Original Article

A Pharmacy Blueprint for Electronic Medical Record Implementation Success

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ABSTRACT

Objective: Implementation of an integrated, electronic medical record (EMR) has been promoted as a means of improving patient safety and quality. While there are a few reports of such processes that incorporate computerized prescriber order entry, pharmacy verification, an electronic medication administration record (eMAR), point-of-care barcode scanning, and clinical decision support, there are no published reports on how a pharmacy department can best participate in implementing such a process across a multihospital health care system.

Method: This article relates the experience of the design, build, deployment, and maintenance of an integrated EMR solution from the pharmacy perspective. It describes a 9-month planning and build phase and the subsequent rollout at 8 hospitals over the following 13 months.

Results: Key components to success are identified, as well as a set of guiding principles that proved invaluable in decision making and dispute resolution. Labor/personnel requirements for the various stages of the process are discussed, as are issues involving medication workflow analysis, drug database considerations, the development of clinical order sets, and incorporation of barcode scanning of medications. Recommended implementation and maintenance strategies are presented, and the impact of EMR implementation on the pharmacy practice model and revenue analysis are examined.

Conclusion: Adherence to the principles and practices outlined in this article can assist pharmacy administrators and clinicians during all medication-related phases of the development, implementation, and maintenance of an EMR solution. Furthermore, review and incorporation of some or all of practices presented may help ease the process and ensure its success.

Key Words—eMAR, electronic medical record, health care system, pharmacy

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The Detroit Medical Center (DMC), an 8-hospital academic medical center with 2,000 licensed beds, is the largest health care provider in southeast Michigan. Specialties include a children's hospital, level 1 trauma and burn centers, neonatology, surgery, a women's hospital, an eye institute, and a rehabilitation hospital. There are 369,000 emergency department (ED) visits, 8,500 births, and 57,000 surgeries per year. Providing care at the DMC are 2,800 attending and private physicians; 2,000

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residents, fellows, and medical students; and 12,000 full-time employees. DMC's integrated electronic medical record (EMR) system includes a single database with online physician order entry, physician and nursing documentation, and closed-loop barcode medication administration (BCMA) and documentation. Integrated ancillary systems include pharmacy, radiology, ED, surgery, and scheduling. The EMR system processes 3.2 million medication orders and more than 20 million total orders per year. The DMC is a Healthcare Information and Management Systems Society (HIMSS) Stage 6 EMR Adoption Model Hospital, which requires full physician documentation, full clinical decision support system, and full radiology archiving and communications.

With the publication of the Institute of Medicine's quality and safety reports from 1999 to 2004,^{1,2} the DMC Board of Trustees committed the majority of available capital over a 2-year period to invest in technology and resources to make the organization a leader in patient safety and quality by implementing a closed-loop medication system. Computerized prescriber order entry (CPOE), pharmacy verification, electronic medication administration record (eMAR), clinical decision support, and point-of-care barcode scanning are the hallmarks of this system. To accomplish this clinical and technical transformation, the department of pharmacy collaborated with other disciplines to develop the system.

In this article, we describe our experience of the design, build, and implementation of an EMR in the DMC health care system from the department of pharmacy perspective. Others may find this information useful, as a literature review using International Pharmaceutical Abstracts did not identify any published articles from this perspective. The American Society of Health-System Pharmacists has published CPOE implementation guidelines.³ We believe that we have a unique perspective that compliments that article. We address the full closed-loop medication process that includes CPOE, pharmacy verification, eMAR, point-of-care barcode scanning, and clinical decision support within an environment of a multi-hospital system.

SETTING THE FOUNDATION

Implementation of a fully integrated EMR system has been proposed as a means of improving patient safety and quality,⁴⁻⁹ and the pharmacy department is integral in its development. Medication use processes play a prominent role within the EMR. They are highly complex and unique to individual institutions

and health care organizations. No turnkey EMR systems truly exist. A significant labor commitment and a framework to support decision making and conflict resolution, especially in the environment of a multifacility system, are key to a successful outcome.

The DMC implemented Cerner Millennium, an integrated EMR system. The legacy pharmacy system, MSMEDS, was replaced as part of this implementation. A planning and build phase lasting 9 months preceded the rollout, which began in April 2006. Enterprise-wide implementation was accomplished over a 13-month period ending in May 2007 through a series of rollouts at 8 hospitals serviced by 6 pharmacies.

