Optimizing Medication Safety:

At King Abdullah Medical City advanced technologies help improve safety, security and control of N&C medications

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Summary

At King Abdullah Medical City (KAMC) patient safety is the highest priority. The use of narcotics and controlled (N&C) medications to manage pain is essential to the treatment of acutely ill or post-surgical patients. However, inappropriate use of these agents can lead to respiratory depression and even death. Moreover, N&C medications often are diverted by unauthorized users for resale or recreational use. To help ensure their appropriate use, KAMC analyzed its entire medication use process and identified many manual tasks that could be automated and optimized by integrating medication safety technology with the hospital information system (HIS).

This article includes information on KAMC's decision to improve N&C medication management and why KAMC has selected Pyxis™ technologies, including the Pyxis MedStation™ system with advanced automated dispensing cabinets (ADCs) and the Pyxis C^{II}Safe™ system for storing, tracking and documenting controlled drugs. Best practices with regard to technology use and initial results of the implementation and integration of the Pyxis technologies throughout the facility are described.

King Abdullah Medical City in Saudi Arabia is a 1500-bed, non-profit, healthcare organization dedicated to providing the highest-quality patient care, education and research in a safe, harmonious, healing environment. The 550-bed KAMC hospital located in The Holy Capital of Makkah provides oncology, hematology, neurology, cardiac and critical care services, as well as a catheterization laboratory and specialized surgery centers. Through excellence and innovation, KAMC promotes a culture that inspires both clinical and non-clinical staff to the highest levels of collaboration and learning. By creating a comprehensive healthcare model that can be emulated regionally and internationally, KAMC is working to help others also attain the highest possible levels of patient care, education and research.

Introduction

KAMC considered various technologies with regard to their capabilities to meet the following goals: minimize medication errors and enhance the security and control of N&C medications, while simultaneously improving productivity and documenting compliance with regulations that require a hospital to be able to account for all controlled substances at all times. Based on staff evaluations and the positive experiences of many healthcare facilities in the Kingdom of Saudi Arabia (KSA), KAMC selected the Pyxis medication safety technologies from BD as the most appropriate solution.

BD

Need for Improved N&C Medication Management

Before Pyxis Implementation

Before Pyxis, each stage of N&C medication use involved numerous time-consuming, error-prone, manual tasks (*Figure 1A*). On nursing units N&C medications were stored in locked cabinets that were opened manually using two keys. To meet regulatory requirements and help prevent diversion, on every care unit the charge nurse had to count and manually record the N&C cabinet drug inventory in specific books at the beginning and end of every shift. A second nurse had to witness the inventory and co-sign the documentation.

Before an N&C drug could be removed from the cabinet, a nurse reviewed the physician's order. A nurse manually recorded every drug removal and the updated inventory in specific books, and then time of administration and any drug wasting in the patient's chart. A second nurse was required to witness the transactions and co-sign the documentation.

