Computerized provider-order entry: challenges, achievements, and opportunities

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The Merriam-Webster dictionary defines 'traction' as the adhesive friction of a body on a surface on which it moves.[1] Within the field of biomedical informatics, we have updated that definition so that the 'body' may refer to a technological advance, and the 'surface' to a person, group, or environment in which the technological advance has been introduced. In this context, traction implies not just adoption, but adherence, or the 'state of steady or faithful attachment'.

By any measure, the past 5 years has witnessed the attainment of traction by computerized provider order entry (CPOE). Certainly, the work undertaken by the Institute of Medicine to position CPOE as the most critical component of a safe decision-making environment,[2–5] leading to the eventual mandates for CPOE as a part of certified health information technology,[6] justifies this assertion. The early efforts of informatics researchers such as McDonald,[7] Miller *et al*,[8] Geissbuhler and Miller[9] and Warner *et al*,[10] who first described the potential of clinical decision support during order entry has finally been accepted. The evidence in support of this technology is, in fact, sufficiently compelling that there is no longer much value in publishing any but the most innovative and well-designed studies in this domain.

Despite the attainment of traction, researchers in our field have not ignored many of the challenges associated with the vision of quality healthcare combined with usable tools. In the world of order entry decision-support, usable implies addressing the challenges of alert fatigue, high rates of alert overrides and human factors engineering to align the cognitive process of ordering with user interfaces for CPOE. There have been numerous reports about the unintended consequences of using CPOE. These reports range from an early observation about problems with picklists[11] to adoption barriers[12] and later, unintended consequences[13–15] and even errors facilitated by CPOE.[16]

This issue of *JAMIA* includes a number of articles focused on these ongoing CPOE challenges. One of those challenges—the issue of alert fatigue—can be addressed through innovative human factors engineering. The articles led by Scott *et al*[17] and Riedman *et al*[18] specifically discuss this approach. Using simulation, Scott and colleagues[17] compared the prescribing error rates associated with displaying electronic prescribing alerts using interrupting versus non-interrupting modalities. Their results address the relative advantages and disadvantages of different design strategies for commercial e-prescribing decision support, and remind us about the importance of human factors engineering expertise in clinical systems development. Riedman and colleagues[18] report on a Delphi study to prioritize the best ways to improve medication delivery alerts. This study addresses some of the attributes of potential drug interactions that, if included in drug knowledge bases, could be exploited using human factors engineering to help decision makers respond to alerts.

In addition to the alignment of functional requirements with good design principles, attention to prescribing workflow is an emerging area of importance. Baysari and colleagues[19] report on their observational study involving teams of physicians on ward rounds, as they encountered prescribing alerts that should have potentially previously planned therapeutic interventions. Their paper builds on the early observations by many researchers in the field who have noted the importance of understanding established workflow as a prerequisite to system design.

Articles in this issue also remind us about the need to measure rates of error and guideline adherence to improve CPOE systems iteratively. For example, Nanji and colleagues[20] used a retrospective method to evaluate the incidence of medication prescribing errors after implementing an e-prescribing system. Their study identified a few categories of errors that may come as a surprise to some *JAMIA* readers. Wetterneck and colleagues[21] evaluated the incidence of duplicate medication orders before and after CPOE implementation. Their study utilized a pre-post methodology and identified factors that led to a significantly higher rate of duplicate orders after CPOE implementation. Finally, the study by Austrian[22] points to the importance of careful comparative effectiveness research methods to assess how CPOE can impact guideline adherence.

Of course, as with all technological advances, it is clear that the traction provided by CPOE allows other technologies to evolve. In this issue, Cheung and colleagues[23] continue a discussion catalyzed recently by Friedman *et al*[24] about a learning e-health system. Cheung *et al*[23] describe a registry for medication incidents that features multidisciplinary input and prescriber or pharmacy comparative feedback. The system also supports centralized surveillance for serious incidents, and mechanisms to disseminate warnings at that scale.

Efforts to improve CPOE further, to integrate CPOE into the evolving landscape of health information technology and to propose breakthrough ideas in this domain are underway by experts in biomedical informatics. *JAMIA* will continue to be a source of these innovative and transformative articles.

