SESSION 12
Reengineering Medication Management From the Bedside Using Bar-Coding and Wireless Technology

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The major challenge in healthcare today is how to deliver quality care and improve patient outcomes while reducing costs. In an environment where managed care, fixed fees and capitation are playing an ever-increasing role in reimbursement formulas, the goal is to keep the patients healthy, reduce their hospital stays and prevent avoidable re-admissions, visits, and extended stays. No one disputes that the only way to effectively accomplish this daunting task is through technology. In today’s evolving world of healthcare, patient safety is of the utmost importance. Medication errors exact a staggering toll on the quality and safety of patient care, yet approximately 65% of medication errors are preventable. Studies have distinguished where errors can occur in the medication management process (Figure 1). Until now, companies in the marketplace have solely addressed how to tackle the portion of the pie where the smallest percentage of errors is occurring—the dispensing arena. The medication safety issue, including medication ordering, administration and logistics, requires automation and verification at the point of care. A comprehensive medication management and logistics system using bar-coding and wireless technology can significantly impact the safety and subsequent outcomes of patient care while reducing overall costs. By reengineering medication management from the bedside and not the supply side, using wireless technology and bar-coding, hospital organizations are assured an automated system with an integrated patient-centric focus rather than inventory/order fulfillment. A demonstration of a point of care medication management system using bar-coding and wireless technology will be presented and results from a case study of a hospital will be presented showing the benefits of real-time information and workflow and event management.

![Figure 1: Where Medication Errors Occur](image)

### MEDICATION ERRORS

Medications have tremendous healing powers but conversely medication errors can have debilitating and life threatening effects. Children’s Hospital in Los Angeles did a focus study on medication errors and adverse drug events in 1996 and documented “70 Ways to Mess Up Your Medications” (Figure 2). It cannot be emphasized enough that with today’s technology these medication incidents can be prevented.

#### Adverse Drug Events

An Adverse Drug Event (ADE) is described as an injury caused by the use of a drug. If the ADE is the result of an error, it is by definition, preventable. Bates, et al, found an ADE rate of 6.5% of admissions (“Incidence of Adverse Drug Events and Potential Adverse Drug Events,” JAMA, July 5, 1995). In a subsequent article, the additional length of stay associated with an ADE was 2.2 days (“The Costs of Adverse Drug Events in Hospitalized Patients,” Bates, et al, JAMA, Jan. 22, 1997) (Figure 3). It was further noted that preventable ADEs (those caused by error) accounted for roughly half of the total additional costs associated with ADEs even though they represented only one-third of the total number of incidents.

Most hospitals rely on self-reporting to document medication errors. Clinicians may lack positive incentives to report medication errors or fear punishment for having too high of a reported rate. They work in a complex environment and may not always recognize that an error has occurred. Or, they may lack the time or adequate reporting mechanisms to properly document the error. As a result, reported errors represent only a fraction of actual errors. This under-reporting is well–documented in industry literature and has been substantiated by hospital interviews.
The impact of errors on the cost of care is substantial, affecting length of stay, transfers to intensive care, additional tests and treatments. The under reporting of errors makes it difficult to attribute specific costs to the ADE. Medication errors also cause damage to a hospital’s reputation and internal morale, as well as creating emotional distress for caregivers. These effects are often dramatic, but are also difficult to quantify.

Adverse drug events are comprised of the previously discussed preventable medication-related errors as well as non-preventable drug reactions. The Journal of the American Medical Association stated that 30% of acute care patients experience adverse drug reactions during a hospital stay. Online reporting of adverse drug reactions at the point of care would dramatically improve the efficiency and accuracy with regards to reporting such events. By scanning the patient’s bar coded wristband prior to administration, systems are able to track the exact medications administered to a patient, thereby removing the guesswork from the documentation process. Furthermore, reactions documented online prevent healthcare providers from re-ordering/re-administering the drugs involved, thus preventing further reactions.
COST REDUCTION FROM REENGINEERING MEDICATION MANAGEMENT

Medication preparation and dispensing systems have evolved over time. Historically, pharmacies used a traditional delivery method that entailed a complex, tedious process in which orders were handwritten, brought to pharmacy where they were filled, checked, and dispensed in a patient-specific manner at the pharmacy level, and then sent to the unit for administration. Since up to 40% of orders are changed in the course of a patient’s stay, medication wastage and rework were the results and contributed to increased costs.

