

Comparison of Two Electronic Order Forms for Medical Consultation: Think-Aloud Usability Assessment With Referring Clinicians

April Savoy, PhD^{1,2,3}, Himalaya Patel, PhD¹, Mindy E. Flanagan, PhD⁴, Joanne K. Daggy, PhD⁴, Barry C. Barker¹, James E. Slaven⁴, Brian W. Porter¹, Alissa L. Russ, PhD^{1,2,5}, Michael Weiner, MD, MPH^{1,2,4}

¹Center for Health Information and Communication, Department of Veterans Affairs, Veterans Health Administration, Health Services Research and Development Service CIN 13-416, Richard L. Roudebush VA Medical Center, Indianapolis, IN, USA; ²Regenstrief Institute, Inc., Indianapolis, IN, USA; ³Indiana University School of Informatics and Computing, Richmond, IN, USA; ⁴Indiana University School of Medicine, Indianapolis, IN, USA; ⁵College of Pharmacy, Purdue University, West Lafayette, IN, USA

Due to its early role in the medical referral process, the consultation order is a focal point for breakdowns in communication about referrals. Both referrers and consultants agree that the current approach to referral communication is flawed, and poor usability of electronic health record (EHR) user interfaces (UIs) is a contributing factor (Mehrotra, Forrest, & Lin, 2011; O'Malley & Reschovsky, 2011; Zuchowski et al., 2015). To improve EHR UIs for ordering consultations, experts have recommended including these features: a list of consulting services, integrated clinical information (e.g., relevant diagnostic test results), referral guidelines (e.g., when *not* to order a consultation), clear options for communicating urgency (e.g., urgent or routine), and multiline free-text fields, including one field to indicate the reason for consultation (Bergus, Emerson, Reed, & Attaluri, 2006; Esquivel, Sittig, Murphy, & Singh, 2012; Militello et al., 2016). Our objective was to assess users' reactions to these recommendations with a comparative usability evaluation. We designed a UI prototype for consultation orders that incorporated the aforementioned recommendations. We hypothesized that the prototype would elicit more positive comments about its usability than would the UI of a currently available EHR (a control UI).

Using Axure RP 7 (Axure Software Solutions, San Diego, CA), a UI prototype was built for selecting a consulting service and ordering a consultation (Militello et al., 2016). Next, the prototype was evaluated by potential users from an urban medical center. Primary care clinicians who ordered consultations were recruited. The evaluation was conducted in a laboratory set up to simulate a clinician's office with a desktop computer (Russ et al., 2012). The prototype was a set of web pages presented in a maximized browser window. The control UI was a simulated instance of the Computerized Patient Record System, version 1.0.30 (Department of Veterans Affairs, Washington, DC). Working individually, clinicians completed three clinical cases with one UI and three similar cases with the other UI. To meet the requirements of a larger evaluation, each clinician was presented cases in the same order for both UIs. To limit order effects, case order was randomized between clinicians, and UI order was counterbalanced. Additionally, to mitigate carryover effects, clinicians completed a distractor task between UIs. A concurrent think-aloud (TA) method was used to elicit procedural and evaluative comments about both UIs (Boren & Ramey, 2000; Russ et al., 2010). At the beginning of each sitting, the TA procedure was introduced with a one-minute demonstration video (Nielsen, 2014). To permit undisturbed measurement of task time for the larger

evaluation, TA was used for only the first two cases per UI, similar to other research (Russ et al., 2014). After three clinical cases with the first UI and some tasks related to the larger study, the clinician was introduced to the second UI and its associated clinical cases as before. Including procedures for the larger study, each clinician's participation lasted approximately one hour. TA comments were coded by topic and categorized as positive, neutral, or negative. Using proportional-odds cumulative logit regression modeling with the ordinal response (positive, neutral, negative), differences were tested in the probability of having more positive evaluative comments between the two UIs. The logit model included a random intercept for each clinician to account for correlation of responses from the same clinician (Brown & Prescott, 2015) and fixed effects for UI and comment topic.

