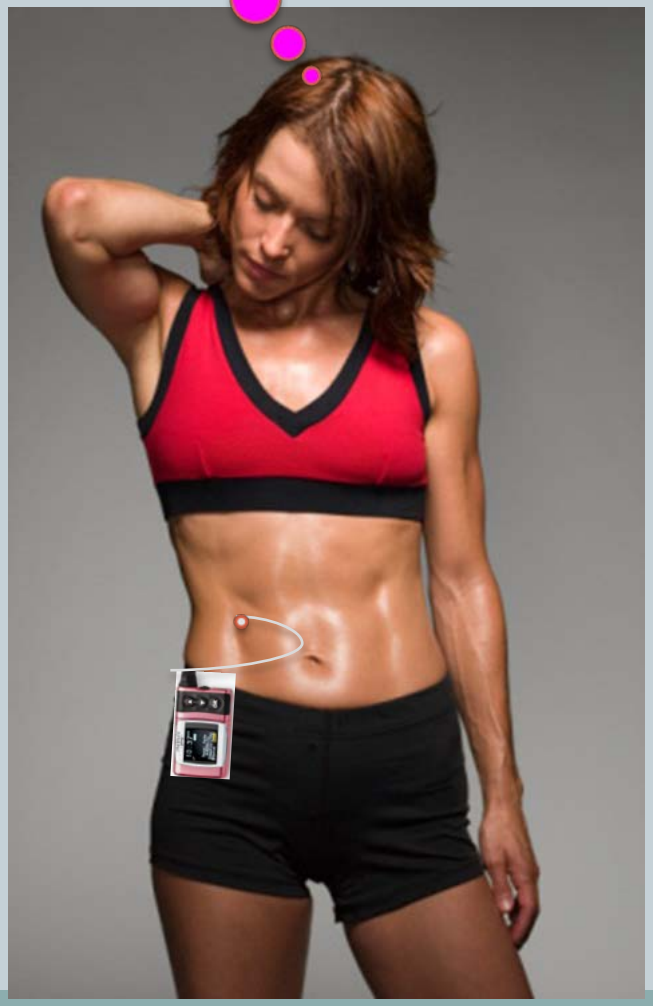
User Considerations

- How much insulin does the patient use in 3 days?
- How active is the patient?
- Is tethering patient to pump practical?
- Is the patient exposed to:
  - Water?
  - Extremes of temperature?
- Will the patient need a more durable device?
- What does the patient want and why?

