Slide 1: Use of handheld devices for point of care decision support
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Slide 2: The Context
- Medical knowledge base has exploded
- Complexity of decision-making much greater than before

Slide 3: The Context
- Clinical questions are common
- Questions are central to adult learning
- But questions often go unanswered

Slide 4: The Context
- Increasing number of clinical decision support tools
- Many have potential to improve shared decision-making
- But often too complex for easy point of care use

Slide 5: What are Handheld Decision Support Tools (HDST)?
- Subset of decision support tools designed for handheld computers (e.g. PDAs and smartphones)
- Includes algorithms, scoring systems, multivariate models, and formulas

Slide 6: What are advantages of HDST?
- They facilitate complex calculations as well as simpler point scoring systems, algorithms, and flowcharts.
- Readily updated
- Uniform access to information in multiple locations
- A single compact device can hold hundreds or thousands of HDST

Slide 7: Research
First reports in literature:
- Edward, 1986: critical care calculations on programmable calculator
- Ebell, 1994: pen-based system for Bayesian diagnosis
- Acuff, 1994: fluid calculator for burn patients on Palm

Slide 8: Research

- Widely used by trainees (Kho, 2006; Tempelhof, 2009)
- Improved adherence to respiratory tract infection guideline in study of 99 PCPs (Rubin, 2006)
- Improved prescribing of NSAIDs in an RCT (Berner, 2006)
- RCT of handheld computer versus paper aids showed improved learning and practice of EBM (Leung, 2003)

Slide 9: How are HDSTs developed?

- Expert opinion
- Simple calculators
- Multivariate scores
- Point scores
- Classification and Regression Trees

Slide 10: Developing HDST: Expert opinion and calculators

- Expert opinion:
  - Apgar score for neonatal assessment (Apgar, 1953)
  - Mini-Mental State test for diagnosis of dementia (Folstein, 1975)
  - APACHE score for assessment of severity of illness in critical care (Knaus, 1981)
- Calculators
  - Bayesian calculators
  - BMI, creatinine clearance, etc

Slide 11: Developing HDST: Multivariate scores

Predicting outcome of near drowning (Graf, 1995)

\[ X = 6.38 - (4.23 \times X_{\text{Reflex}}) - (0.01 \times X_{\text{Glucose}}) - (2.3 \times X_{\text{Male}}) \]

\[ p = \frac{1}{1 + e^x} \]

Slide 12: Developing HDST: Point scores

- Begin with multivariate model
- Create additive point score based on:
  - Counting (i.e. 1 point per clinical finding or risk factor). Example: Strep Score
  - Assign points based on beta or exp(beta), i.e. the odds ratio. Example: Score to predict rheumatoid arthritis at one year in patients with joint pain

Slide 13: Developing HDST: Point scores

A chart of demographic variables and points for each.

**Slide 14: Developing HDST: Point Scores**

- Good balance between accuracy/validity and simplicity/practicality
- Lend themselves well to developing risk categories
- Work well on handhelds

**Slide 15: Developing HDST: Classification and Regression Trees**

- Series of multivariate analyses are used to identify best single value to partition patients into those with and without disease
- Creates treelike algorithm
- Good face validity
- Challenging on handheld device, though

**Slide 16: Factors to Consider when Evaluating HDSTs**

- Usefulness
- Clinical context
- Other factors

**Slide 17: Factors to Consider when Evaluating HDST**

- Usefulness = (Relevance x Validity) / Work
- Is it relevant?
  - Is it a common or important clinical problem? Or is dataset availability driving study?
  - Has it been shown to improve patient oriented outcomes?
  - Example: Ottawa Ankle Rules have been shown to reduce ER length of stay and save money

**Slide 18: Factors to Consider when Evaluating HDST**

- Usefulness = (Relevance x Validity) / Work
- Is it valid?

**Slide 19: Factors to Consider when Evaluating HDST**

- Usefulness = (Relevance x Validity) / Work
- Has work been minimized?
- Dropdown lists, not text:

• Automatically fill in data from patient record, automatically recalculate values
• Choose simpler variables, i.e. CURB-65 (5 variables) rather than Pneumonia Severity Index (20 variables)

**Slide 20: Factors to Consider when Evaluating HDST**

• Clinical context
• Too often cutoff is chosen based on statistical considerations

(Image to the right is a ROC curve for RA data)

**Slide 21: Slide 21: Factors to Consider when Evaluating HDST**

• Clinical context
• Remember threshold model for decision-making

**Slide 22: Factors to Consider when Evaluating HDST**

Clinical context: Option 1
Table of probabilities for RA at 1 year and clinical choices:

• Reassess: 0-3 points
• Monitor: 4-7 points
• Treat: > 7 points

**Slide 23: Factors to Consider when Evaluating HDST**

Table of probabilities for RA at 1 year and clinical choices:

• Reassure: - = 3 points
• Monitor every 4 months: 4-6 points
• Monitor every 2 months: 7-8 points
• Treat: > 8 points

**Slide 24 Clinical context: Option 2**

Factors to Consider when Evaluating HDST

• Clinical context
• How many patients benefit? 232 vs 183?

**Slide 25: Factors to Consider when Evaluating HDST**

• Other factors:
• Financial (dis)incentives

• Mistrust of "black-boxes"
• Rule seen as overly simplistic
• Apprehension about using HDST in front of patients
• Using rule deprives physician of opportunity to reason independently

Slide 26: Final thoughts

• HDST were developed to bring computing power to the point of care
• What is the impact of increased use of EHRs on the need for HDST?
• Is there a role for HDST in a future that puts a terminal or laptop at every bedside?

Slide 27: Final thoughts

• Create HDST for new form factors: netbooks and beyond
• Build on unique features of smartphones such as integrated GPS, camera: for example, an automated system to diagnose skin lesions using smartphone camera and neural network
• Design applications to address specific needs of mobile healthcare professionals: home health care, ED physicians, hospitalists, students/residents, nursing home visits, military

Slide 28: Thank you!