Using Innovation Technology to Enhance Patient Care Delivery

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The ultimate goal of using innovative technology is to deliver more effective patient care—effective both clinically and fiscally. This goal presents complex challenges. Effective patient care is the result of the coordinated efforts of an extensive, multidisciplinary patient-care team, all of whose members must have what they need to provide optimal care. Five elements are essential to any system of effective patient care—selecting the right outcomes to achieve, having the right clinical data, using the right presentation of that data, making the right decisions, and implementing the right processes—then validating that the outcomes are achieved. Technology implementation is most likely to be successful when it optimizes these elements.

Planning for the effective use of technology must proceed from the ground up, drawing less on corporate information systems priorities or vendor product offerings than on the diverse workflow needs of clinicians—what they need to meet patients' needs. An information system must provide actionable information that matters to the clinicians. The central focus is always on the patients' needs for care.

The effectiveness of this approach is evident from extensive experience in assessing and prioritizing various clinical information technologies and from the recent introduction of a new medication safety technology at the point of care. This report used these examples to discuss what we know and consider what could be designed. The ultimate purpose of this presentation is to suggest a way of looking at technology to identify what will be useful clinically.

Throughout this report, the focus will be on the use of technology by clinicians in providing hands-on patient care in the acute-care setting. The end result of implementing technology effectively is that the nurse's role changes from a hunter/gatherer of data and rules to a clinical decision maker who tests the reasonableness of the rules and, as appropriate, implements them. The clinician remains the central figure in the use of innovative technology to deliver more effective care. (Note: The term clinician is used to describe any member of the patient-care team who makes decisions regarding patient care, whether physician, nurse, pharmacist, or therapist.)

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CLINICAL INFORMATION TECHNOLOGY

Some of the concepts in this report are based on work performed by the author and others at Catholic Healthcare West (CHW), a 48-hospital system based in California, Arizona, and Nevada. The challenge was to craft a strategy for moving forward on the issue of clinical information systems.

To meet this challenge, the multidisciplinary team developed an innovative auditing and planning process. This process was used to develop clinician-driven standards for inpatient clinical information system functionalities, measure the level of technology use in each hospital against system standards, and provide tools to help hospital executives prioritize clinical system investments across all CHW hospitals.[1]

Clear, complete descriptions identified the clinical functionalities to be included in an integrated information system and the order in which they should be introduced to ensure optimal utilization of the various system components. The underlying premise was that the central focus of clinical systems planning must be the diverse workflow needs of clinicians and that their in-depth involvement is critical to success.

Defining functionalities. Because of an extremely diverse group of stakeholders, the team first defined 55 functionalities needed for caregivers to function efficiently in the acute-care setting. These were defined and reviewed by the physician Medical Informatics Information Officer (MIIO), nursing leadership, physician informaticists, and a variety of information technology (IT) department leaders. For each of the 55 items, the team defined the technology capabilities required, the likely users, the rationale for its implementation, barriers typically experienced, and any other functionalities that would need to be implemented before the functionality under discussion could be put in place.

Prioritizing Functionalities. Once this comprehensive list had been defined, the next step was to engage a diverse group of stakeholders to prioritize the functionalities. Stakeholders included hands-on caregivers, both nurses and physicians, and front-line supervisors, managers, executives, and representatives from such departments as quality, medical records, clinical laboratory, radiology, and pharmacy. A series of regional meetings brought together 15 to 40 clinical personnel from each region's acute-care facilities to participate in the prioritization process.

The criteria used for prioritization were whether the functionality was required for clinical decision-making and would be used regularly, would have a favorable impact on service or financial outcomes, would be welcomed by the people affected by it, and fix something that indeed was broken. In other words,

if a paper method still worked relatively well, it would receive lower priority than a paper method that was completely unsuccessful in meeting users' needs.

Some functionalities were ranked high by a very strong consensus; others were ranked high by some and low by others. The items for which there was a strong consensus were adopted as high priority for implementation across the system. This approach remains the key strategy for CHW in prioritizing its clinical systems investments.

High-priority functionalities include basic administrative systems, such as admission, discharge, and transfers (ADT), registration and order entry, and departmental systems for laboratory, radiology, and pharmacy. Comprehensive results review also is a high priority, including laboratory results, culture results, radiology transcribed reports, and other forms of transcribed reports, such as history and physicals and discharge summaries.

At the point of care (POC), the most important functionalities include computer documentation of the patient's vital signs, POC testing, and intake and output (I&O), with presentation of this information in various forms to meet clinicians' needs. The documentation of medication administration in the computer is also a key functionality. Flow sheets that integrate clinical data, laboratory data, and medication administration information are also critical requirements. Other elements of clinical documentation of care prioritized substantially lower than POC numbers.

