

Medication Safety and Quality of Care:

King Faisal Specialist Hospital & Research Centre in Jeddah opens a new era in medication management with the Pyxis Enterprise Solution from BD.

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Summary

Continuously improving patient safety and quality of care are critical goals for any health care organization. The use of advanced technology is essential to achieving these goals. In 2015 King Faisal Specialist Hospital and Research Center in Riyadh and Jeddah implemented the Pyxis™ Enterprise Solution (ES) from BD to help transform their medication management process. The advanced capabilities of Pyxis ES enable it to communicate with the Cerner Millennium® electronic medical record (EMR), helping to simplify medication administration and provide nurses and pharmacists with the information they need to optimize medication safety, clinical workflow and quality of care.

This article presents information on the need for improved medication management, the Pyxis ES technologies, implementation and initial results, to help pave the way for other hospitals and health systems to benefit from the use of advanced medication management technologies.

Introduction

King Faisal Specialist Hospital & Research Centre (KFSH&RC) in Jeddah, KSA, is one of the leading medical institutions in the Middle East, known for its state-of-the-art medical technologies and techniques. KFSH&RC has received accreditation by various international bodies, including Joint Commission International Accreditation (JCIA) and has been awarded Magnet designation, the ultimate credential for high quality nursing worldwide. Implementing the most advanced technologies is a reflection of the KFSH&RC mission and vision—to provide the highest level of specialized healthcare as a world-leading institution of excellence and innovation.

KFSH&RC-Jeddah is a 350-bed tertiary care hospital with seven operating rooms and 7 intensive care units. To address organizational goals (Table 1) and better serve pharmacists, nurses, anesthetists, information technologists, administrators and, most of all, patients, KFSH&RC-Jeddah has implemented multiple Pyxis ES system components (Sidebar, last page) throughout its facility in patient-care units, operating theatres and the emergency department.



“We decided to implement Pyxis technologies in our hospital based on the previous positive experiences encountered with Pyxis in many health care facilities in Saudi Arabia. We expect the system to improve the overall medication process workflow in inpatient areas, improve the quality of patient care, and enhance the control and security of narcotics and controlled (N&C) medications.”

Mr. Tarek Hassan El Kady,
Specialist Pharmacy Automation and Support Services,
KFSH&RC-Jeddah

Table 1.

Organizational goals driving use of automation
Patient safety
Patient care
Patient satisfaction
Quality
Operational efficiency
Cost reduction
Charge capture
Regulatory compliance

Need for Improved Medication Management

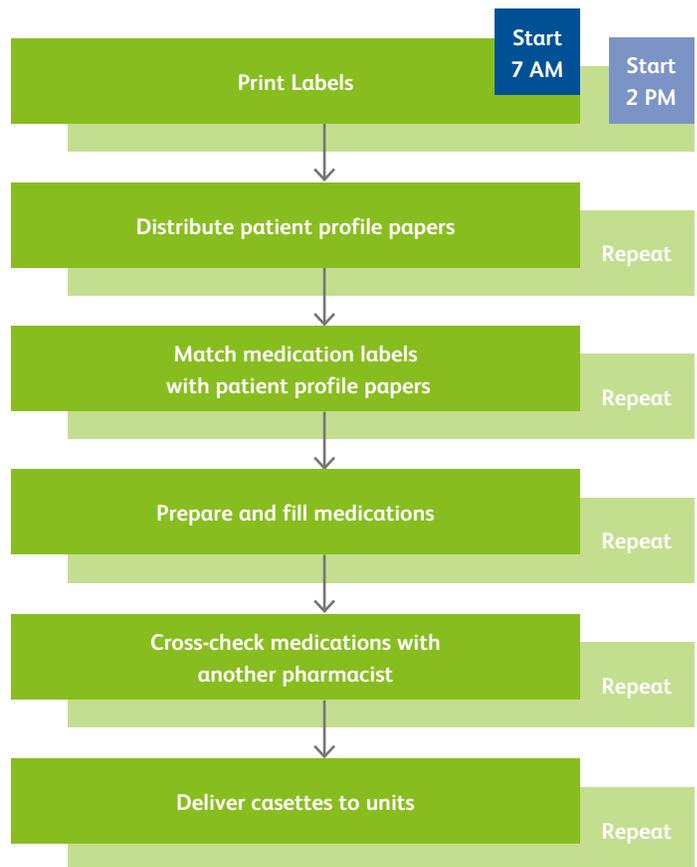
The rapid initiation and continuation of medication therapy as ordered are critical to providing advanced medical care. Pharmacists and nurses need streamlined processes in which medications are accurately prepared, delivered, and readily available when needed in a single location as close to the patient as possible. At KFSH&RC-Jeddah, changing from the previous cart-fill approach to the Pyxis ES systems has transformed the medication management process enterprise-wide.

