Inpatient Notes: Realizing the Promises of Hospital Electronic Order Sets

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Order sets are a commonly accepted form of clinical decision support (CDS) to improve clinical care. Paper checklists of clinical orders for medications, diagnostics, and procedures have existed for decades. Integration of these into the electronic health record has promised to make it easier for clinicians to provide evidence-based care that is tailored to specific patient situations. Unfortunately, many paper order sets have simply been transcribed into electronic systems, without design enhancements to take advantage of the unique potential of these systems. Inadequate attention to design, implementation, and study of electronic order sets has led to the unrealized promise of their potential.

Order sets often attempt to codify well-defined clinical pathways. However, messy, real-world situations often defy simple categorization. Many hospitals have order sets for congestive heart failure (CHF) and pneumonia, but few have ones for patients suspected of having both. The CHF order set may include an exhaustive menu of dozens of options, ranging from routine admission orders to every medication class for CHF management, including vasopressors and inotropes, and several options for each class. Many options are prechecked (1) to strongly favor "class I recommended" medications, such as β-blockers and angiotensin-converting enzyme inhibitors, even when the ordering clinician may wish to avoid them in the context of evolving sepsis and cardiogenic shock. The resulting information overload from this comprehensive list of options may hinder more than help when managing a complex patient with an evolving condition (2). The hospitalist may well abandon the "convenience" of the order set and manually order furosemide and ceftriaxone, forgoing any potential benefits of the order set.

Measurement is a critical first step in improving the utility of order sets. For example, at our institution, we found many order sets in which most items were rarely used (<2% of the time) (3). Even for the CHF order set, critical medications, such as carvedilol and lisinopril, were rarely ordered at the time of the order set use and, when ordered, were often retracted. Conversely, order sets for narrow, standard protocols (for example, for hemodialysis and bronchoscopy) had nearly 100% usage rates and rare retractions.

From these observations, we concluded that the simple "checklist" order set format works best for protocolized processes that involve a standard set of simultaneous actions. An example is the preprocedure order set for bronchoscopy. However, for more open-ended clinical situations that involve uncertainty and the dynamic progression of decision points, long lists of orders are often cumbersome and unhelpful.

For order sets to be useful, they need to optimize *all* of the "5 rights" of CDS: Deliver the right information, to the right people, in the right intervention formats, through the right channels, and at the right points in the workflow (4). Order set design often focuses on maximizing the quantity of right information, but other aspects, such as the right points in the workflow, are neglected.

Order sets for more complex situations will be more clinically useful if they are oriented to specific conditions and situations. For example, an order set for "admission for CHF with volume overload" may be different from one for "discharge after CHF admission." This specificity can ensure that only relevant orders are included in the order set, excluding distracting options that are not useful at those points in the clinical course. It can also allow for the inclusion of embedded decision support text to provide more nuanced explanations about when and why to select certain options.

To realize their promise to improve care, order sets must evolve from long lists of loosely related orders to short lists of the *right* orders for the particular patient and situation. More flexible formats, such as customizable order panels that allow users to add and remove items, may be nimbler, balanced by the effort needed to maintain and organize many customizations. Even as our institution is building order sets specific for coronavirus disease 2019 (COVID-19), our experience confirms that recommended orders should be tailored to specific points along the clinical course, lest the decision support opportunity be missed altogether. A single COVID-19 order set cannot meet the needs of clinicians in outpatient, inpatient, and intensive care settings, and different orders will be required for different phases of care (for example, screening, diagnosis, treatment, and recovery). Designing multiple order sets, specific for each of these points in the clinical course, may be a better approach. We are actively developing next-generation CDS systems that invoke advances in data science and machine learning to enable personalized order recommendations that automatically infer patient context. The system is able to dynamically adapt content on the basis of its understanding of previous, similar cases (5). For example, using these technologies, the hospitalist may not even need to search for a named order set. Instead, they can simply enter an order for spironolactone and these prototypes will suggest related orders, including furosemide and other treatments for CHF. If the hospitalist subsequently orders rifaximin, the "dynamic order set" will recognize the clinical condition to be cirrhosis and will prioritize lactulose and other treatments for complications of this condition.

Order sets have the potential to be powerful CDS tools. However, to be effective, more sophisticated order sets will require innovative design and continuous evaluation, study, and improvement. Effective design of

order set content requires trained teams with representation from stakeholders, including end-user physicians (commonly hospitalists), nurses, pharmacists, informaticists, and others. Order sets must be situationally specific and evidence-based and provide high-level decision support at various points in the clinical workflow. Usage and performance gaps should be monitored, preferably through automated, data-driven metrics, and incorporated into continuous improvement cycles.

As electronic health record capabilities mature, it is time to move beyond simple checklist order sets in favor of more sophisticated order sets that provide high-level CDS for complex situations. Much work remains to be done, but effective application of innovations, technologies, and design concepts may finally realize the promises of electronic order sets.

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