At the end of each shift the charge nurse counted the remaining inventory, requested the N&C medications needed to refill the cabinet, and noted any discrepancies, which had to be resolved. Again, every step was manually documented, witnessed and co-signed. Empty or partially empty ampoules of N&C medications had to be returned to pharmacy before they could be replaced on the nursing unit. Pharmacy used three different regulatory books to document, witness and co-sign every step.
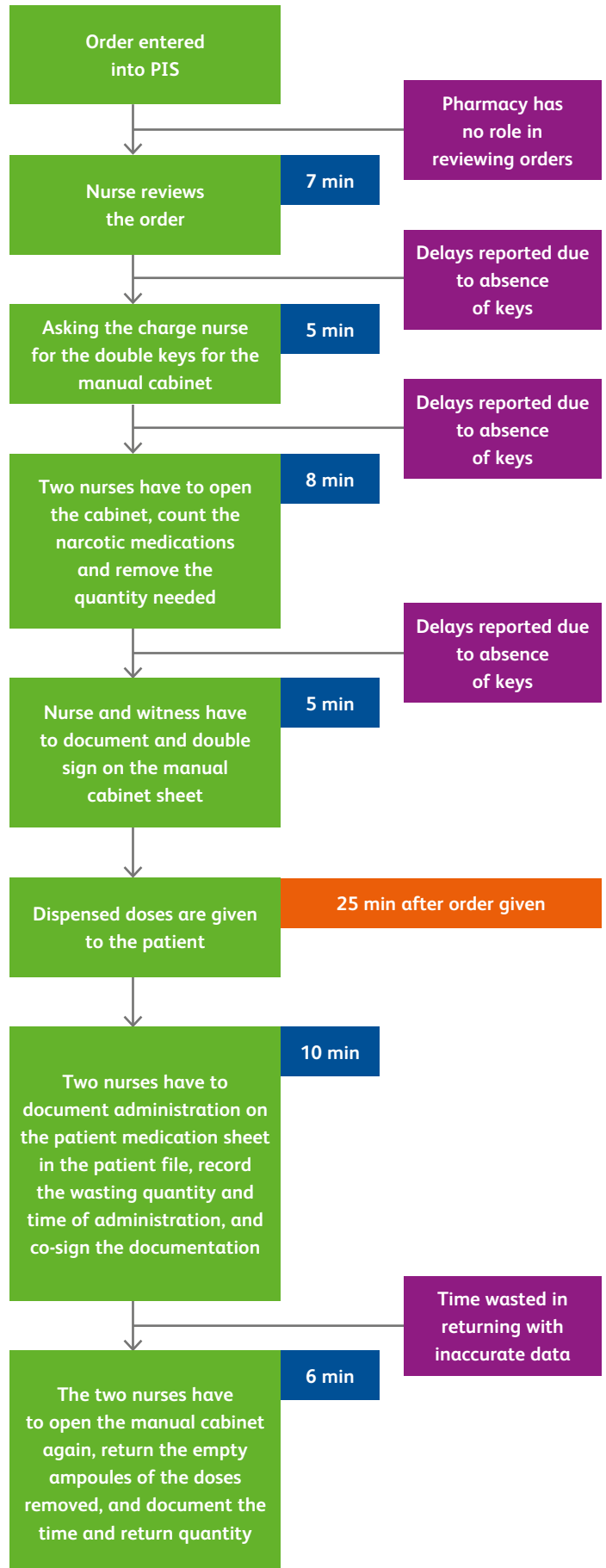
Disadvantages

KAMC recognized that this approach to managing N&C medications presented many challenges that needed to be addressed.

Medication safety

The physician's order was not reviewed by pharmacy. N&C cabinets on the care units were not linked to the Pharmacy Information System (PIS), so pharmacy had no way to check that patients received the correct medication, dose, frequency, and route that the physician had prescribed. Pharmacy also had no way to monitor expired medications. Manual documentation

Figure 1A.
Before Pyxis

Step	Time	Note
Order entered into PIS		Pharmacy has no role in reviewing orders
Nurse reviews the order	7 min	Delays reported due to absence of keys
Asking the charge nurse for the double keys for the manual cabinet	5 min	Delays reported due to absence of keys
Two nurses have to open the cabinet, count the narcotic medications and remove the quantity needed	8 min	Delays reported due to absence of keys
Nurse and witness have to document and double sign on the manual cabinet sheet	5 min	
Dispensed doses are given to the patient	25 min after order given	
Two nurses have to document administration on the patient medication sheet in the patient file, record the wasting quantity and time of administration, and co-sign the documentation	10 min	
The two nurses have to open the manual cabinet again, return the empty ampoules of the doses removed, and document the time and return quantity	6 min	Time wasted in returning with inaccurate data

increased opportunities for errors. By the time a nurse was free to manually record a transaction on the medication sheet in the file, he or she might not remember the time of administration or other data accurately. Frequent interruptions could also interfere with accurate, timely reporting.

Security

N&C cabinets on the nursing units did not automatically document transactions, so pharmacy had no way to monitor and control inventory stored on the units. Identifying and resolving inventory discrepancies and possible drug diversion involved difficult, complicated processes for nursing and pharmacy.