Cart-fill

Before the implementation of Pyxis ES, pharmacy distributed all medications by filling patient-specific cassettes with a 24-hour supply of unit-dose medications that were delivered to the nursing unit in medication cabinets or carts. Preparing, checking and delivering the cassettes was an error-prone, time-consuming, six-step process that required the manual completion of many critical tasks and twice-a-day replenishment (Figure 1).

Figure 1.

Cart-fill: Twice-a-day replenishment



After physicians’ orders were received and verified by a pharmacist, technicians used computerized lists to prepare medications to fill the cassettes. Every cassette had to be checked by a pharmacist before being delivered to a care unit. Every morning patient profiles were printed for cassette refill. Every afternoon an updated list was printed to cover new orders for medications to be administered that evening.

Some medications were available in the care units as open floor stock, which nurses refilled by requesting the

necessary quantities from pharmacy on a daily basis. Missing doses had to be obtained from the pharmacy separately—a time-consuming process that could lead to pharmacist, nurse and patient dissatisfaction.

High-risk N&C medications were stored in a cabinet in the medication room with access restricted to in-charge nurses. Any removal or wasting of N&C medications had to be manually documented by one nurse and witnessed by a second. At each shift change the charge nurse had to document inventory and request refills of N&C medications. Identifying, documenting and resolving discrepancies and possible drug diversion were difficult and time-consuming processes.

Although still widely used, the cart-fill system is labor-intensive and results in first-dose delays, missing doses, drug hoarding, 'work-arounds,' billing inaccuracies, and inordinate amounts of time spent crediting unused doses.³ Table 2 summarizes the significant disadvantages of the cart-fill system compared to automated dispensing cabinets (ADCs).² The need to improve medication management was clear. The challenge was to select the best technology from among the wide variety of automation technologies available, all with similar functionalities for supporting medication management.

Table 2.
Cart-fill vs. ADC²

	Unit-dose Cart	ADC – Profile Mode
Organization	By patient in open bins	By drug in controlled-access cabinets
Accuracy	At time of dispensing	Always
Discontinued orders	Doses still available	Doses NOT available
Borrowing	All doses available	Secure pockets with limited access
Pharmacist review	Bypass opportunities	Required
Diversion tracking	Poor	Excellent

Technology Criteria

To help select technology that would best meet the high standards of the hospital's vision for improving medication safety and management, KFSH-Jeddah developed the following criteria:

Select a medication safety automation technology / vendor for:

Enterprise-wide integration

- Provide enterprise-wide functionalities across multiple facilities.
- Provide capabilities for achieving the highest levels of interoperability between medication management systems and the EMR.
- Provide an easy-to-use process for establishing strict security criteria for user access.
- Provide different operational modes for ADC use such as patient order (profile mode) or emergency (non-profile mode) setting.
- Support implementation and compliance with KFSH&RC policies and procedures.
- Meet all regulatory requirements for managing N&C medications.

Safe, secure storage and dispensing

- Provide high-level storage capacity, medication security and single-item access.
- Provide multiple checks during dispensing.
- Automatically document every medication transaction.
- Incorporate bar code scanning in restocking, dispensing, returning items to and removing items from ADCs.
- Provide a system of alerts to flag high-alert and other critical medications.
- Use at least two unique identifiers to identify a patient.
- Provide additional protections such as highlighting last names to help ensure correct patient selection.
- Use a system of electronic clinical data categories to display information for clinicians.

Data management and reporting

- Provide an easy-to-use method to track batch numbers, expiry dates or other identifiers, if needed.
- Provide easy-to-use analytical reporting tools to support the hospital core measurements and help the pharmacists manage N&C medications.
- Provide an easy-to-use method to maintain accurate records of patient visits.

For training and education

- Provide easily accessed, continuously updated training tools for staff.
- Provide easy-to-follow down-time and back-up procedures.

Technology Selection

Extensive consultations between BD and KFSH-Jeddah led to the selection of Pyxis ES as the best solution to meet the hospital's needs, and clarified which components to implement and when.