The next era of pharmacy dispensing systems resolved some of medication wastage by introducing unit dose delivery so that if orders were changed, medications could be credited back to pharmacy. Although drug costs declined, the effort required for crediting non-usage increased. Furthermore, the issues of having medications available to nurses, accountability of inventory and patient safety were not fully addressed.

Automated medication dispensing systems have become the industry standard for provision of pharmacy services and, due to technology, have widespread potential benefits. Consultant Pharmacists, March 1998, summarizes the advantages of automated pharmacy systems:

“Automated systems can outperform human tasks that require tedious repetition, tiresome movement, intense concentration, immense memory retention, and meticulous record keeping. This describes many of the tasks of the drug distribution process. Automated pharmacy systems replace many labor-intensive tasks, thereby saving pharmacist, technician, and nursing time. Automation is an enabler for the re-engineering of pharmacy practice and frees pharmacists for the practice of pharmaceutical care.

Automated pharmacy systems can reduce medication errors, improve documentation, increase authorized access to both medication and information, and enhance security. Turnover of personnel and on-the-job stress may be reduced when pharmacists are freed from ‘count and pour’ dispensing
for more rewarding, patient-centered tasks. These benefits can be summarized in terms of increased productivity, accuracy and drug use control, and in improved patient care.”

Although the benefits of changing to an automated medication management system are evident, a cost savings justification is often necessary. Cost containment, cost reduction and productivity improvements are the central themes of our economic story:

1. Savings come from the prevention of medication errors and adverse drug events. Medication errors lead to additional costs resulting from additional length of stay; additional labs, tests, and treatments; transfers to intensive care; additional caregiver time; additional accreditation, litigation, and risk management activity.

2. Savings come from improving the patient care process as it relates to medication use. Productivity gains in nursing stem primarily from streamlining the medication verification, troubleshooting and documentation steps. The system also supports the shift of pharmacy from a distributive role to a consultative, pharmaceutical care model, which generates additional economic benefit.

3. Savings come from improved efficiency of the medication logistic process (Figure 4). The system will reduce inventory, labor and management costs associated with the various medication distribution methods commonly used in hospitals. Supporting administrative priorities generates additional value. These include billing compliance, accreditation activities, nursing staff recruiting and retention, patient satisfaction, and public relations to name a few. In addition, the hospital will benefit from the state-of-the-art wireless network and bar code system while taking a major stride forward in electronic order entry and charting.

**Figure 4:** Reengineering Medication Management—Changing Workflow to Improve Productivity

**POINT OF CARE MEDICATION MANAGEMENT SYSTEM USING BAR-CODING AND WIRELESS TECHNOLOGY**

Point of Care Medication Management delivers the complete requirements for a closed loop information system by improving clinical quality and operational costs savings in the daily operation of the dispensing and control of pharmaceuticals. All other available systems are silo-based products whereas a Point of care medication management system is not. Instead it goes beyond medication preparation and dispensing systems and targets the complete medication process to include all constituencies: physicians, nurses, pharmacists and lab technicians.

A Point of care medication management system delivers the following functionality and features: patient profile, drug/supplies tracking at point of care, narcotic control and electronic documentation, alerts messaging & event monitoring, inventory management, electronic messaging, medication charting, locator of people, product, patient & storage units, workload planning, audit exception reporting, dynamic report writer and strong security at all levels.

To accomplish the patient safety aspect of medication management, a Point of care medication management system utilizes mobile smart carts that bring the medication administration process to the point of care (Figure 5). Furthermore, cost capturing of medication usage is traditionally performed.
as medications leave the pharmacy requiring much time and effort to be spent in calculating and dealing with returned stock. A Point of care medication management system captures charges at the point of administration as the patient’s bar-coded wristband is being scanned, thus significantly reducing the crediting issue.

The System’s technology is Client Server—Windows® NT allowing ready integration with evolving hospital information systems. The system is HL7 compliant. The relational database, featuring Oracle 8, provides clustering replication and Web connectivity and creates reports instantly with the user-friendly report writer. The architectural design is open and scaleable. With respect to wireless technology, the System follows the industry standard of 802.11, allowing easy adoption of future wireless technologies. All solutions are fully Year 2000 compliant.