Productivity and Efficiency

Every N&C medication transaction involved multiple, time-consuming tasks *(double-checks, witnessing, manually documenting transactions in one to three books, documenting the removal of a medication from the N&C cabinet on one sheet and its administration to a patient on another).* Documenting N&C inventory at the start and stop of each shift and requesting replacements for empty ampoules required extensive work by the charge nurses. For direct-care nurses, documenting and witnessing N&C transactions many times per shift increased workload and reduced productivity and satisfaction. Searching for missing keys or a second nurse to witness and co-sign documentation could delay medication administration and negatively affect treatment, especially in urgent cases.
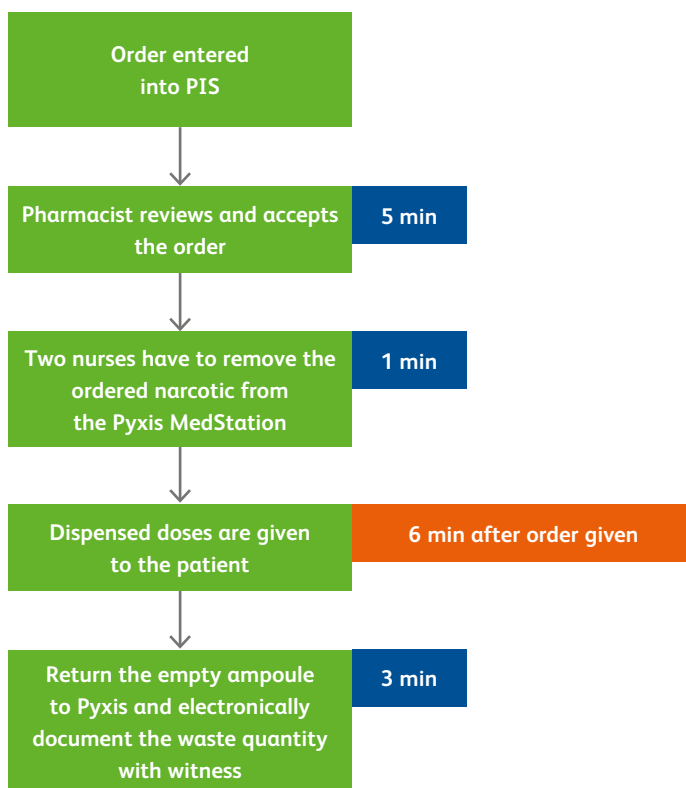
N&C Medication Management with Pyxis

To overcome these disadvantages and optimize N&C medication management, KAMC chose the the Pyxis solution from BD. This decision was based on the reputation for improving medication safety and availability that BD technologies had established in many other institutions in KSA and on the trust that developed as BD worked with KAMC during the development and selection process. KAMC installed Pyxis MedStation automated dispensing cabinets (ADCs) in 50 locations throughout the hospital, including all nursing wards, ambulatory center, emergency department, cardiovascular catheterization laboratory, and operating rooms. Pyxis C^{II}Safe system was installed in central pharmacy and linked to the MedStations hospital-wide, enabling pharmacy to manage N&C medications

more securely and accurately from central pharmacy to the point of use with a virtually paperless workflow *(Figure 2).*

Storage

**Figure 1B.
With Pyxis**

Order entered into PIS	
Pharmacist reviews and accepts the order	5 min
Two nurses have to remove the ordered narcotic from the Pyxis MedStation	1 min
Dispensed doses are given to the patient	6 min after order given
Return the empty ampoule to Pyxis and electronically document the waste quantity with witness	3 min

With all MedStations linked to the PIS, pharmacy can easily set roles and permissions for user accounts to help ensure that only authorized personnel can remove N&C medications. During replenishment, bar code scanning of unit-dose N&C medications helps ensure restocking accuracy. A variety of drawers accommodate different types of medications.

Removal

Integration of the MedStations with the PIS helps prevent medication errors and greatly reduces turn-around times. "Profiled" MedStations contain a list of ordered medications for each patient, providing a patient-centric user interface that bridges information in the PIS. The nurse does not have to go back and forth between different systems to view information, creating a more efficient workflow and helping to avoid errors. In addition, a clinician can select a drug only from the MedStation's patient-specific list and obtain a medication only after the physician's order has been verified by a pharmacist.