A standardized infrastructure facilitates effective and efficient implementation across an enterprise. This includes an organizational structure with central executive leadership, pharmacy process workgroups (Table 1), uniform policies and procedures, and a central Pharmacy and Therapeutics (P&T) Committee (Figure 1). This structure includes the Corporate Executive of Pharmacy Services.

DESIGN

Core Principles

Acknowledging that DMC is a multifacility system with the potential for procedural and practice conflicts, the EMR steering committee developed a set of core principles: patient safety, single standard of care, mandatory CPOE, eMAR, and medication barcode scanning. The EMR steering committee, reporting to executive leadership, was part of a larger organized structure that also included the project management organization (PMO) and physician, finance, and patient care leadership committees (Figure 2). The core principles were used to direct the project teams in their design and build. These

Table 1. Infrastructure to support implementation of integrated electronic medical record at Detroit Medical Center

Pharmacy Workgroups
• Drug information/drug use policy
• Information systems
• Clinical coordinators
• Pharmacy directors
• Pharmacy purchasing
• Pharmacy operation managers

Figure 1. Review process for Detroit Medical Center system-wide medication decisions. CPOE = computerized prescriber order entry; EMR = electronic medical record.

principles are multidisciplinary, but we will focus on those relevant to the medication use process in our discussion.

Patient safety drives the content and presentation of medication-related orders and processes. Principles of medication safety were incorporated from the onset (eg, tall-man lettering, avoidance of unsafe abbreviations, indications for PRN orders, etc). Similar to previously developed paper order sets, the electronic order sets are viewed as teaching tools to guide the practitioner in selecting the safest and most effective evidence-based therapies. Linking drug information with the eMAR is a useful method to communicate medication safety information to nursing (eg, high-alert medications, drug-food interactions). Furthermore, having this information immediately available at the time of medication administration benefits patient care.¹⁰

Implementing a single standard of care, a seemingly simple concept, can be problematic due to unique and sometimes conflicting cultures and practices between and within facilities. Medication-related practices, already standardized across the DMC, were incorporated into the build. These included practice guidelines, therapeutic drug monitoring, criteria monitored drugs, and a system-wide formulary.

Subtle differences in clinical practice between facilities were identified and resolved as part of the overall standardization process. For example, 3 of our sites had active labor and delivery departments with individualized postpartum treatment plans. These were subsequently harmonized into a single system-wide order set through a consensus-building process.

CPOE is mandatory for all providers in identified patient care areas and processes where the EMR is fully implemented (“in scope”). This eliminates the risk of transitions between areas that are in and out of scope and supports regulatory standards related to patient safety (eg, minimizing the use of verbal orders). Scope decisions are based on the complexity of the process, the availability of resources, the functionality of the software, and the potential for success. Benefits of mandatory CPOE include elimination of paper processes in pharmacy (allowing for a more efficient review and verification of medication orders), paper order sets (eg, lack of availability, multiple and potentially out of date versions), and errors related to handwriting illegibility.^{4,7,11-13} Patient safety may be compromised if more than one medication order process exists. At the DMC, we determined that all inpatient areas, the ED, and select outpatient venues were “in scope.” Based upon these criteria,

Figure 2. Detroit Medical Center electronic medical record (EMR) committee relationships. CIO = chief information officer; CMO = chief medical officer; CNO = chief nursing officer; EVP = executive vice president; MEC = medical executive committee; PMO = project management office.

ambulatory and procedural areas, in general, were deemed “out of scope” for the initial implementation.

An eMAR enhances the capture and documentation of medication administration in a standardized format that is readily accessible to all practitioners. It provides a real-time, single source of truth for medications, prompts for timely administration, and medication billing on administration. An eMAR is necessary for the implementation of barcode scanning.

Medication barcode scanning has been well documented in the literature as a useful technology to improve patient safety.^{9,14-21} Barcode scanning technology supports a majority of the Nine Rights²² of the medication administration process. Post implementation, we have observed a significant, sustained 45% reduction in medication errors related to right patient, right drug, right dose, right time, and right route as reported through our Web-based, spontaneous, incident reporting system.