Demonstration of a point of care medication management system using bar-coding and wireless technology by user group

(1) Patient
Unparalleled patient safety is one of the many benefits to patients. Each patient receives a bar coded identification bracelet at admission. All patient information including patient location, attending physician, allergies, and diagnosis are provided through an HL7 interface to the hospital’s admitting department. The patient’s weight, height and body surface are recorded permitting the system to automatically calculate appropriate therapeutic doses when the physician is prescribing. All this information is linked real-time to the patient’s bar coded bracelet ensuring that the right patient is receiving the right dose of the right medication at the right time via the right route. The system successfully closes the patient safety loop by addressing all the areas where medication errors can occur.

The system addresses the five rights of clinical practice through scanning verification at the point of care, scanning both the medication and the patient’s bracelet. The real-time tracking provides automatic charting of all events, providing caregivers with an automatically up-dated patient profile at all times, including allergies, medication administrations and lab results, thus preventing any further adverse drug reactions. The system’s workflow management capabilities ensure that patients are receiving the right medications at the right times, and are being charged only for the medications that are actually administered to them. Billing is captured at the point of care when the patient’s bar coded bracelet is scanned before the nurse administers the correct medication. In addition, the system has a built in alerts and reminders application to notify the nurse of any changes or errors before administering the medication, thus preventing any medication errors from occurring.

(2) Nursing
Nurses are able to access and provide medication to patients instantly with the AUTROS Point of Care Medication Management System, eliminating unnecessary delays. Nurses have mobile medication carts that store medications in locked drawers and use handheld scanners to open open appropriate medication drawers and verify the 5 rights of medication administration. The screen on the mobile
Palm handheld device displays patient’s medication, dosage, previous administration time and results. Moreover, nurses always have an accurate real-time MAR worksheet, whether in a paper or paperless environment. Messaging and information displayed on wireless Palm handheld devices alert nurses as to pre-medication checks and missed doses. The system makes medication administration easier and faster thanks to the bar code technology which not only ensures the 5 rights of clinical practice, but also records results such as refused medication or adverse reactions. The reduction in administrative paperwork means that nurses can spend more time doing what they do best—caring for patients.

The system is designed with the built-in tools required to make a nurse’s job easier and yet more efficient all at the same time. Mobile medication depots provide nurses with easy access to patients at the time of medication administration, using a real-time electronic MAR at the patient’s bedside. The electronic narcotic control built into the system provides nurses with a much-needed aid for managing the inventory control. Automatic charting eliminates the labor-intensive paperwork nurses are required to do in order to manually up-date patient charts and provides them with more time to spend on clinical tasks.

(3) Pharmacy
A Point of care medication management system provides an instant and much needed communication link between physicians, nurses and pharmacists. It standardizes dosage and special administration instructions, and automatically relays missed doses and adverse drug reactions from the patient’s bedside to the pharmacy. Less time is spent on inventory management, since the inventory tracking system prepares suppliers’ orders automatically when stock is low.

Consultant Pharmacists, March 1998, summarizes how technology impacts the pharmacy profession:

“Advances in technology are changing the world, and the pharmacy profession stands to benefit greatly from the proliferation of technological innovation. Nowhere is this more apparent than in the availability and use of medication dispensing technologies to accelerate the transition of pharmacists from the traditional, product-focused dispensing role to that of patient-focused service provider.”

Pharmacists can spend more time advising hospital staff on medication issues, and less time doing paperwork. Also, pharmacists can spend more time on clinical-related activities rather than inventory management. A Point of care medication management system offers a clinical intervention and adverse event module and provides pharmacists with on-line access to all patient data and reports.


The pharmacy base station instantly receives medication orders through Spread Spectrum Wireless LAN technology. Medication dispensing is based on average days supply. And most commonly used unit dose medications are bulk-stocked in mobile smart carts. The system determines the requirements for each storage unit. Patient-specific medications can also be stocked in smart carts. All medications are bar coded, which ensures that nurses are retrieving the correct medication and that inventory is charged at the point of care. The system alerts pharmacy staff in real-time of medication demands.