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REFERENCES

1. *Merriam Webster Online Dictionary*. 2011. http://www.merriam-webster.com/dictionary/traction (accessed 31 Aug 2011).
2. **Aspden P.** Institute of Medicine (US). *Committee on Data Standards for Patient Safety. Patient safety: Achieving a New Standard for Care*. Washington, DC: National Academy Press, 2004.
3. **Aspden P.** Institute of Medicine (US). *Committee on Identifying and Preventing Medication Errors. Preventing Medication Errors*. Washington, DC: National Academy Press, 2007.
4. **Institute of Medicine CoQHCiA.** *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy of Sciences, 2001.
5. **Institute of Medicine Committee on Quality of Health Care in A.** To Err is Human : Building a Safer

Health System. Washington, DC: National Academy Press, 2000.
6. **Blumenthal D,** Tavenner M. The "meaningful use" regulation for electronic health records. *N Engl J Med* 2010;**363**:501—4.
7. **McDonald CJ.** Protocol-based computer reminders, the quality of care and the non-perfectability of man. *N Engl J Med* 1976;**295**:1351—5.
8. **Miller RA,** Waitman LR, Chen S, *et al*. The anatomy of decision support during inpatient care provider order entry (CPOE): empirical observations from a decade of CPOE experience at Vanderbilt. *J Biomed Inform* 2005;**38**:469—85.
9. **Geissbuhler A,** Miller RA. A new approach to the implementation of direct care-provider order entry. *Proc AMIA Annu Fall Symp* 1996:689—93.
10. **Warner HR,** Olmsted CM, Rutherford BD. HELP—a program for medical decision-making. *Comput Biomed Res* 1972;**5**:65—74.
11. **Weiner M,** Gress T, Thiemann DR, *et al*. Contrasting views of physicians and nurses about an inpatient computer-based provider order-entry system. *J Am Med Inform Assoc* 1999;**6**:234—44.
12. **Poon EG,** Blumenthal D, Jaggi T, *et al*. Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. *Health Aff (Millwood)* 2004;**23**:184—90.
13. **Ash JS,** Sittig DF, Poon EG, *et al*. The extent and importance of unintended consequences related to computerized provider order entry. *J Am Med Inform Assoc* 2007;**14**:415—23.
14. **Ash JS,** Sittig DF, Dykstra RH, *et al*. Categorizing the unintended sociotechnical consequences of computerized provider order entry. *Int J Med Inform* 2007;**76**(Suppl 1):S21—7.
15. **Ash JS,** Sittig DF, Dykstra R, *et al*. The unintended consequences of computerized provider order entry: findings from a mixed methods exploration. *Int J Med Inform* 2009;**78**(Suppl 1): S69—76.
16. **Koppel R,** Metlay J, Cohen A, *et al*. Role of computerized physician order entry systems in facilitating medication errors. *JAMA* 2005;**239**:1197—230.
17. **Scott GP,** Shah P, Wyatt JC, *et al*. Making electronic prescribing alerts more effective:scenario-based experimental study in junior doctors. *J Am Med Inform Assoc* 2011;**18**:789—98.
18. **Riedmann D,** Jung M, Hackl WO, *et al*. How to improve the delivery of medication alerts within computerized physician order entry systems: an international Delphi study. *J Am Med Inform Assoc* 2011;**18**:760—6.
19. **Baysari MT,** Westbrook JI, Richardson KL, *et al*. The influence of computerized decision support on prescribing during ward-rounds: are the decision-makers targeted? *J Am Med Inform Assoc* 2011;**18**:754—9.
20. **Nanji KC,** Rothschild JF, Salzberg C, *et al*. Errors associated with outpatient computerized prescribing systems. *J Am Med Inform Assoc* 2011;**18**:767—73.
21. **Wetterneck TB,** Walker JM, Blosky MA, *et al*. Factors contributing to an increase in duplicate medication order errors after CPOE implementation. *J Am Med Inform Assoc* 2011;**18**:774—82.
22. **Austrian JS,** Adelman JS, Reissman SH, *et al*. The impact of the heparin-induced thrombocytopenia (HIT) computerized alert on provider behaviors and patient outcomes. *J Am Med Inform Assoc* 2011;**18**:783—8.
23. **Cheung KC,** van den Bemt PM, Bouvy ML, *et al*. A nationwide medication incidents reporting system in The Netherlands. *J Am Med Inform Assoc* 2011;**18**:799—804.
24. **Friedman CP,** Wong AK, Blumenthal D. Achieving a nationwide learning health system. *Sci Transl Med* 2010;**2**:57cm29.