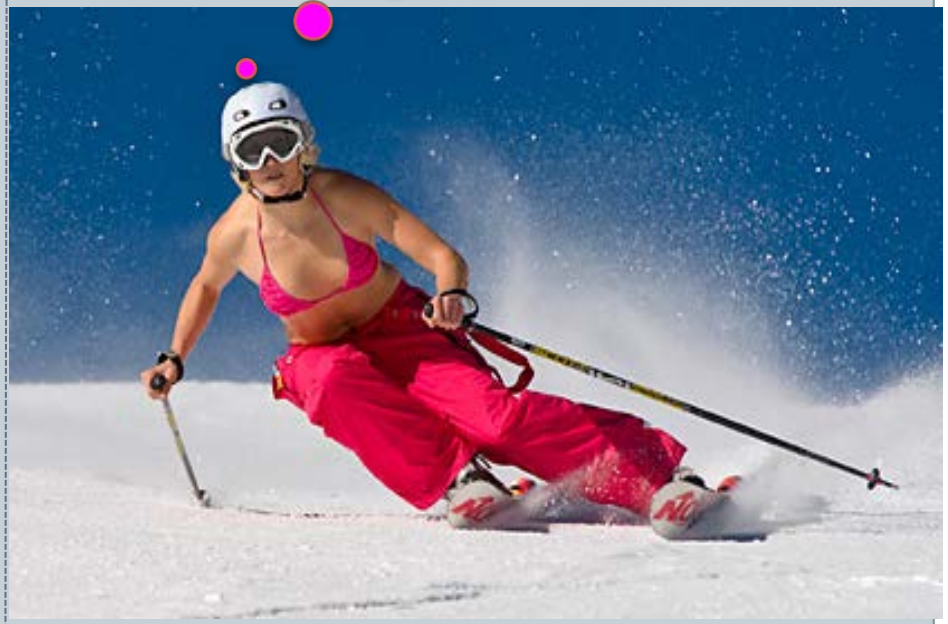
Miscellaneous

Misc. Points

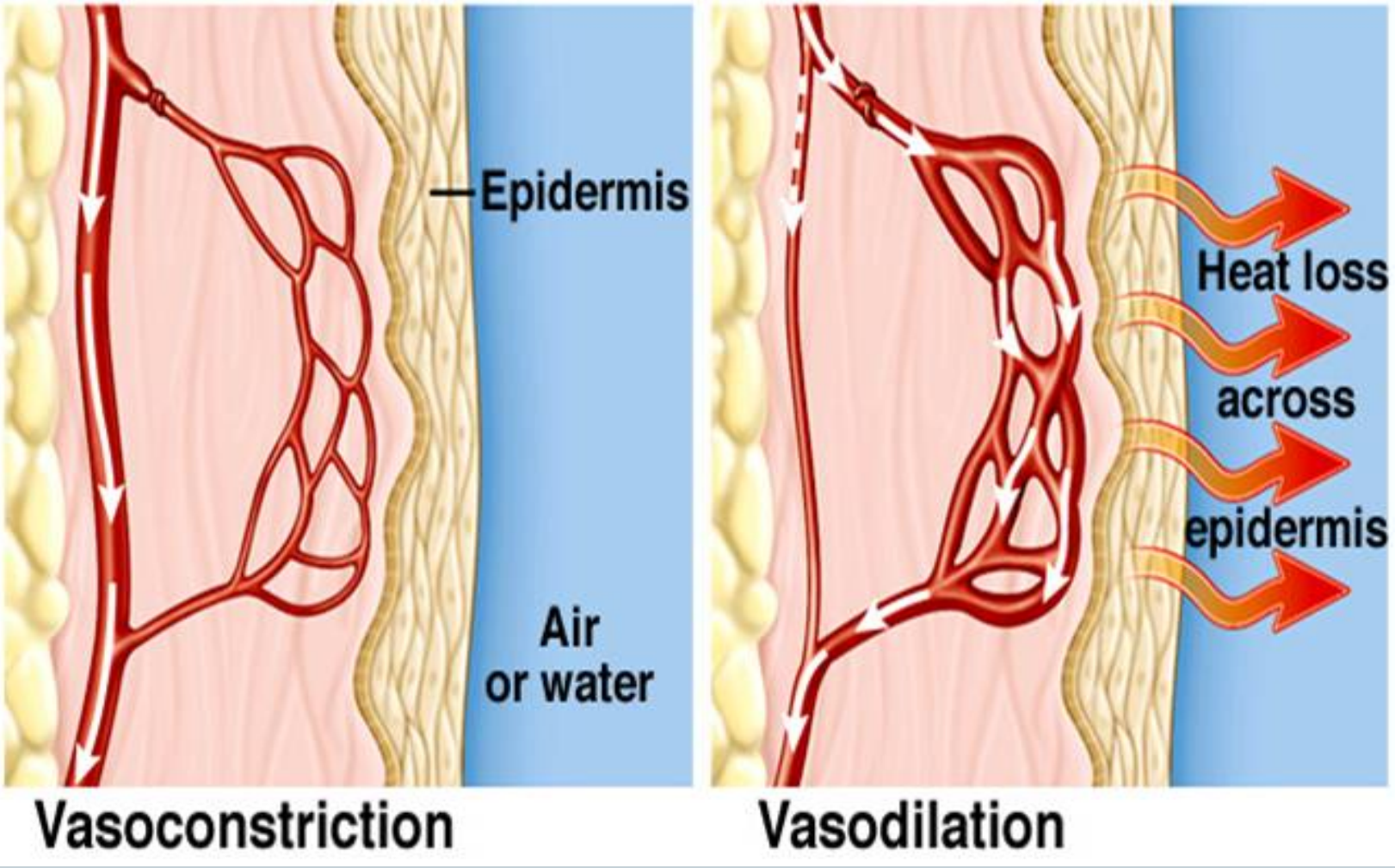
My BG is low again



Must. Get.
More. Insulin.



Insulin Absorption & Temp



Air Travel & Insulin Pumps

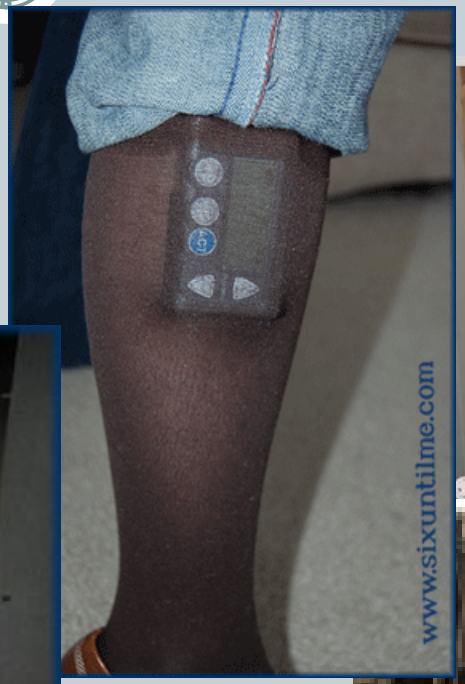
- Study looked at 10 insulin pumps during flight & in hypobaric chamber with pressure simulating flight.
- Decrease in ambient pressure → predictable unintended insulin delivery by:
  - Air coming out of solution & forming bubbles
  - Expansion of existing bubbles in cartridge before takeoff → increase by 36% in size

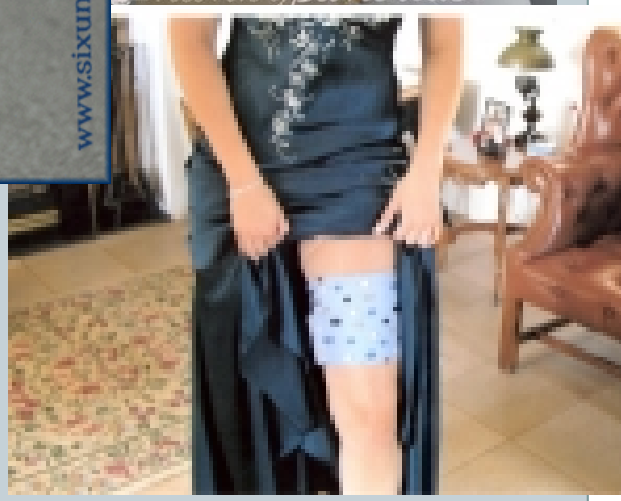
King et al. *Diabetes Care* 34: 1932-1933, 2011.

Pumps in Young Women

- Perceived body images & social acceptance
- Increased self-consciousness
- Greater body dissatisfaction
- Decreased body esteem

Pump Concealment





Misc Points

- Increased risk for DKA
- Pump volume should approximate
  - total daily dose x 3
- Infusion sets MUST BE CHANGED Q3 days
- Insulin on board 4-5 hours
- Close follow-up by specialist (CDE, Diabetologist)
- All rapid acting insulin analogues equivalent
- Infusion should never be stopped – loss of insulin during a shower ~.25 units
- Bolus wizard should be used for ALL corrections
- Have a back-up plan for pump failure (glargine dose and prescription)

Most Important Factor when Prescribing Pump Therapy??

THE PATIENT!!!

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