As soon as the order has been verified, a nurse can remove the ordered medication from a MedStation close to the point of use. The Pyxis system automatically records when a drug was removed, by whom, and whether any drug was wasted.

Replenishment

Using C^{II}Safe, pharmacy technicians can easily check MedStation inventories and print out a list of the medications needed to replenish N&C inventories to the minimum "par" levels for typical usage. A pharmacist double-checks the prepared medications, adding another layer of safety to help avoid errors. Pyxis C^{II}Safe system delivery sheets help ensure that technicians deliver the right medications to the correct MedStations. Policies, procedures, and staff training on proper operation of the ADCs help optimize workflow, productivity and the availability of the correct N&C medications in the MedStations.

Returns

After medication administration, a nurse places the clearly labeled empty ampoules in the external return bin. Unused or partially used ampoules documented during removal are placed in the MedStation internal bin.
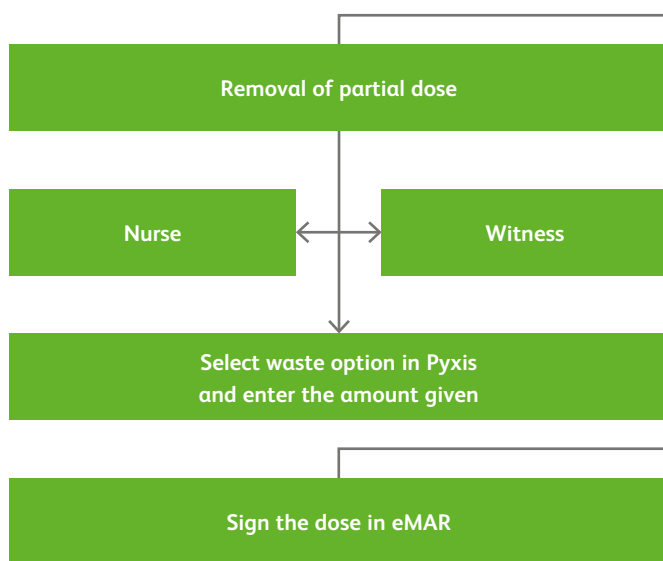
A pharmacy technician returns the empty ampoules from the external and internal bins. Excess inventory is placed back into pharmacy stock, once a pharmacist checks and verifies the returned medications. Bar code scanning automatically documents the return of medications to the central pharmacy Pyxis C^{II}Safe system cabinet. The data can easily be retrieved to document regulatory compliance.