Pharmacy benefits from the just-in-time inventory control, eliminating shrinkage. Other controls included electronic narcotic handling and security alerting mechanisms as additional inventory control measures. Real-time tracking of information provides pharmacy with complete auditing and reporting capabilities that are currently not available in most hospitals.

(4) Hospital Administration
In these times of fiscal restraint, a Point of care medication management system helps control costs while improving patient care. Not only is paperwork for nursing and pharmacy staff dramatically reduced, the system actually improves the quality of record-keeping and inventory tracking. The base station maintains a perpetual inventory of the contents of the mobile medication carts and keeps track as doses are administered, wasted or replaced, allowing your hospital to move closer to a just-in-time inventory. The system works seamlessly with your hospital information network to create a virtual information bank to deliver integrated healthcare.

(5) Materials Management
The system can be extended to manage inventory in other areas of a hospital. For example, materials and supplies can be tracked using the bar coding and scanning technology at the point of care. Food supplies can be controlled in the same manner. The cost attributed to wasted meals in a hospital is significant. An ordering and workflow/event management module provides an integrated food management system. Other modules using the same management tools can be used for bed management, lab patient tracking and lab specimen management.
CASE STUDY

In 1994, West Park Hospital went in search of a medication delivery system to meet its need for a highly automated pharmacy system and an integrated information system that would link all facets of the medication delivery system. West Park Hospital was looking for a system that linked all aspects from pharmacy to the patient’s bedside. The system would include the automation of physician order-entry, pharmacy verification, drug fulfillment, medication administration and inventory management. West Park also required electronically secured and computer controlled medication carts on each service unit. The carts needed to provide controlled access to medications, release drugs as required and collect data real-time for record keeping and charting. In addition, West Park Hospital required an integrated system that would dramatically reduce costs, increase efficiency and productivity and ultimately improve patient safety by eliminating medication errors entirely. West Park Hospital met with over 25 different vendors but couldn’t find one system that would meet all these requirements. AUTROS Healthcare Solutions was the only vendor willing to work with West Park Hospital to create a whole new vision for medication management.

The objectives were to: (1) Improve the quality of patient care while reducing overall costs, (2) Eliminate medication errors and increase patient safety, (3) Provide caregivers with the decision support tools necessary for therapeutic cost-effective prescribing, (4) Provide a real-time link between physicians, nursing, pharmacy and materials management—caregiver connectivity, (5) Control costs, (6) Eliminate paperwork, (7) Improve quality of record keeping, (8) Improve inventory management—Just-in-time inventory, (9) Implement a system that is easy to use, modular and can interface with other systems.

The results indicated that West Park Hospital was able to meet the safety recommendations made in 1995 by a special panel created by the American Society of Hospital Pharmacists, the American Medical Association and the American Nurses’ Association that outlined the actions needed to prevent adverse drug reactions in hospitals. The panel’s top recommendation was the establishment of a process in which medication orders are entered directly into computer systems. The panel also recommended bar coding, and the development of a better system for monitoring and reporting adverse drug reactions. A Point of care medication management system meets all the recommendations of this expert panel.

Reengineering the Medication Management process brought benefits to the entire caregiver team. Now Physicians can use the mobile terminals for computerized prescribing, they have instant access to patient records, medication history and adverse reactions. The changes have provided the physicians with a system that provides safety checks: drug allergy, duplicate therapy, interactions, dose check, plus diagnostic and hospital protocols information right at their fingertips to promote evidence-based care. Now Pharmacists instantly receive medication orders through Spread Spectrum Wireless LAN Technology real-time instead of batched, they have a system creates patient and medication bar codes automatically, automatically up-dates patient records and medication inventory for them, and provides immediate clinical pharmacy intervention. Now, Nurses have mobile medication carts that store medications in locked drawers, they use scanners on mobile terminals to read medication and patient bar codes, scan the bar coded MAR and the system opens the appropriate medication drawer in the cart and indicates which bin the correct medication is in. The system provides them with an electronic Medical Administration Record (MAR) that is automatically updated after the patient receives medications, thus there is no more paperwork when they finish their rounds. Nurses can also send messages, questions and information directly to the pharmacy through PC terminals or the mobile terminals, and have on-line access to safety features, such as pulse checks and overdose tracking, timely missed medication tracking, and they are user definable. Finally, Lab Technicians use the Palm handheld devices to access lab orders in real-time, enabling them to barcode the sample containers, ensuring that they have the right sample for the right patient.

