Get Pumped
Patch Or Line Pump – Which Works Best?

Take Control Of Your Diabetes
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View slides at www.diabetesnet.com/presentations/
Disclosure

Karmeen Kulkarni, MS, RD, BC-ADM, CDE

- Employed by Abbott Diabetes Care, a division of Abbott Laboratories
Disclosure

John Walsh, PA

- Book sales – all pump companies
- Advisory Boards – Tandem Diabetes, Unomedical, Spring, Halozyme
- Consultant – Bayer, Roche, BD, Abbott, Tandem Diabetes, Medingo, Spring
- Speakers Bureau – Tandem Diabetes
- Sub-Investigator – Glaxo Smith Kline, Animus, Sanofi-Aventis, Bayer, Biodel, Dexcom, Novo Nordisk
- Pump Trainer – all pumps
What We’ll Cover

- New Line Pumps
- New Patch Pumps
- Line Blurs Between Line and Patch
- Pump–CGM Combos
- Developments Toward The Closed Loop
- The Ideal Pump
The Ideal Pump

Styling

- I-Phone, a la Steve Jobs
- Color hi-res touch screen
- Rounded corners
- Individualized colors & cases
### Patch Versus Line Pumps

<table>
<thead>
<tr>
<th>Line Pump</th>
<th>Patch Pump</th>
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<tbody>
<tr>
<td>- Small infusion set size = more site options</td>
<td>- Worn on body</td>
</tr>
<tr>
<td>- Easy to detach for showering, sports</td>
<td>- No external tubing in some</td>
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<tr>
<td>- Variety of needle and tubing lengths</td>
<td>- Shorter infusion line</td>
</tr>
<tr>
<td>- Infusion set can loosen, leak, be knocked off</td>
<td>- Some require controller to bolus</td>
</tr>
<tr>
<td></td>
<td>- Patch can loosen, leak, be knocked off</td>
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</tbody>
</table>
New Line Pumps

- Tandem t:slim
- CellNOVO
- Asante Pearl
- Dana Diabe-care II-SG
- D-Medical Spring
Pumps – Asante Pearl

- Uses a prefilled pen cartridge
- Modular design
- 3.88" x 1.72" x 0.75"
- Luer lock infusion sets
- Alarms gradually get louder
- Built-in flashlight
- Pay as you go pricing

FDA and CE approved
The Ideal Pump

New Pressure Pumps

- Precise delivery – up to 1000ths of a unit
- Simpler “motor”, no gears, no stiction
- Less weight
- No dose change from gravity or on airplanes
- Clinical verification needed

Boyle’s Law: \( pV = k \) or \( \Delta V = k / \Delta p \)
Pressure Pump – D-Medical Spring

- One moving part – a spring generates pressure for 300 unit reservoir – no motor, no gears
- Reusable hardware & screen
- Simple, low cost, small, very light
- Accurate insulin delivery
- Old school styling

Submitted for FDA and CE approval
Pressure-MicroPulse Pump-Tandem t:slim

- Small solenoid generates pressure – isolated micro-delivery chamber delivers 0.001 to 0.03u per pulse
- All dose settings on one page
- Fast USB download: PC, MAC
- No airplane/gravity problems
- Fast trumpet curve

Tandem t:slim
I-Phone style, color hi-res touch screen, easy to use
Thin 300 u reservoir

Submitted for FDA and CE approval
Wax Motor – CellNovo Pump

- Small wax cube is heated to deliver 0.05 u volumes of insulin
- 10 u bolus = 200 pulse cycles – Are boluses slow?
- Performance in heat/cold?
- Data sent to internet or phone
- Connects to short infusion set
- 2 rechargeable pumps

CE approved in Europe
New Patch Pumps

Valeritas V-Go

Roche/Medingo Solo

Omnipod

Calibra

Debiotech Jewel

Others: Medtronic, Medsolve, Altea
Patch Pump – Valeritas V-Go

- Simple design for Type 2 & some Type 1 diabetes
- 1 u bolus button on pump
- No controller
- Preset basal rates
- No bolus calculator or BOB tracking

FDA approved
Patch Pump – Roche Medingo Solo

- Precise dispensing screw
- Manual auto inserter
- 200 units, 1 oz
- Bolus button on pump
- Color screen control
- Accurate bolus calculations

FDA approved, submitted for CE approval
Patch Pump – Debiotech JewelPump

- Tiny micro-electro-mechanical (MEMs) silicon motor
- Nanotechnology motor can be mass produced
- Modular, 0.75 oz, 0.02 u delivery
- 450 u insulin bladder makes pump relatively large
- Unlicensed, ?cost
## Future Patch Pumps

### Future Modular Patch Pumps

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolus button</td>
<td>Allows bolus when controller is forgotten</td>
<td>No BOB tracking</td>
</tr>
<tr>
<td>Modular design</td>
<td>Green, easy to detach for 3 Ss, less $</td>
<td>Some extra assembly steps</td>
</tr>
<tr>
<td>Better BOB handling</td>
<td>Better protection against insulin stacking</td>
<td>None</td>
</tr>
<tr>
<td>More data in controller</td>
<td>Better data access and clinical care</td>
<td>None</td>
</tr>
</tbody>
</table>
Line Blurs Between Patch & Line Pumps

- Small line pumps can attach to skin like a patch
- Remote lets line pumps hide
- Patch pumps vary:
  - Autoinserted infusion set
  - Infusion set within a separate base
  - Infusion line to nearby infusion set
Patch Or Line?