Figure 2.
Nursing workflow

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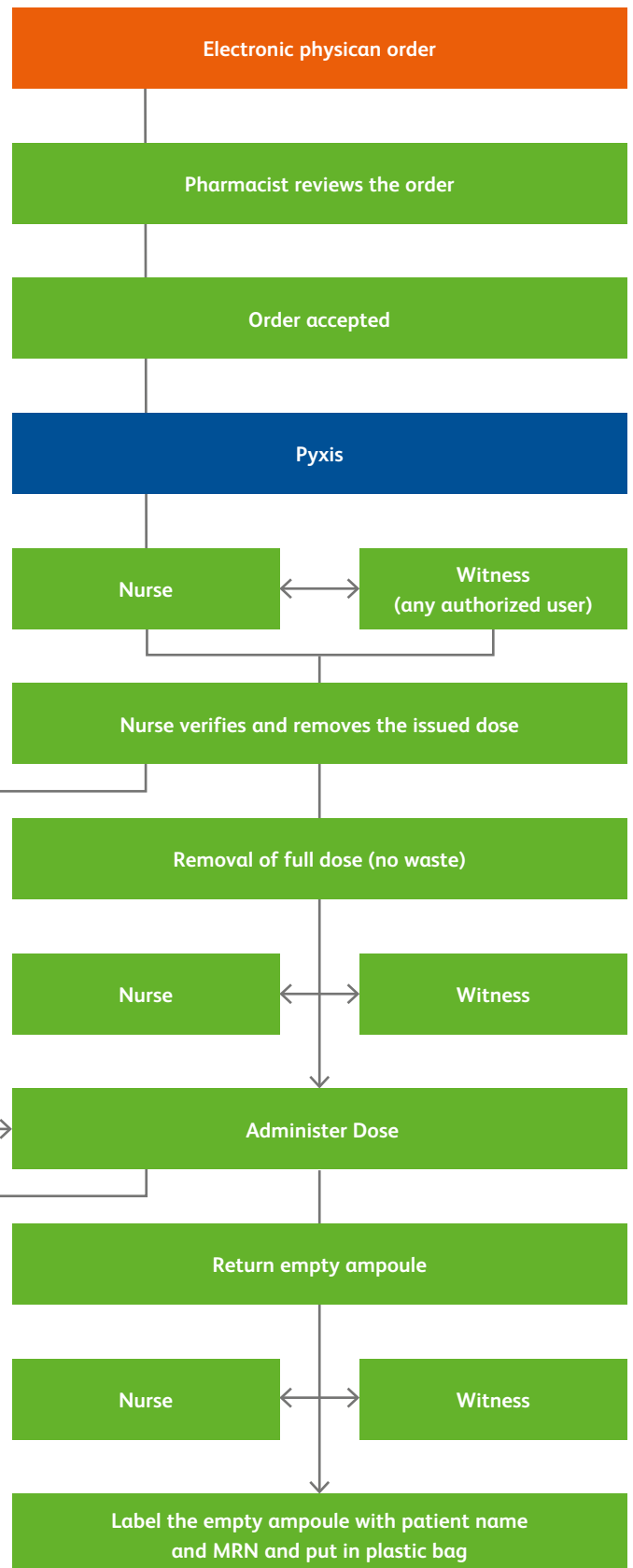
Results

Reduced turn-around times

Implementation of the Pyxis MedStation and Pyxis C^{II}Safe system (as shown in Figure 1A and 1B) has helped to optimize N&C medication management at KAMC:

- 38% reduction in the number of steps in the N&C medication workflow *(Figure 3)*.

- 76% reduction in the patient's nurse's time for N&C medication administration *(Figure 4)*.

- 86% reduction in the second nurse's time to witness N&C transactions *(Figure 5)*.

Figure 3.
N&C Medication Workflow: Pre- and Post-Pyxis Implementation

Before: 8 steps
After: **5 steps – 38%**
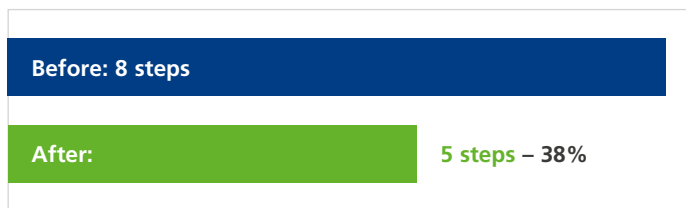
Figure 4.
Nursing Workflow for N&C Medications

Before: 25 min
After: **6 min – 76%**
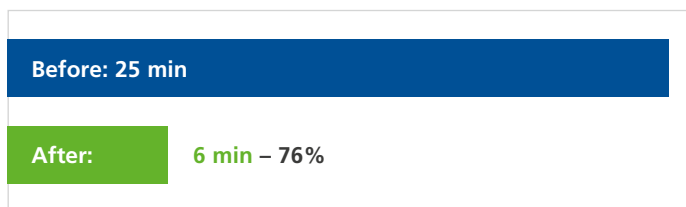
Figure 5.
Witnessing Nurse's Workflow for N&C Medications

Before: 16 min
After: **3 min – 86%**
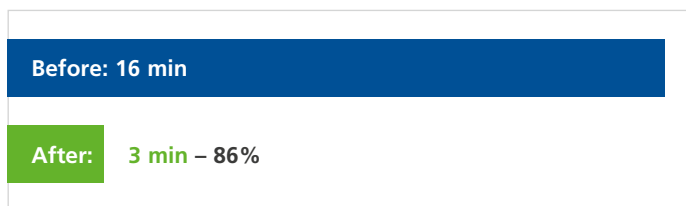
Benefits