Labor

Determining pharmacy labor requirements for a complex, integrated EMR implementation is not clear cut. Multiple interdependencies blur the boundaries between pharmacy and other health care disciplines. Allocated pharmacy resources must be sufficient to ensure adequate representation in all planning, design, and build aspects related to the medication use process. Personnel requirements include permanently assigned pharmacy staff, ad hoc pharmacy staff, permanent non-pharmacy information technology (IT) staff, and vendor resources. In our case, approximately 4 full-time equivalents (FTEs) were assigned to participate in the project. These included 2 permanently assigned full-time pharmacists. Specialists, managers, and pharmacy informatics (PI) staff participating on an ad hoc basis comprised the remaining 2 FTEs. This pharmacy staff worked closely with the IT staff (2 FTE) and vendor resources

(1 FTE). Their role was to advise on specific solutions related to various operational and clinical issues.

Staff selection is critical to the success of the project. Individuals participating should be high performers with computer database/technology aptitude. Other desirable attributes include the ability to see the big picture, process orientation with expertise in pharmacy distribution and clinical services, self-direction, and logical/analytical problem-solving skills. These individuals are typically the most talented employees in the pharmacy department. Reallocation of these employees is likely to affect day-to-day operations, but leveraging their knowledge in the development of the EMR system will offset this staffing impact.

Workflow

Medication-related processes are multidisciplinary and can vary between and within health system organizations. As a result, a detailed workflow assessment using a gap analysis approach is vital to the design and build of an EMR. Table 2 identifies major medication processes and makes recommendations for workflow analysis participants.

Workgroup members create flowcharts for their assigned process in multidisciplinary sessions. Although it may seem that these charts can be produced most efficiently by 1 or 2 individuals and then circulated for feedback, this practice should be avoided. Bringing the workgroup members together enlightens each participant to all of the steps and interdependencies inherent within a process. Furthermore, it also serves to identify

steps and shortcuts, many of which may be contradictory to institutional policy and/or safe practice. After creating a flowchart of the current process, the workgroup develops a new flowchart incorporating EMR technologies. Utilizing a “start-stop-continue” methodology, current and future states are compared and action plans are developed. PI and IT staff input is essential during this phase to ensure a clear understanding of the process components and the capabilities of the proposed EMR solution. A tendency to replicate the current manual or paper processes electronically should be tempered by a close examination of how the processes may be made safer or more efficient through the new technologies. Any questions regarding these capabilities, steps in the process, or documentation are identified and placed on an issues list for later resolution.

Development of an integrated EMR is an iterative process requiring compromise by all disciplines. Pharmacy has been on the leading edge of health care information technology.²³⁻²⁵ As a result, applications have evolved to suit the needs of the profession. Pharmacists have learned to customize these programs to accomplish tasks and fulfill needs for which they were not originally intended. The new EMR functionality, by necessity, consists of completely new programs that are not based on those previously used within pharmacy. Therefore, a pharmacy department may have to tradeoff some of its existing computer functionality (at least initially) in order for the entire institution (including pharmacy) to benefit from the integration of information provided by the transition to an EMR.

Table 2. Medication process workflow analysis

Process	Participants
Prescription process – medication and laboratory orders	Physicians, physician assistants, clinical nurse practitioners, other independent practitioners, pharmacists, PI staff, and IT staff
Order review and verification	Pharmacists, prescribers, PI staff, and IT staff
Medication preparation and checking	Pharmacists, pharmacy technicians, PI staff, and IT staff
Delivery of medication	Pharmacists, pharmacy technicians, nursing staff, PI staff, and IT staff
Medication administration and documentation	Pharmacists, nursing staff

Note: IT = information technology; PI = pharmacy informatics.

BUILD

Database Considerations

Medication database considerations for an integrated EMR system go well beyond the architectural space of the pharmacy. Pharmacy database components cannot be designed and built in isolation in an integrated system; they must support all phases of the medication use and billing processes. The interdependent nature of these processes necessitates constant communication between the pharmacy and clinical build teams. At DMC, the pharmacy’s role included building order catalog and pharmacy database elements to maintain the relationships between code elements. For example, a product in the order catalog built in grams must also be built in grams in the pharmacy database and be consistent with the way nurses administer and chart the dose. Effective BCMA scanning and seamless integration with automated dispensing cabinets (ADCs), robots, and medication

repackagers is accomplished through the incorporation of National Drug Code (NDC) and unique identifiers in the drug database. Appropriate cost and charge structure must include considerations for federal and state billing requirements and may require adjustments to accommodate Healthcare Common Procedure Coding System (HCPCS) coding and NDC reporting.

