Cognitive Debiasing through Sparklines in Clinical Data Displays
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Abstract
Sparklines, embedded contextual information graphics, can help reduce diagnostic errors by highlighting trends in data, simplifying cognitive tasks and providing context for decision making. Examples applied to heparin induced thrombocytopenia, cardiac catheterization and pediatric viral illness illustrate the concept. Sparklines are ideal in situations where the limited textual data representations obfuscate interpretation, the graphic aids interpretation of the data, and the graphic guides decision making.

Background
Medical decision-making errors are often due to underlying cognitive errors. Faulty information processing may lead to errors due to bounded rationality, hypothesis generation errors, or failure to recognize important features hidden in the data. Minimizing sources of error in medical decision-making may improve diagnostic decisions.

Embedded contextual information graphics are illustrative tools that represent relationships in data. Dr. Edward Tufte conceived of a sparkline as a “small, high-resolution graphic embedded in a context of words, numbers, images.” Sparklines can be targeted at the reduction of errors through several mechanisms: highlighting trends in the data, simplifying the cognitive task and providing context (cognitive debiasing).

Potential Uses

Highlighting Trends: Temporal trends may frequently be present within data. Following the administration of heparin, physicians must monitor for heparin-induced thrombocytopenia (HIT), a potentially life-threatening complication. Because platelet counts may remain in the normal range during the course of HIT, a sparkline showing trends may be ideal for recognizing its development. (Figure 1).

Simplifying Tasks: By simplifying cognitive tasks, sparklines may dampen the limitations of bounded rationality, e.g., by overcoming the limitations of working memory. A sparkline displaying intra-ocular pressure control and visual field changes may ease the overload in synthesizing two disparate data sources, aiding glaucoma management. An anatomic sparkline may succinctly summarize a difficult to visualize verbal description of coronary artery lesions (Figure 2).

Providing Context: The failure to consider potential diagnoses and their prevalence is a common source of diagnostic error. A sparkline showing the seasonal variation of common pediatric respiratory viruses (Figure 3) may enhance diagnosis by suggesting pathogens and providing the time-variable base-rates.

Key Points.
- Clinical variables of an anatomic, continuous or regular character lend themselves well to visualization.
- The conventions used in information graphics must be obvious from the context or mimic the conventional representations.
- There must be a straightforward association of the graphic to the context to guide clinical deduction.
- When possible, sparklines should be displayed only when specifically appropriate to the clinical situation.

Conclusions
The increasing prevalence of computing and information retrieval resources in medicine provide invaluable tools for clinical decision-making. Properly designed contextual information graphics, such as sparklines, can encode a great deal of task-relevant data and integrate appropriately into clinical data presentation. The design of medical information displays may be significantly enhanced, and patient safety improved, by optimizing the clinical utility of information graphics.

References