Safety

The following changes help improve the safety of N&C medication use. With the MedStation system, a pharmacist now has to verify a physician's order before a medication can be prepared or dispensed. Technicians use Pyxis C^{II}Safe

system printed lists to know which medications to prepare and where they should be delivered. Patient names are clearly displayed on the MedStation to help ensure correct patient selection when a nurse removes a medication for administration, and a profiled MedStation only allows a nurse to remove a drug that is on the patient's approved medication list. Clinical data categories (CDCs) display medical safety information to help avert medication errors *(Tables 1A and 2B)*. Medication labels with specific patient-related details also help avoid medication errors, and notifications given during drug removal help avoid duplicate drug administration.

Table 1A.
Examples of MedStation Clinical Data Category Information

CDC	List name	Sample responses	Examples of use
Heparin	Has patient received Lovenox today?	If no, ADMINISTER If yes, CANCEL & CALL PHARMACY	Heparin to avoid excessive anticoagulation
High-alert medication	High-alert medication	Double check dose/math before administration	Insulin

Table 1B.
Examples of Clinical Data Category Settings in KAMC

Medication	Pyxis Setting 1	Pyxis Setting 2	Clinical Data List
Dextrose 50% Vial	Multiple	• Required. • Override only. • Type in allowed.	• Hyperkalemia Hyperglycemia • If other, please specify the condition
Magnesium sulfate injection	Single	• Required. • Override only.	• Magnesium sulfate by CICU protocol.
Potassium chloride injection	Single	• Required. • Override only.	• Acute correction of hypokalemia *(renal impairment)*
Morphine sulfate	Single	• Required.	• Double-check dose and strength

Security

Integrating Pyxis C^{II}Safe system and the Pyxis MedStations and having pharmacy do replenishment improve inventory control of N&C medications. N&C medications are now stored in the MedStations in separate, secure pockets, and the new systems allow pharmacy to control permission and rights for user access. Biometric fingerprint reader technology further enhances MedStation security.

Each medication transaction, including wasting and returns, is recorded accurately and time-stamped. Secondary witness is required and documented for all narcotic and controlled drug transactions. Administered and wasted doses are accurately documented.

More secure storage and accurate, complete documentation of all transactions help avoid the risk of missing or diverted N&C medications. Being able to compare detailed transaction reports with the physician order entered in the HIS helps improve pharmacy and nursing detection of wrong administration or possible diversion.

Quality of care

Nurses no longer need to wait for the charge nurse to bring the cabinet key and, instead, only need another nurse who has MedStation access privileges, saving time that can be particularly important in critical situations. The MedStation clearly displays times for medication administration, helping to ensure timely patient care. CDCs electronically displayed on the MedStation can be used to advise clinicians on proper use of N&C medications.

Continuous improvement/regulatory requirements

Staff can easily retrieve and work with electronically stored data to help meet regulatory requirements or identify opportunities for further improvement.

Resource optimization

Storing medications at the point of use helps reduce waiting, decrease time to initial dose (TTID), and enhance supply chain efficiencies. Maintaining inventory at pre-determined levels helps to avoid stock-outs and improve the reliability of medication availability. Proactive instead of reactive medication management helps optimize inventory, decrease costs and increase clinician satisfaction. Informative, detailed training and education of staff help to avoid system downtime.

Financial optimization

Using Pyxis MedStations also helps to reduce medication costs. With the previous cart-fill approach, blister-packs containing multiple pills or capsules were sent to the units. Now pharmacy sends unit doses to the MedStations, and a nurse retrieves only the quantity needed for medication administration. With integration and advanced technologies, the new system is easier for the logistics team to manage, helping to reduce labor and costs. Automating many previously manual processes improves ease of use for pharmacy to manage medications and for IT to manage the system, helping to reduce labor costs.

Improved employee satisfaction

The use of barcode scanning to verify medications improves the security, safety and storage of N&C medications and increases pharmacists' confidence that patients will receive medications as ordered. Preparing only the medications that are actually needed reduces the amount of pharmacist and technician labor and increases pharmacist time to focus on patient care. Pro-active replenishment has improved the reliable availability of medications at the point of use and reduced stock-outs and nurses' need to go to central pharmacy, thereby improving clinician satisfaction and time to focus on patient care.