The drug formulary build must be synchronized with the reference database (eg, Multum, First Databank) to support checking interactions, including drug-drug, drug-allergy, drug duplications, and dose ranges. To achieve the optimal balance between these safety features and alert fatigue,²⁶⁻³⁰ the drug information workgroup in conjunction with the P&T Committee determine default severity settings and regularly review alert reports and customize the content.

We strongly recommend construction of a single standardized drug database. We consider it to be a primary success factor for EMR implementation in a multifacility integrated delivery network. The effort required to design, build, and maintain a nonstandard database for a multifacility system will grow exponentially and can become a barrier to success.

Clinical Order Set Conversion

To implement an EMR, paper order sets and pathways used by the health system must be converted to an electronic format. Although DMC had preexisting system-wide, evidence-based preprinted order sets (eg, heart failure, community acquired pneumonia, etc), many sites had developed nonstandardized order sets for those disease states and conditions not previously addressed at the system level. The sheer number of order sets created a daunting task for the P&T Committee to review and approve over a short time frame.

To address order set issues, a Clinical Order Set Advisory Committee (COSAC) was created. The COSAC had representation from all ancillary services that were impacted by orders generated in the EMR (eg, radiology, laboratory, respiratory therapy, nursing, pharmacy). The group developed a naming convention and classification system for commonly used tests and order sets. Consistent with the core principle of a single standard of care, it was agreed that all order sets would be uniform across the system and unique to that given disease or clinical condition (eg, one order set for asthma exacerbation, one for diabetic ketoacidosis, etc). The COSAC met weekly for at least 1 year. Once reviewed by COSAC, order sets

that were medication-related with therapeutic implications were forwarded to the system P&T Committee for final approval. These were named “[Disease Name] – P&T EBG.” This conveys to the end user that this particular order set is an evidence-based guideline (EBG) reviewed and approved by the system P&T Committee. Additionally, convenience order sets (eg, admission orders with standard laboratory tests or bundles of therapeutically related drugs and tests) were developed to facilitate ease of order entry. An example would be a “respiratory bundle,” which included beta agonists, steroids, and anticholinergics along with pulmonary functions tests. These types of order sets did not require P&T Committee approval. Drug information specialists were granted authority to review convenience order sets and approve where appropriate, provided that (1) it was unique and acceptable for use by all sites managing that particular patient population, and (2) medications were formulary and compliant with system-wide guidelines. If the drug information specialist deemed that further discussion was required, he/she forwarded the order set to the P&T Committee for review and approval.

Many lessons were learned during this process, however, the following were most notable:

1. There was a need for separation and designation between pediatric/adult and ED/inpatient order sets. The naming convention of order sets designated for pediatric and ED use included the prefixes PEDS and ED, respectively.
2. Paper order sets may not translate well into an electronic environment. The tendency is to mimic the flow of a paper order set process. This is not always possible or practical, and it took time for COSAC members and others to develop an electronic process flow mindset. Paper order sets have minimal formatting constraints, however, EMR order sets may be limited by the vendor's predetermined configuration. We worked through issues related to timing of medication orders and spatial separation of drug information reference material from the actual orders.
3. Despite the establishment of a system-wide P&T Committee many years prior to EMR implementation, “bootleg” order sets, paper forms, and other site-specific processes were identified. Although it is time consuming, it is worth the investment in resources to standardize as needed and remain committed to the principle of a single standard of care.

Barcode Medication Administration

Preparing the pharmacy for BCMA requires a top to bottom evaluation of all distributive, clinical, billing, and administration processes to assess the potential impact of the new technology. Interoperability of the existing technology is a critical component of this assessment and may impact budgets due to the potential upgrade or replacement of software and hardware. Implementation of BCMA concurrent with a change from charge on dispense to charge on administration has a significant impact on the distributive processes within the pharmacy.

A great deal of preparation, testing, and education is required to ensure that all dispensed doses have readable barcodes. Differences in packaging, product form, and symbology result in inconsistent barcode content and placement. This lack of standardization in combination with multiple distribution systems such as centralized robotics, ADC, and manual dispensing complicates the implementation and maintenance of BCMA processes. Multiple solutions, including drug database modifications, product selection, repackaging, customized barcodes, and process changes, are required to ensure interoperability and integration.

These strategies are integral to our successful BCMA implementation. Our robotics system utilizes an overwrap that is printed with a linear barcode during the repackaging process, whereas unit dose, cabinet based dispensing, and manual processes rely heavily on manufacturer barcodes. Manufacturer barcode issues that cannot be resolved through technological or purchasing adjustments are repackaged or relabeled with extemporaneously prepared and manually applied “dot” labels. Our dot labels consist of a 2-dimensional (2D) Aztec barcode on small circular stickers that can be affixed to many types of packages.