The Pareto Principle. Interestingly, the findings illustrate the validity of the Pareto Principle.[2] Applied to clinical systems, it suggests that 80% of the value of an implementation can be achieved by implementing only 20% of the functionalities (the 80/20 rule, if you will). Tremendous value can be realized by giving priority to a small number of highly useful functionalities in implementing a clinical information system. The challenge is to identify the correct functionalities on which to focus. Prioritization based on clinician-driven standards makes such identification possible.

Assessing existing functionalities. Once prioritization was accomplished, a team of 3 people, including 2 nurses and the medical informatics physician, visited 43 CHW hospitals. Speaking with the doctors and nurses taking care of patients in the wards, they used a list of all functionalities to ascertain whether or not they were using technology to assist them in patient care.

Striking gaps were found in even the most basic functionalities. Even for simple forms of data review, the reality for many hands-on caregivers is that they are still living in a paper world. Given the ever-increasing dependency of decision making on laboratory data, shortened lengths of stay, and increased patient volumes and acuities, the continuing reliance on efficient distribution of paper has become more and more absurd.

With respect to capturing even the most basic POC information on a computerized system, the audit showed that much less was happening than many had assumed. For example, only 21% of CHW hospitals had vital signs and I&O information available in the computer for clinician use. Computerized medication charting was found in only 1 of the 48 hospitals. Recent straw polls conducted during presentations to diverse groups have validated that these numbers reflect national trends. Even in many otherwise sophisticated hospitals and academic medical centers, such POC information is found on a clipboard that is often unavailable at the time decisions are being made.

Another striking finding was that the most common implementation sequence for clinical documentation was to try to capture assessments and interventions before capabilities were put in place to capture the POC numbers. When that happened, controversies over the level of detail required or the awkwardness of capturing information caused either delays in technology implementation or project failure. In contrast, sites that started with the POC numbers generally had expeditious implementations. When there was resistance, it usually was because the format to report the information was not optimized for hands-on caregivers.

What We Know

As a result of this work, CHW now has a broad consensus about what technology is needed and when for hands-on clinicians to do their tasks efficiently and effectively. However, elsewhere this understanding often is not reflected in the way technology is implemented by health care systems seeking to install a clinical information system. Furthermore, most deployments have huge gaps, with the vast majority of caregivers currently missing many of the more basic critical functionalities. This needs to be remedied urgently, long before embarking on the most sophisticated application of rule-based systems, such as computerized prescribe order entry to the POC. Although rules are important, the most important evidence to be considered in practicing evidence-based medicine is what is happening to the patient here and now–especially the POC numbers–not what was recently published in the literature.

Looking to the immediate future, the goal is to improve how decisions are made at the POC. To do this, systems and caregivers each have different roles. The system's role is to retrieve whatever germane data exist for the situation at hand. Using whatever rules apply, the system should integrate the data with the rules to make them patient-specific and lead the caregiver in the right direction. The clinician's role is to make clinical observations, such as taking a history or doing a physical examination, and act on them. In addition, the clinician also must verify that the rules applied by the system make sense.

Because the rules will be oversimplifications, an individual patient's situation might mean that the rules should either not be applied at all or be altered. For example, a secondary disease state may interact with another disease process and necessitate changes in therapy. Finally, the clinician's role is to make clinical decisions when no rules are available. Certainly this will happen on a routine basis.

What Can Be Designed

It is sometimes easier to create a vision for the future than it is to say what should be done today. Although it is important to have a vision of the preferred future, clinicians and planners should not be deterred from focusing on more immediate steps. A long-term vision does not automatically benefit from what is

learned by going down the road and implementing smaller steps. Often, after a couple of steps have been taken, a recalibration needs to occur that substantially alters both the goal and the timing.

From the information presented so far, it is clear that there are huge information gaps. Any attempt to talk about implementation of a sophisticated functionality with caregivers whose basic needs are not being met seems disconnected from their reality. Recalling Maslow's hierarchy of needs, someone who is cold and hungry is more likely to be interested in discussing food and shelter than poetry. Clinicians are in an analogous situation. Because they have so many needs and not all of them can be met at once, it is essential to prioritize where to begin. Even if one plans to do everything, one cannot do everything first. Only those sites that already have accomplished the basic tasks can move on to the next step.

