Current State of Visualization of EHR data: What's needed? What's next? (Session No: S50)

Panel:
- Danny Wu, University of Michigan
- Vivian West, Duke University
- Dawn Dowding, Columbia University
- Hadi Kharrazi, Johns Hopkins University
- Jesus Caban, Walter Reed National Military Medical Center
Methods, Technologies, and Evaluation

Current State of Visualization of EHR data: What's needed? What's next?
Session Number: S50

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What is visualization?

• 18th Century: William Playfair (graphs, pie charts, bar graphs)
• Graphs for vital signs, Fishbone diagrams for lab results
• 1994: Powsner & Tufte: test results and data plotted on graph*
• 1990s: Shneiderman and Plaisant et.al. Lifelines for patient summaries

“Interactive, visual representations of abstract data to amplify cognition.”**


What is visualization?

“15 year period (exotic research specialty) …next period and mainstream of user interface and application design
• Shower of products using its techniques
• Large scale databases and documents
• eCommerce, Internet”

1999: San Francisco; Morgan Kaufmann Publishers, Inc.
The “power” of big data in health care

<table>
<thead>
<tr>
<th>Volume</th>
<th>Electronic health records</th>
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</thead>
<tbody>
<tr>
<td>Variety</td>
<td>Insurance claims/billing</td>
</tr>
<tr>
<td>Velocity</td>
<td>Social and environmental data</td>
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Bad chef versus culinary expert with huge number of food choices

Need to find innovative ways to use it to get the most out of it
Visualization techniques and tools

• VOLUME: Systematic literature review 2014: EHR health care data limited*

  Change in 3 short years!

• VARIETY: Graphs, charts, maps, dashboards, interactive visualizations with longitudinal data

• VELOCITY: From Excel to Tableau and beyond—who is the user, what is the data source, and what are you trying to do with the data

Challenges

The amount of EHR data and its display

• Difficult to see and identify meaningful patterns in visualizations
• Zoom, pan, and filter tools reduce clutter but will not suffice for ‘big data’

Size & complexity of EHR data

• Color, density, and filtering techniques distinguish variables
• No reported techniques discuss applicability to entire datasets from EHR and potential for knowledge discovery

Ability to use temporal data in visualizing aggregate data from EHRs is important to users

Need design that presents a single interactive screen
Research Design:

1. **Data** from retrospective EHR data queries (via DEDUCE*)

   Three sets of visualizations base on type of data used

*DEDUCE (Duke Enterprise Data Unified Content Explorer): https://www.ctsi.duke.edu/node/908*
# Data used in visualizations

<table>
<thead>
<tr>
<th>SET 1</th>
<th>SET 2</th>
<th>SET 3</th>
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</thead>
<tbody>
<tr>
<td>(86 unique codes)</td>
<td>(240 Pts)</td>
<td>(2940 Pts)</td>
</tr>
<tr>
<td>Unique encounter ID</td>
<td>Unique patient ID and encounter ID</td>
<td>Unique patient ID</td>
</tr>
<tr>
<td>Admit date</td>
<td>Ht, wt VS: BP, P, R, T</td>
<td>Death status, ethnic group, gender, race, religion</td>
</tr>
<tr>
<td>DRG or ICD code</td>
<td></td>
<td>Diabetes, hypertension</td>
</tr>
<tr>
<td>Inpt length of stay</td>
<td>No. visits over time</td>
<td>Relationship between demographics &amp; diseases</td>
</tr>
<tr>
<td>Trends over time</td>
<td>VS changes over time</td>
<td></td>
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<tr>
<td>No. times event occurred</td>
<td></td>
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</table>
Evaluation of alternative visualization methods

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<table>
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<tbody>
<tr>
<td>1.</td>
<td>Bar graph</td>
</tr>
<tr>
<td>2.</td>
<td>Radial Coordinates</td>
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<tr>
<td>3.</td>
<td>Bipartite graph</td>
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<td>4.</td>
<td>Sankey diagram</td>
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<td>5.</td>
<td>Box &amp; Whiskers</td>
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<tr>
<td>6.</td>
<td>Scatterplot</td>
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<tr>
<td>7.</td>
<td>Bubble graph</td>
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<tr>
<td>8.</td>
<td>Scatterplot distribution</td>
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<td>9.</td>
<td>Heatmap</td>
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<td>10.</td>
<td>Slope/Best of fit</td>
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<td>11.</td>
<td>Lines graph</td>
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<tr>
<td>12.</td>
<td>Stacked bar graph</td>
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<td>13.</td>
<td>Marimekko Chart</td>
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<tr>
<td>14.</td>
<td>Stream graph</td>
</tr>
<tr>
<td>15.</td>
<td>Parallel sets</td>
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Evaluation of different ways to visualize data

Research Design:

2. **Subjects**: Users of DEDUCE queries--MD(6), Pharmacist(1), Admin. Director(1), Data analyst(1), Project leader(1)
   - Ages: 30s to early 60s
   - Females (3), Males (7)
   - Data used to using: demographics, medications, procedures, labs, diagnoses, geographic data, imaging data, social data, vital signs
Evaluation of different ways to visualize data

Research Design:

3. One hour with each, scripted explanation of visualizations by interviewer

4. REDCap Questionnaire using 5 point Likert scale: evaluate and rank
   • The information is easy to understand
   • I can quickly find the information I am looking for
   • This is a useful way to look at the data
Evaluation results

- Respondent had significant effect on way the interview was conducted and time involved
  - Orientation to facts versus trends
  - Orientation to populations versus individuals
  - Concrete versus abstract reasoning
  - Familiarity with visualization used
  - Visual thinking (experience)
- Importance of usability (legends, labels, color, size, placement of axes, amount of data, understandability)
Interaction results

Hands-on experience with bipartite graph and parallel sets

- Limitations
- But well-received
- Provides more data, specific data easier to find, can see trends more easily
Parallel sets temporal visualization
Acknowledgements

Visualizations: Leigh Ann Herhold, David Borland (RENCI)

Work supported by the US Army Medical Research and Material Command (USARMC) under Grant No. W81XWH-13-0061. The views, opinions and/or findings contained in this presentation/report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

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Thank you!

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