"At KAMC the implementation of the Pyxis MedStation and Pyxis C^{II}Safe systems has helped optimize resources and reduced the need for nursing-pharmacy phone calls and possible miscommunication. We are justifiably proud of our practice, with streamlined paperless workflow, and greater accuracy and efficiency in managing N&C medications and meeting regulatory requirements—all the result of our having implemented Pyxis systems."

Pharmacist Mohammed Ali Al-Ghanmi,
Director of Pharmaceutical Care Department,
King Abdullah Medical City, KSA

Conclusion

At KAMC, Pyxis technologies from BD are
viewed as an integral part of advanced healthcare delivery.
By automating and optimizing previously error-prone
manual processes in N&C medication management, the
implementation and integration of the Pyxis MedStation and
Pyxis C^{II}Safe systems help minimize the possibility of N&C
medication errors, thereby improving patient safety, clinician
satisfaction and inventory management. More reliable, timely
availability of medications at the point of use helps improve
clinician satisfaction and allows pharmacy and nursing staff
to focus more of their attention on patients. In keeping with
the KAMC dedication to excellence and innovation, the use of
Pyxis medication technologies helps clinicians and other staff
maintain best practices and provide the highest quality care.

"The implementation of the Pyxis systems
to help optimize dispensing and inventory
control of N&C medication at KAMC is all
part of meeting our ultimate goal: patient
safety. We now have complete confidence
that the N&C medications we dispense
every day go to the right patient, right dose
with the right instructions at the right time
in a shorter period of time, and that every
transaction is automatically documented
electronically, helping to ensure accuracy
and prevent diversion. Automating N&C
medication management has freed our
staff from error-prone manual processes to
devote more of their time and attention to
clinical interventions and quality of care."

Pharmacist Tariq Saad Tamim,
Supervisor of Pharmacy Automation & Informatics Unit
Pharmaceutical Care Department,
King Abdullah Medical City, KSA
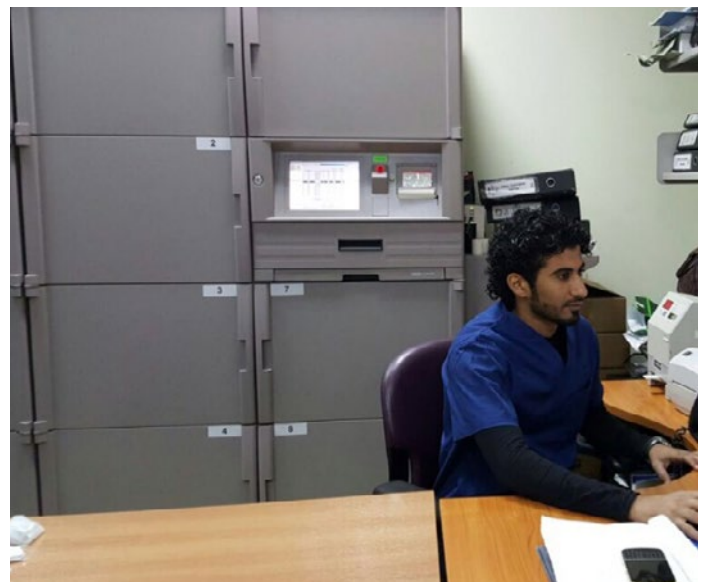
Pyxis components implemented at KAMC hospital

Pyxis MedStation system is an automated dispensing system that integrates with central pharmacy systems to help decrease the time to initial dose (TTID) and improve medication availability, safety, staff productivity, charge capture, and documentation accuracy.

Pyxis C^{II}Safe system enhances the value of the MedStation system by storing, tracking and monitoring narcotic and controlled (N&C) medication inventory hospital-wide. Streamlining documentation from the pharmacy to the nursing floor virtually eliminates time-consuming and error-prone manual recordkeeping and makes it easier to quickly spot discrepancies or signs of diversion.