BENEFITS OF REAL-TIME INFORMATION AND WORKFLOW AND EVENT MANAGEMENT

Outcomes-Based Management

Although a ‘buzz’ phrase in today’s healthcare environment, the impact of outcomes-based management to healthcare organizations should not be overlooked. Compliance of caregivers to hospital standards has continually been an issue facing hospital administrators. Hospital pharmacy and therapeutics committees spend valuable time deciding hospital policies, procedures and standards of practice; however, it is generally commented that little regard is given to such definitions. Hospital systems, until now, have been unable to adequately provide clinicians with these standards of practice at the point of care. Furthermore, historically, there has been no auditing of the quality and cost of care provided. A Point of care medication management system has the ability to offer clinicians hospital standards for

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ordering at the point of care, as well as outcomes-based management of patients with its outcomes-based management component, providing administrators with insight into clinician compliance, as well as the decision support tools necessary to reassess standards of practice.

The substantial costs of the preventable medication errors resulting in adverse medication events (AME) justify investment in automated medication management systems, which link electronic medication ordering, dispensing and administration.

Inventory Management
Inventory control in hospitals continues to be a major issue due to its significant financial impact on the hospital’s bottom line. The role of hospital personnel as inventory managers should switch to one of care providers. Truly automated preparation and dispensing systems should be capable of decrementing inventory at the point of care and automatically re-ordering stock based on usage. Furthermore, drug costs are rising and therefore, a system that encourages just-in-time inventory, along with major divergence reductions and minimum wastage of medication and supplies, is ideal. The last concern of medication management with respect to inventory control relates to billing and revenue capture. An on-going issue for hospital personnel is the time required for bill reconciliation. Processes are usually tedious and require extensive documentation and any inaccuracies result in rework.

Workflow Management
Improvement of efficiency and attainment of higher productivity levels are typical goals of healthcare organizations. Due to size, structure and systems in place, hospitals are constantly attempting to balance the productivity scale. Reengineering of the medication management process from the typical 42-step process to a simpler workflow is required (Appendix D). An enterprise’s first goal should be patient safety. Second is the organization of the medication management process to minimize the time a patient goes without their prescribed medication. Its third goal is to reduce the cost of medication administration.

A hospital information system should be capable of organizing priorities, aiding in decision-making through provision of useful information, and coordinating roles and responsibilities of caregivers. The results are availability of information, increased productivity and care team connectivity—all of which ultimately lead to enhanced patient care. Supply chain functionality can save healthcare enterprises 10% to 40% of their medication logistics costs. Point of Care Medication Management organizes a caregiver’s most immediate concerns relating to patient care, provides task-oriented alert messaging to caregivers regarding patient care and encourages fail-safe techniques for medication administration, which includes pre-medication administration checks, and assurances of the 5 rights of clinical practice.

CONCLUSION
Up until now, the industry has only had access to silo-based products. These systems for traditional pharmacy and materials management only dealt with list cost (acquisition) and fulfillment cost (distribution). The technology was only supporting this and not the true logistics costs, the administering costs, the cost to the patient and the safety issues. The technology did not deal with case costing so there was no way of accounting for materials at the point of care. In order for verification of receipt caregivers had to go through a multi step process. However, with the AUTROS Point of care medication management system, the process is reengineered by driving the process off the scan at the point of care. The scan drives replenishment, case costing and payables. The same scanner also does the receiving into the medication or supply storage unit onto the floor where the medication is to be administered. A Point of care medication management system does address these issues by reducing the cost of processing and receiving, improving quality control at a lower cost and increasing patient safety by delivery the 5 rights of clinical practice and reducing the average length of patient stay. In addition, a Point of care medication management system provides powerful decision support for clinical people and powerful management support for management by delivering a real-time information system versus a one-off analysis system. Finally, reengineering medication management at the bedside using bar-coding and wireless technology that is Internet and intranet enabled provides caregivers with information whenever they need it.

AUTHOR BIOGRAPHY
Eric Paul, PHARM D., President of AUTROS Healthcare Solutions, has been the chief strategist in developing the AUTROS Point of Care Medication Management and Pharmacy System and examining the processes of medication management and logistics systems.