In prioritizing information, focus on data that are actionable. These data are unambiguously interpreted and, when abnormal, cause decisions to be made. Examples of such information are the vital signs, I&O information, and POC testing. If blood pressure is low or temperature is high, clinical decisions are made and plans are changed. Consider which data have the potential to change clinical outcomes and give them higher priority.

As technology is deployed to the POC, 3 levels of sophistication emerge. First is the full range of clinical observations and results. These certainly include laboratory results and the quantitative information from the POC. Second, the device used to acquire the vital signs also should transmit that information into the clinical information system, where it can be used to influence the methods of care. Third, medical knowledge as expressed in rules of care, standard dosing regimens, or contraindications should be incorporated in the information system, as should the actual methods for the care given.

Once a clinical information system (CIS) application has been rolled out, one of the most productive next steps is to optimize the application, to tweak it to make it even more efficient for caregivers once they have become proficient in using it. After that, determine which other users also might benefit from repurposing the data.

Most likely, new users will want the information presented in a different format. Nonetheless, the resources required to make such modifications are typically minor in comparison with those required to implement another module or the next application. In addition, the value of extending an existing application to other caregivers is typically enormous because it permits them to change how they do their job in a previously unavailable way.

Once critical data are available online to enhance the ability of caregivers to complete their tasks, new types of reports and alerts also become feasible. Such reports can help the institution focus on the 20% of patients who need 80% percent of clinicians' attention. An approach to using clinical information system data called CaseFinders illustrates this point.

Casefinders. Most patients, if they receive their routine medications and treatments, will convalesce quite well. A much smaller group of patients, however, are unstable, and their needs for care frequently change. If their needs are not met promptly, these patients can experience unfavorable clinical outcomes. The real power of POC numbers and online laboratory results can be fully used when these data are combined to identify a subpopulation of patients who are decompensating and warrant more focused care.

For example, a respiratory therapy supervisor's report can use the data to identify all inpatients who are having trouble with their breathing. The supervisor then looks in on these patients to assess their need for a change in their respiratory care or the need for transfer to a critical care area. A house nursing supervisor's report can identify patients who are most unstable. The supervisor then can shift resources around to meet their increased care needs.

In a setting where an inexperienced caregiver is overwhelmed, the greater wisdom of a supervisor can provide the necessary suggestions for additional clinical interventions or simply another pair of hands. Reports such as these have been used at Scripps Mercy Hospital in San Diego for >5 years. Derivative reports also have been implemented at 2 CHW hospitals.

The CaseFinders reports became possible after patient data were moved from the clipboard to the computer. The use of technology moved from "cool" to "must have." A similar transition is evident in the recent introduction of a new medication safety system at the POC.

MEDICATION SAFETY TECHNOLOGY

The need to support clinicians in medication use at the POC can be recognized both intuitively and from the evidence. A 1995 study by Bates et al[3] indicated that medication errors resulting in preventable adverse drug events (ADEs) or potential adverse drug events (PADEs) occurred most often during ordering (56%) and administration (34%). However, before administration, pharmacists caught 6% of the ordering errors, and nurses intercepted an additional 42%. Nurses also intercepted 33% of all transcription and dispensing errors. However, 0% of drug administration errors were intercepted. In a study by Leape et al,[4] 51% of the nonintercepted potential ADEs and PADEs occurred during administration, making safety at the POC one of the greatest areas for potential improvement in the medication use process.

What We Know

Medications delivered intravenously present the greatest potential for harm. A study[5] of pediatric inpatients showed that 54% of potential ADEs were associated with intravenous (IV) medications. A personal communication with D.W. Bates in October 2001 indicated 61% of the serious and life-threatening potential ADEs were associated with IV therapy. This makes sense intuitively because IV therapy involves powerful, fast-action drugs delivered to acutely ill patients. It is generally accepted that PADEs associated with IV infusion devices are usually a result of incorrect programming.

So-called "smart" technology now puts safety software inside an advanced infusion therapy system to prevent IV medication errors. For each patient type, such as neonatal ICU or medical-

surgical ICU, the system's drug library contains institution-defined medication lists and standard concentrations, preset dosing units with "hard" limits that cannot be overridden or "soft" limits that can be overridden at a clinician's discretion, and minimum and maximum dose limits.

The system provides a "test of reasonableness" at the POC. If the programmed dosing does not fall within the established parameters, an alert sounds, and the infusion cannot proceed until the issue is addressed. If the alert is the result of incorrect programming, a simple check can serve to correct the mistake and prevent an incorrect dose from being administered.