Our bulk repackager is used primarily for medications that are unavailable in manufacturer unit dose packaging or to resolve manufacturer barcode issues. These issues resulted in a 15% to 20% increase in packaging. The repackager produces linear barcodes with variable content. We chose to encode a unique (non-NDC) identifier rather than the NDC. This allows us more flexibility when packaging multi-source drugs and minimizes maintenance in both the packaging and clinical system databases.

Barcoding multidose bulk medications presented challenges. In addition to the issues discussed above, the billing process remained in a charge-on-dispense status. Our initiative to optimize the charge

administration practice required the repackaging of bulk products into unit dose medications where feasible. A special case exists with certain opioid liquids that remain in bulk form and are also stored in the ADC. In that case, a roll of barcoded dot labels is stored in the compartment with the medication. The nurse applies the dot label at the time of removal of the product from the ADC to facilitate scanning at the patient’s bedside. In general, repackaging may result in space constraints. ADC inventory levels should be scrutinized to ensure appropriate space allocation for all items, especially in facilities that utilize a cartless dispensing model.

Manual dispensing processes require focused evaluation and maintenance monitoring to ensure a usable barcode on each dosage unit. Label placement, curvature of bottles and solution bags, on-the-fly repackaging, and general medication safety requirements all need to be considered. In our experience, use of 2D barcodes effectively resolved these issues.

The importance of initial and ongoing testing cannot be overstated. We use a robust methodology that requires testing of all barcodes against a complete medication order, including route and dosage form for all order types (eg, unit dose, bulk medications). This important step verifies that all elements of a patient’s medication regimen are correctly identified and that the medication ordering and drug databases are properly synchronized. Reference database content (eg, Multum) must be current. Barcode testing must be coordinated with purchasing personnel. New products and/or products from alternate manufacturers are tested prior to being placed into inventory. Multisource products require the most vigilance, especially if automatic substitution by the wholesaler is allowed.

We found the 2D Aztec symbology to be the most functional format. This format provides a smaller footprint and enhanced reliability. Our initial implementation with linear barcodes proved problematic, as they must be relatively flat when scanned. Scanning was difficult when labels were placed on curved surfaces such as bottles and intravenous solutions. Additionally, partial obliteration of the linear barcode with smears or pen marks renders it unusable. In contrast, the smaller Aztec symbology is not distorted by curvature and its size allows for multiple 2D barcodes to be placed on the label to provide scanning options in case any are unusable. We have summarized our current barcode symbology strategy in **Table 3**.

Table 3. Barcode considerations

Barcode source	Current barcode type	Comments
Pharmacy label	2D	Initial linear barcode proved problematic on curved surfaces.
Bulk repackager	Linear	Use permanent, unique, non-NDC product identifier.
Robot	Linear	NDC modification may be required.
Dot label	2D	Use permanent, unique, non-NDC product identifier.
Manufacturer	Linear, stacked linear, 2D	Lack of standards in barcode content and size may prove problematic. May require active engagement of manufacturer or product repackaging.

Note: NDC = National Drug Code; 2D = two-dimensional.

IMPLEMENTATION AND ISSUE MANAGEMENT

In preparation for implementation, training and support needs must be identified. Based on training requirements, we allocated 8 hours per pharmacist and 4 hours per pharmacy technician. Pharmacists were trained in chart review, order entry, and verification and were cross-trained in prescriber order entry and nursing eMAR documentation. Technicians received training in label generation and billing.

To assist in a successful rollout, pharmacist volunteers should be enlisted to serve as super-users. These individuals serve as experts that staff can turn to for assistance in resolving questions and problems, both during and after implementation. These super-users work closely with the PI staff to identify unanticipated problems and to communicate their solutions to the staff. At DMC, they received approximately 40 hours of training in the design, build, testing, and functional use of the system. We identified a ratio of 1 super-user for every 15 pharmacy employees to be sufficient; however, adjustments can be made to meet the needs of individual sites.

A multidisciplinary EMR command center is essential to address implementation issues. We found that 2 weeks of around-the-clock availability was sufficient to support the go-live at each site. We established a separate pharmacy command center (PCC)

in close proximity to pharmacy operations to provide ready access to PI expertise and a physical presence for immediate response to issues.