Thirty clinicians completed all six cases. The median clinical experience was 17 years, with 13 years in the current health care system (range 3–40 for both). Across the two UIs, 619 comments were recorded: 198 positive, 111 neutral, and 310 negative. Clinicians provided a median of 18 comments (range 8–50). Most of the comments about the prototype (59%) were positive, whereas significantly fewer of the comments about the control UI (7.9%) were positive, $OR = 13.5$, 95% CI [9.2, 19.8], $p < .001$ (adjusted for topic, $p = .001$). Most clinicians (26 of 30) reported that they preferred the prototype over the control UI. Reasons for this preference included screen layout, ease of use, clarity of instructions, and ease of template discovery. The prototype also elicited concerns, primarily that new terms were not defined. For example, clinicians expressed uncertainty about the differences among the prototype's three levels of urgency: stat ("immediately"), routine, and urgent. Clinicians characterized the control UI as problematic in its ease of use, workflow fit, and visual layout, all of which impeded decision making and task completion.

In summary, using the TA elicitation method during a simulation, we identified insights into how referring clinicians perceive UIs for ordering consultations. Our usability evaluation was limited to a single site at which all clinicians used the control UI regularly. However, our results demonstrate usability enhancements from the cited design recommendations and support their implementation. Future studies are needed to assess the impact of these UI usability enhancements on the quality of referral communication in clinical settings.

REFERENCES

- Bergus, G. R., Emerson, M., Reed, D. A., & Attaluri, A. (2006). Email teleconsultations: Well formulated clinical referrals reduce the need for clinic consultation. *Journal of Telemedicine and Telecare*, 12(1), 33-38. doi:10.1258/135763306775321434
- Boren, M. T., & Ramey, J. (2000). Thinking aloud: Reconciling theory and practice. *IEEE Transactions on Professional Communication*, 43(3), 261-278. doi:10.1109/47.867942
- Brown, H., & Prescott, R. (2015). Mixed models for categorical data. *Applied Mixed Models in Medicine* (3rd ed., pp. 153-182). Chichester, United Kingdom: Wiley.
- Esquivel, A., Sittig, D. F., Murphy, D. R., & Singh, H. (2012). Improving the effectiveness of electronic health record-based referral processes. *BMC Medical Informatics and Decision Making*, 12, 107. doi:10.1186/1472-6947-12-107
- Mehrotra, A., Forrest, C. B., & Lin, C. Y. (2011). Dropping the baton: Specialty referrals in the United States. *The Milbank Quarterly*, 89, 39-68. doi:10.1111/j.1468-0009.2011.00619.x
- Militello, L., DiIulio, J., Russ, A. L., Savoy, A. W., Flanagan, M. E., Patel, H., & Weiner, M. (2016). Design concepts to support management of outpatient consultations in the Veterans Health Administration. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 60(1), 1475-1476. doi:10.1177/1541931213601338
- Nielsen, J. (2014). Demonstrate thinking aloud by showing users a video. Retrieved from <https://www.nngroup.com/articles/thinking-aloud-demo-video>
- O'Malley, A. S., & Reschovsky, J. D. (2011). Referral and consultation communication between primary care and specialist physicians: Finding common ground. *Archives of Internal Medicine*, 171(1), 56-65. doi:10.1001/archinternmed.2010.480
- Russ, A. L., Baker, D. A., Fahner, W. J., Milligan, B. S., Cox, L., Hagg, H. K., & Saleem, J. J. (2010). A rapid usability evaluation (RUE) method for health information technology. *AMIA Annual Symposium Proceedings, 2010*, 702-706.
- Russ, A. L., Weiner, M., Russell, S. A., Baker, D. A., Fahner, W. J., & Saleem, J. J. (2012). Design and implementation of a hospital-based usability laboratory: Insights from a Department of Veterans Affairs laboratory for health information technology. *Joint Commission Journal on Quality and Patient Safety*, 38(12), 531-540.
- Russ, A. L., Zillich, A. J., Melton, B. L., Russell, S. A., Chen, S., Spina, J. R., . . . Saleem, J. J. (2014). Applying human factors principles to alert design increases efficiency and reduces prescribing errors in a scenario-based simulation. *Journal of the American Medical Informatics Association*, 21(e2), e287-e296. doi:10.1136/amiajnl-2013-002045
- Zuchowski, J. L., Rose, D. E., Hamilton, A. B., Stockdale, S. E., Meredith, L. S., Yano, E. M., . . . Cordasco, K. M. (2015). Challenges in referral communication between VHA primary care and specialty care. *Journal of General Internal Medicine*, 30, 305-311. doi:10.1007/s11606-014-3100-x