If the dosing has been programmed correctly yet is still out of range with a hard limit, the nurse informs the physician that the medication cannot be administered as ordered. With a soft limit, the nurse decides whether overriding the limit can be justified or whether it is necessary to check with the physician before proceeding. The system also provides a constant reminder when drugs are infused at doses greater than usually recommended. Finally, analysis of critical data from the system's continuous quality improvement log provides a new source of information to assist health care providers in patient safety and continuous process improvement activities.

The introduction of this system also supports the importance of clinician involvement in both the development of new technology and its implementation in clinical settings. Clinicians were deeply involved in the development of both the infusion system and the safety software. The medication safety software technology was first used on a hospital-wide basis at Clarian Health Partners, Inc, a 1400-bed system in Indianapolis. Clarian nurses were part of a multidisciplinary product-selection team and worked with pharmacists, biomedical engineers, and physicians to customize the system software on the basis of the institution's best practice guidelines. Extensive clinical involvement resulted in customization of the data set being completed in 60 days and implementation at the first campus completed in 3 hours, with an immediate impact on the reduction of IV medication errors. A high level of clinician use and satisfaction resulted from a selection and implementation process that involved extensive input and focused on meeting clinicians' needs for care.

The new system is an example of a critical piece of technology at a critical point in patient care—a point at which, if something is done wrong, the consequences can be dire. The system remembers the dosing limits, but the nurse is the decision maker when clinical judgment is required.

In most care settings today, the caregiver is expected both to remember and implement the rule. In this new world of technology-assisted care, the system is expected to figure out which rule should be applied and prepare to implement it, although the caregiver still is expected to verify the rule's appropriateness for a given clinical situation.

The difference in terms of the expectations of clinician performance is profound. In the new world of technology, the skill set of the nurse moves from remembering the protocol and programming pumps to applying protocols and questioning suggestions made by the computer. It is important to note that, given the tendency of most people to assume that "if it came from the computer, it must be right," there is a substantial opportunity for technology-introduced errors. To avoid this, as technology is used to save steps and simplify procedures for greater efficiency and safety, the providers' skill set will have to evolve to a higher standard.

At the same time, by relieving staff of rote work and emphasizing their interactions with patients and clinical competence, nursing professionals can be reenergized. Having met the basic needs and implemented technology at the POC that provides actionable data, applies rules, and makes caregivers more efficient at implementing them, the opportunity exists to reevaluate how that same information can be leveraged for greater usefulness.

What Can Be Designed

With the introduction of smart technology, the programming module has changed from a simple device to a computer, raising the possibility that complex processes at the POC can be simplified further.

For example, some medications need to be infused over 1 hour or longer, while other medications can be infused rapidly without adverse consequences. This information should be displayed for the clinician, who should not be expected to remember such things. In fact, the technology used to administer such medications should be included in the clinical information system loop as much as feasible and be programmed automatically in keeping with the rule. Because the new infusion systems bring a computer to the bedside, yet more opportunities exist to deploy automated data acquisition and interpretation to the POC.

IMPLICATIONS OF FAILURE TO CHANGE

The most serious implication of failing to focus on the right stuff is focusing on the wrong stuff, which immediately leads to quicksand. Keeping focused on the patient facilitates seeing and agreeing on what should be done. The technological possibilities can be evaluated not only on the basis of often-limited data but also on intuition—the invaluable "gut sense" acquired through years of clinical training and experience. As with the other examples discussed above, experience shows that this approach produces a high likelihood of agreement as to what should be implemented and when. Most importantly, when technology is selected in this manner and clinicians are involved throughout the planning and implementation process, the results are full utilization and better outcomes, and nurses are reenergized to do what they entered nursing todo—namely, care for patients—more efficiently and effectively.

VISION FOR THE NEAR FUTURE

Considering what we know and what could be designed yields the following vision for the near future.

- Focus on meeting clinicians' needs for patient care.
- Put first things first—basic functionalities, then actionable data, then higher processes.
- Concentrate on the 80/20 rule. Take small steps. Get and stay involved. ■

REFERENCES

1. Goldberger D, Kremsdorf R. Clinical information systems: developing a systematic planning process. J Ambulatory Care Management 2001; 24:67-83.
2. Koch R. The 80/20 principle. New York: Doubleday; 1998.
3. Bates DW, Cullen DJ, Laird N, et al. Incidence of adverse drug events and potential adverse drug events: implications for prevention. ADE Prevention Study Group. JAMA 1995;274:29-34.
4. Leape LL, Woods DD, Hatlie MJ, et al. Promoting patient safety by preventing medical error. JAMA 1998;280:1444-7.
5. Kaushal R, Bates DW, Landrigan C, et al. Medication errors and adverse drug events in pediatric inpatients. JAMA 2001;274:25-43.