Challenges of Trustable AI and Added-Value on Health B. Séroussi et al. (Eds.) © 2022 European Federation for Medical Informatics (EFMI) and IOS Press. This article is published online with Open Access by IOS Press and distributed under the terms of the Creative Commons Attribution Non-Commercial License 4.0 (CC BY-NC 4.0). doi:10.3233/SHTI220596

Testing Medical Student Diagnostic Reasoning Using Clinical Data Visualizations

Lucille CHENG^{a,1} and Yalini SENATHIRAJAH^a ^aUniversity of Pittsburgh School of Medicine, USA

Abstract. This experiment aimed to (1) induce System-1-type diagnostic reasoning in medical students through the acquisition of cognitive user interface (UI) heuristics and (2) understand qualitatively how clinical data visualizations could enhance medical education. Third- and fourth-year medical students were presented patient cases through a novel electronic health record (EHR) design then asked to diagnose patients after being shown the cases either briefly and repeatedly (Group A) or twice over a longer period (Group B). Group A had higher accuracy than Group B. Findings support the possibility of inducing System-1 reasoning via UI heuristics and potential of integrating data visualizations in medical education.

Keywords. EHR, System-1-type diagnostic reasoning, medical education, clinical reasoning, clinical data visualization, graph

1. Introduction

Clinical decision-making can be described using the dual-process theory [1], which postulates that cognitive processes consist of the fast, intuitive System 1 commonly seen with seasoned physicians and the slow, deliberative System 2 more associated with learners like medical students [2][3]. However, Rosby et al. showed that inducing accurate System-1-type diagnostic reasoning in novices was possible by training students to use cognitive heuristics via rapid repeated exposures to clinical x-rays in contrast to longer, fewer exposures [4].

Here, we further explored that notion by (1) attempting to induce System-1-type diagnostic reasoning in inexperienced medical students through the acquisition of cognitive UI heuristics and (2) better understand the impact of clinical patient data visualizations on students' cognitive load and medical education.

2. Methods

Subjects were 15 third- and fourth-year medical students who had completed at least one clinical rotation, randomized to two matched groups based on past EHR experience. They were first trained with eight adapted patient cases with clinical data indicative of non-alcoholic fatty liver disease (NAFLD) and/or metabolic syndrome, on a novel EHR

¹ Lucille Cheng, University of Pittsburgh School of Medicine, 3550 Terrace St, Pittsburgh PA USA 15213; E-mail: Luc56@pitt.edu.

visualization (Figure 1). Each group was then shown four of eight cases repeatedly, but with Group A up to four times at 30 seconds/case and Group B only twice at 2 minutes/case. In a final test, they were shown all eight cases, asked to diagnose the patient (i.e., has metabolic syndrome and/or NAFLD) and elaborate on their experience. Our null hypothesis (N_0) was that exposure frequency has no impact on accuracy.



Figure 1. One of eight cases participants on the UI compared to the conventional EMR screen from Epic (right). All cases were displayed on the same UI based on the open-source visualization h-graph (h-graph.org).

3. Results

Group A scored slightly higher on average than Group B, with a mean percentage correct of 0.76 (95% [0.68, 0.84]) vs 0.69 (95% [0.58, 0.80]). We failed to reject the null hypothesis (p-value = 0.40). 73% of participants (n=11) rated the new version on par or higher than existing EHRs (3+/5). Its ease of use and intuitiveness was rated similarly high (mean score = 3.73/5 and 4.2/5, respectively). Students also described "pattern-recognition" strategies consistent with System-1 decision-making and Rosby et. al [3]. These include: (1) layout consistency aiding search, (2) trends between lab value displays and subsequent diagnosis, and (3) visualization-specific features like color-coordination.

4. Discussion and Conclusion

Though not new, this type of clinician-side data visualization is rarely utilized and has promising implications for medical education enhancements. Students diagnosed patients more accurately after short, repeated exposure to the data visualization interface, implying the possibility of inducing Type-1 diagnostics. Using such techniques during care delivery could reduce cognitive burden and allow even novices to diagnose quickly and correctly. This area is ripe for innovation and further research for medical education.

References

- Evans JS. Dual-processing accounts of reasoning, judgment, and social cognition. Annu Rev Psychol. 2008;59:255–278.
- [2] Djulbegovic B, Hozo I, Beckstead J, Tsalatsanis A, Pauker SG. Dual processing model of medical decision-making. BMC Med Inform Decis Mak. 2012 Sep;12:94.
- [3] Rosby LV, Rotgans JI, Tan G, Low-Beer N, Mamede S, Zwaan L et al. Inducing System-1-type diagnostic reasoning in second-year medical students within 15 minutes. Medical Teach. 2018 Oct;40(10):1030-1035.