- Modular Patch
- Patch With Line
- Line Acts Like Patch
Remote Controls For Line/Patch Pumps

- Allows line pump to stay hidden
- BG meter and CGM readout
- Gives boluses
- Phone access
- Maintains dosing history

Some remotes must be present to bolus
How Long To A Closed Loop?

- Needed:
  - Faster insulin
  - Better CGM accuracy
  - Sensor redundancy
  - Less sensor lag time

- Dual delivery with glucagon
- Glucose control algorithms
- Failsafe hardware/infusion sets
The Ideal Pump

Speedy Insulin

- Super Bolus
- Warm the infusion site
  - InsuPatch by InsuLine
- Faster insulins
  - Novo Nordisk
  - Biodel
- Speed up insulin absorption
  - Halozyme
- 1.5 mm intradermal microneedles
  - BD
The Ideal Pump
A Long-Lasting Implanted CGM

- Few disposables
- Minor surgery
- Funded as rental?

Dexcom G1 2004

Sensors For Medicine

MicroCHIPS Illume

GlySens

GlucoWizard™ Sensor when compared to a US penny
Sensor Size (5 x 0.5 x 0.5) mm
CGM – Implanted Fluorescent Molecules fluoresce & change color as glucose rises or falls
- Small size, low power, low cost, long life, great accuracy
- Dual fluorescent chambers for low and high BGs

From Y. J. Heo et al: Institute of Industrial Science at the University of Tokyo
CGM – Raman Spectroscopy

- Reads light reflected off glucose
- First non-invasive monitor that may have reasonable accuracy
- No calibration – set at factory
- No consumables
- Continuous or intermittent use
- Needs more battery power: 2 rechargeable external batteries

C8 Medisensors
Early Closed Loops

**Medtronic Veo**
- 3 day sensor
- Low glucose suspend – basal off 2 hrs, on 1 hr, off 2

**Animas Vibe**
- 7-day Dexcom G4 sensor
- Closed loop studies underway with JDRF, Dexcom, BD, Afrezza

Veo available in Europe since 2009, approved for clinical studies in US
Closing Session & Raffle – 4:30pm Ballroom 6

Winning With Diabetes
Natalie Strand, MD
2010 Winner of Amazing Race

Your opinion counts: Please fill out the ‘Conference Questionnaire’ on page 103 & 104 of your program guide
The Ideal Pump

Safety

- No device deaths, rare hospitalizations
- No infusion set failures, rare occlusions
- Precise dosing, no hidden insulin stacking, no over-delivery on airplane flights (1.0 to 1.4 u) \(^1\)
- Monitor for hardware, software, & consistent dose errors
- Leak detection
- No easy to remove reservoirs (overdose risk)

Eliminate all unneeded sources for dose errors!

\(^1\) BR King, et al: Diabetes Care September 2011 vol. 34 no. 9 1932-1933
The Ideal Pump
Safe Infusion

Avg. BG for 396 pumps in 6 hr period before a set change was \textbf{200.8} compared to \textbf{170.8} mg/dl for same period 24 hrs later. \(^1\) (Over 6,400 BGs in each 6 hr time slot.)

Large, high profile pods/sets more likely to be knocked off, especially on active kids or teens, when an adult is toting a child, etc.

Low profile metal sets are safest for infants, children, & pregnancy with adhesive over site & line anchored with tape.

No loose, leaky, detached, occluded sets

\(^1\) Unpublished data from Actual Pump Practices Study by Walsh, Roberts, Bailey
The Ideal Pump
Show Glucose Outcomes

- Monitor basal and bolus errors –> “What you’re doing is not working!”
- Avg TDD vs Avg BG – the major BG controller
- Estimate impact on BG when a setting is changed
- Basal/Carb Bolus Balance, Corr. bolus % of TDD
- Avg BG, SD, number of tests
- Frequency/time  <50, <65, >140, >200, >300
The Ideal Pump

Use Formulas For Accurate Settings

APP Study:
CarbF settings found in 899 pumps during software upgrade in 2007

Note use of easy numbers for easy math: 5, 10, 15, 20


Settings do not match true need —> **Use formulas for pump settings**
The Ideal Pump

Future Pump Features

- Show How A Setting Change Will Impact TDD & BG
- Temp Basal + Bolus Doses
- Meal Size Boluses
- Excess BOB Alert (bolusing without BG but ++BOB)
- Low BG Predictor Using Meter (HypoManager)
- Exercise/Activity Compensator
- Infusion Set Monitor – Leak Detector
- Automated Bolus and Basal Testing

* Underway
Still The Best Way To Learn

Slides at www.diabetesnet.com/diabetes-resources/diabetes-presentations
Books at www.diabetesnet.com/dmall/ or 800-988-4772