Common Tools and Techniques for Developing Expert System Interventions across Multiple Behaviors

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Part I. Overview
Expert System Technology for Chronic Disease Prevention

- Interventions for the prevention of chronic diseases should focus on behavior change
- Interventions should be of extended duration
- Interventions should be able to deal with complex behaviors
- Many effective Expert System Interventions have been developed
- Advances in technology permit low-cost communications with “expert” conveniently and on demand

Expert Systems: Definitions

(Also called ‘tailored interventions’ and ‘computer-based interventions’)

General definition
- Software system that mimics the reasoning of a human expert

Empirically based systems:
- Must contain a collection of facts and rules about a field, and
- Must contain a way of making inferences from these facts and rules.

[Negotia, 1985]
Empirical Expert Systems: Basis of Operation

- **Surface Knowledge**
  Heuristics and Empirical Information
  [Initial data base: longitudinal study of self-changers; update after each project]
- **Deep Knowledge**
  Principles and General Theories
  [Transtheoretical Model]
  **Artificial Intelligence**
  Ability of the system to continually modify itself
  [Not included in URI systems. Modification takes place after each trial, employing new data base from trial]

Expert System Components

- Well developed assessment battery
- Set of normative data for initial comparisons
- Decision making rules
- Access to previous data for ipsative comparisons
- Written, verbal, graphic, and pictorial materials which can be assembled to provide feedback
Part II. Surface Knowledge
### Surface Knowledge

- Select Variables that have demonstrated empirical data to support the relationship with outcome
- Use effect size estimates to select the most important variables and tailor on them
- Example: Comparing demographic variables to smoking behavior variables
- Demographics are not important predictors of outcome; smoking variables preferred
- (Demographic may increase engagement—need to demonstrate)

### Variables Predicting Month 24 Abstinence Rates & Effect Sizes


<table>
<thead>
<tr>
<th>Demographic Variables</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.012</td>
</tr>
<tr>
<td>Race</td>
<td>.003</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>.028</td>
</tr>
<tr>
<td>Age</td>
<td>.065</td>
</tr>
<tr>
<td>Education</td>
<td>.072</td>
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</table>

<table>
<thead>
<tr>
<th>Smoking Variables</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time/First Cig</td>
<td>.105</td>
</tr>
<tr>
<td>Longest Quit</td>
<td>.130</td>
</tr>
<tr>
<td># Quit Attempts</td>
<td>.107</td>
</tr>
<tr>
<td># Cigarettes</td>
<td>.177</td>
</tr>
<tr>
<td>Baseline Stage</td>
<td>.167</td>
</tr>
</tbody>
</table>

*Effect Size Metric = % of variance; Cohen Interpretation: Small = 1%; Medium = 6%; Large = 14%*
Best Variables by Effect Size for Smoking Interventions

- **Habit Strength (Dependence)**

- **Stage**

- **Self-efficacy**

- **Decisional Balance**

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**Part III. Deep Knowledge**
Deep Knowledge

- Use an empirically validated theory of behavior change
- Theory provides the architecture for the software
- Intervention should employ a Theory of Behavior CHANGE rather than a theory of behavior

A. Static Variables vs. Dynamic Variables

- Static Variables cannot be easily modified
  - Examples: Past History, Demographic Variables
  - Statistical Modeling: Static Variables = moderators

- Dynamic Variables are open to modification
  - Examples: Psychosocial, behavioral
  - Statistical Modeling: Dynamic Variables = mediators
B. Models of Individual Evolutionary Processes

- Models of Behavior Change need to model change over time
- Models of Behavior only need to establish relationships
- Simply using calendar time will not be adequate
- Nature of change processes are critical
- Pattern of change over time is critical

C. Curvilinear Nature of Constructs over Time

- Constructs that are curvilinear over time should be common in behavior change models
- Person makes no effort before change, then makes increasing effort, then decreases effort as change becomes stable
- Linear models, applied to curvilinear models will greatly underestimate the relationships
- Examples of Nonlinear Constructs: Decisional Balance, Self-efficacy, and Processes of Change
Some Characteristics of a Model of Behavior Change

- Model means multiple constructs with specified relationships typically including:
  - Independent variable(s)
  - Mediator Variables
  - Dependent Variables

Characteristics of the Model
- Dynamic Variables
- Longitudinal Model
- Curvilinear Relationships

Part IV. Overview of Information Systems Technology
**Sequential Approach**

- Most common approach
- Cutoffs based on effect size
- Order (Highest to smallest) in TTM
  - Habit Strength
  - Stage of Change
  - Decisional Balance
  - Habit Strength or Self-efficacy
  - Processes of Change
- Order may change based on stage
- For example, DB has higher effect size in earlier stage than SE

**Simultaneous Approach**

- Cluster analysis employed to determine profiles for homogenous subgroups
- Profile matching assigns individual to most similar subgroup
- Squared Euclidian Distance to each subgroup calculated
- Subject assigned to subgroups with smallest $D^2$
Communication Model

Communication Channels

- **Print**
  - Phone or op-scan form assessment
  - Printed report assembled

- **Telephone**
  - Voice recognition or keypad assessment
  - Pre-recorded sound files

- **Internet**
  - Greatest variety of intervention materials
  - Allows lateral movement
Part V. Examples of Different Behaviors

Behaviors with Multiple Clinical Trials Demonstrating ES Effectiveness

- Smoking
- Diet
- Exercise
- UV Protection
- Stress
- Mammography
- Alcohol
Behaviors with Some Clinical Trials Demonstrating ES Effectiveness

- Regular use of condoms to avoid sexually transmitted diseases
- Drug Abuse
- Adherence and Compliance with Medications
- Organizational change
- School Bullying
- Domestic Violence

Multiple Risk Factor Combinations of Behaviors with Some Clinical Trials

- Diabetes
  - Smoking
  - Diet
  - Exercise
  - Medication Adherence & Compliance

- Weight Loss
  - Diet
  - Exercise
  - Adherence & compliance
Part VI. Summary

**Expert System: Requirements**

- Explicit Decision Making Model
- Existing Empirical Data Base
- Computer Hardware
- Technical Expertise
Expert System Advantages

Scientific
- Assess all relevant information
- Consistent decision making
- Replicable results
- Intervention Fidelity

Expert System Advantages
Practical
- Cost-effective
- Transferable
- Well Documented
- Permanent
- Population-based