The PCC is staffed by the director of pharmacy informatics, the site PI coordinators and field technicians, and the system and IT staff. As issues are reported to the PCC, they are prioritized and logged into a spreadsheet that is reviewed on a daily basis with the EMR vendor and updated with proposed solutions and anticipated resolution dates. This information is shared with all interested parties, including the pharmacy super-users, who regularly communicate issue resolutions to the staff. The PI workgroup continues to address unresolved and newly identified concerns following implementation of the EMR.

During rollout, teams of hospital, pharmacy, and nursing administrators and IT staff make rounds through the institution, asking questions and ensuring that the EMR process is working and that there is sufficient staff support on all shifts. In the pharmacy department, it may be necessary to temporarily increase staffing for the first 2 weeks following rollout while initial problems are resolved and the staff acclimates to the new processes.

There are substantial benefits to leveraging the experience gained from sequential site implementation. We used a common traveling pharmacy implementation team composed of PI coordinators from each site, pharmacy field technicians, and pharmacists from sites that had already implemented EMR. This team travelled to the facility immediately prior to roll out to assist in the process of copying orders from the previous pharmacy system into the new EMR program. Pharmacists at the implementing site, as well as PI coordinators from sites that had not yet gone live with EMR, gained valuable experience through their participation in this process. After this “back end load” was accomplished, the resulting eMAR was compared with a printed MAR provided by the previous pharmacy program.

The key element to ensure a smooth transition is the completion of this backload process prior to nurses and physicians using the new system. This will require a several hour head start by the pharmacy implementation team to ensure continuity and synchronization of order entry. The time required for this process will vary based upon specific workload and allocated resources, and it can be estimated from the following formula:

$$\text{Time needed (min)} = \frac{(\text{Number of orders to be loaded}) \times (\text{Estimated minutes/order})}{\text{Number of staff to backload orders}}$$

The number of orders to be loaded is obtained from the previous pharmacy medication profile system. The estimated time required to verify or enter an order can vary, based on the complexity of the order, any confounding clinical issues, and familiarity with the order verification process. We allowed 2 minutes per order. This time estimate was developed during our training process and proved to be accurate throughout our multiple rollouts.

MAINTENANCE

Once the initial implementation of an EMR is complete, it is essential to develop a process to evaluate and improve it. This includes continuous evaluation of workflow processes; systematic incremental improvements through database changes, software upgrades, and institutionalized application development; and vendor relationships.

Based upon our experience, the transformation of the medication administration process from a paper-based to an electronic environment, including bar code scanning at the bedside, has a significant and immediate impact on nursing and pharmacy workflow.³⁰⁻³⁴ To ensure full adoption of the new technology and processes, an interdisciplinary pharmacy-nursing-IT team periodically rounds on the nursing units gathering feedback from end-users, evaluating workflow process changes, and resolving issues in a timely manner. Rounding frequency varies upon adoption rate and the volume and severity of issues.

Pharmacy needs to be heavily engaged in ensuring that all barcodes scan appropriately to minimize interruptions in nursing medication administration workflow. At DMC, simple feedback mechanisms (eg, plastic bag and a patient information sticker) were put in place on nursing units to provide a way to communicate scanning issues to pharmacy. This process proved vital in increasing the adoption rate of scanning and preventing workarounds that may affect BCMA integrity.⁷

Systematic incremental improvement of the EMR is a key component in increasing the quality of patient care and the adoption by end users. DMC developed an “enhancement” process that provided a forum for clinicians to request improvements to the system. A multidisciplinary group was formed to evaluate and prioritize requests. Pharmacy plays an integral role on the team to provide knowledge and expertise in the medication administration process. Medication process enhancements include revisions to order sets, dose range checking parameters, drug-drug interactions, rules and alerts, and electronic forms. As of this

writing, the DMC has implemented more than 1,200 enhancements.

As part of the enhancement process, the chief executive officer of DMC allocates a separate pool of funds to support a quarterly “EMR Award” initiative. This award is intended to encourage end users to think outside the box and communicate their “perfect world” ideas for creating a better system or process. These ideas can be enterprise-wide or department specific. Prioritization criteria include patient safety, process improvement, financial performance, and regulatory compliance. Examples of these include an acetaminophen total daily dose alert during nursing administration, an auto-populated venous thromboembolism risk factor screening tool for physicians, and a multidisciplinary antimicrobial stewardship summary view.

IMPACT

Practice Model Improvements

Elimination of paper orders and enhanced clinical documentation in combination with the global availability of an integrated clinical information system provides an excellent opportunity to further decentralize and enhance the pharmacist practice model. With the availability of wireless connectivity and mobile computing devices, pharmacists are no longer tied to specific locations and can be deployed throughout the patient care areas, maximizing their visibility and access to clinicians and patients. Redeployment of central pharmacy staff led to the creation of an additional clinical rounding position at one of DMC’s hospitals. Medication use evaluation (MUE) processes became prospective and standardized, with much of the responsibility shifted to the prescriber. Online real-time medication reports allow more efficient clinical workflow and easier chart review. Structured pharmacy clinical documentation facilitates transitions of care.

The new paradigm in which the physical location of the patient is irrelevant to the care process presents operational challenges and opportunities. For example, a patient admitted to an inpatient bed who remains in the ED due to lack of bed availability needs to have routine medications available at his or her current physical location versus final location. Immediate knowledge of the patient’s medication orders that is facilitated by the EMR removes delays and barriers associated with the paper ordering and patient transfer processes and allows the patient to receive therapy earlier in the course of stay. This paradigm also allows for remote review and verification

of patient orders in facilities that do not provide 24-hour pharmacy services. However, patient location for drug delivery may become a moving target during transitions of care.

Revenue Analysis

Electronic medication administration processes enable the conversion of medication billing from charge on dispense to charge on administration. This enhances the integrity of the charge capture process and revenue stream. The billing intricacies of some EMR systems may require that certain medication types such as bulk medications (eg, metered dose inhalers) remain as charge on dispense items. The improvement in the reliability of the charge capture system may produce decreases in revenue as a result of prior charge or credit processes and adoption of the new medication administration workflow. We saw an initial reduction of approximately 20% relative to a 3-month baseline average. We were able to return to baseline over a period of weeks by active financial analysis, additional education, and system database modifications.

Determining the cause of the revenue variance requires a detailed analysis and should occur as soon as reliable patient accounting data are available (within a few days of implementation). Purchasing data and trends are important to validate that the observed variance does not merely reflect a purchasing or prescribing pattern change. Our approach was to closely examine both dollar variances and billed quantity changes. These variances were examined at a charge description master (CDM) level in a top-down fashion with emphasis on both negative and positive changes. The analysis then proceeded to categorize these items based upon medication class (eg, antibiotics), patient care areas (eg, erythropoietin in hemodialysis), product packaging (eg, unit dose vs bulk), and administration methods (eg, IV infusion).

Process differences also have an important impact on revenue. Non-formulary medications are not typically built at the CDM level, making it difficult to identify revenue shortfalls. In addition, manual billing practices in non-EMR care areas must be examined. The set up of ADCs for charge on administration and charge on dispense areas may require a different configuration in the EMR database. Finally, the medication credit process in a charge on dispense environment can contribute to revenue variation.

Disparities between the legacy and new drug database can be an additional source of revenue and quantity issues at the CDM line item level. Database interchange of component line items will affect specific CDM volumes. Offsetting revenue or quantity changes can be found using a CDM cross-walk between the 2 databases. For example, vancomycin IVPB built from a 1 g vial in the old system changes to a 10 g vial in the new system. Database build requirements may also contribute to these discrepancies. For example, the new system may bill in milliliters whereas the legacy system billed in grams. Many of these database build risks may be mitigated by comparing a test bill for the same drug item as produced from both the new and legacy systems. Continuous daily monitoring and drill down of pharmacy revenue provides an early warning of systematic errors that can rapidly compromise the integrity of the revenue cycle. This routine monitoring is especially important during the initial weeks following implementation.

CONCLUSION

Using the blueprint outlined in this article, we planned and implemented a fully integrated EMR at the first site in 9 months. We subsequently completed a rollout in our 7 remaining sites over the next 13 months. This included the design and build of a new pharmacy system, CPOE, eMAR, and bedside barcode scanning. The rapid implementation was facilitated by the foundation that had been laid over the previous years.

The processes and structure outlined in this article allowed us to create and sustain the necessary environment for our success. Clearly, each site will need to customize this approach in order to achieve similar results, since the current state of each facility and its needs will be different. However, a strong foundation and highly structured maintenance and enhancement processes as described will help to ensure successful implementation and continuous improvement.

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