Implementation

KFSH-Jeddah, BD and Cerner used guidelines from the Institute for Safe Medication Practices (ISMP), the American Society of Health-System Pharmacists (Table 3), and worked together through all phases of the implementation.

Pyxis ES Project Phases

Table 3. Implementation guidelines

The Institute for Safe Medication Practices (ISMP), the American Society of Health-System Pharmacists (AHSP), and BD guidelines were followed to help ensure the following core processes were accomplished:

- Create ideal environmental conditions for ADC use.
- Guarantee ADC system security.
- Use pharmacy-profiled ADCs.
- Display appropriate information on the ADC screen.
- Establish and maintain proper ADC inventory.
- Configure ADCs appropriately.
- Establish safe ADC restocking processes.
- Establish procedures to ensure the accurate withdrawal of medications from the ADC.
- Establish criteria for ADC system overrides.
- Standardize processes for transporting medications from the ADC to the patient's bedside.
- Establish procedures for wasting medications and returning unused and empty ampoules.
- Provide materials and methods to educate staff and validate competency on ADC use.

Planning:

Hospital and vendors developed a detailed plan and timeline for managing every step of the hospital-wide implementation. Implementation teams included pharmacists, nurses, clinical education specialists, clinical applications/information technology (IT) analysts and biomedical staff from KFSH&RC-Jeddah, Cerner and BD. The project team conducted extensive location visits and meetings to collect the necessary documents and decision-support data to help ensure a successful implementation.

Preparation:

Pharmacists, in conjunction with the pharmacy and therapeutics (P&T) committee, developed a standardized formulary and aligned the EMR and Pyxis ES datasets. Pyxis ES MedStations and Anesthesia ES stations were configured for optimal use in each patient care area. Based on information obtained during planning, par levels were established for each ADC, i.e., the minimum quantity needed for each drug, which would be automatically reordered to prevent stock from falling below that level. User accounts were established in the hospital's Active Directory, with roles and permissions set by pharmacy. Extensive testing validated all parts of the systems. Video and eLearning materials took nurses through the process of using the MedStations. Hands-on experience was used in a "train the trainer" approach for clinical educators, unit super users, and patient-care managers and supervisors.

Implementation:

Prior to Go-live, each MedStation ES was stocked with the pre-determined par levels. Go-live was conducted according to the timeline. KFSH&RC-Jeddah pharmacy system managers and BD consultants provided support and additional training as needed during and after Go-live.

• 31 Pyxis MedStations ES systems:

To automate medication management enterprise-wide, between December 1, 2013, and March 20, 2014, one MedStation was installed on each of 31 units. On average, one MedStation was installed every 3.5 days.

• 10 Pyxis Anesthesia ES systems:

To improve medication management in specialty care areas, between June 8 and June 20, 2014, one Anesthesia ES station was installed in each of 7 operating rooms, a recovery unit, labor and delivery unit, and the catheterization laboratory. On average, one Anesthesia ES station was installed every 2.2 days.

- Pyxis PARx system:**
Implementation of the PARx system began in January 2014 and Go-live took place in May 2014. PARx uses bar code technology to track medication handling, review and delivery. This helps simplify pharmacy workflow and ensure that the right medication gets to the right pocket in the right MedStation ES. The system also helps staff catch medication errors at one of the earliest points of occurrence, in the pharmacy.
- Pyxis C¹Safe system:**
Implementation of the C¹Safe system began in August 2014, with partial Go-live in March 2015. The integration of the C¹Safe in central pharmacy with the MedStation ES system helps provide seamless, safe and secure management of N&C medications hospital-wide and ensures that clinicians have convenient, yet secure access to controlled substances.
- Pyxis ES Link**
Implementation of the Pyxis ES Link began in April 2014, with Go-live in May. This innovative system helps streamline the medication administration process, save nursing time and improve patient care. With ES Link nurses can easily access clinical information, remotely queue medications, document waste, and devote more time and attention to patient care.
- Knowledge Portal for Pyxis medication technologies**
The Pyxis Knowledge Portal, an intuitive, web-based application installed in April 2014, leverages data from the Pyxis ES systems to manage stockouts, drug shortages, user compliance, and station benchmarks for inventory optimization.

Results

More efficient replenishment

Pyxis ES technologies changed replenishment from twice per day to once per day, and reduced the number of steps from 12 to 6 (50%) (Figures 1–3).

Figure 2 .

Pyxis ES and PARx: Once-a-day replenishment

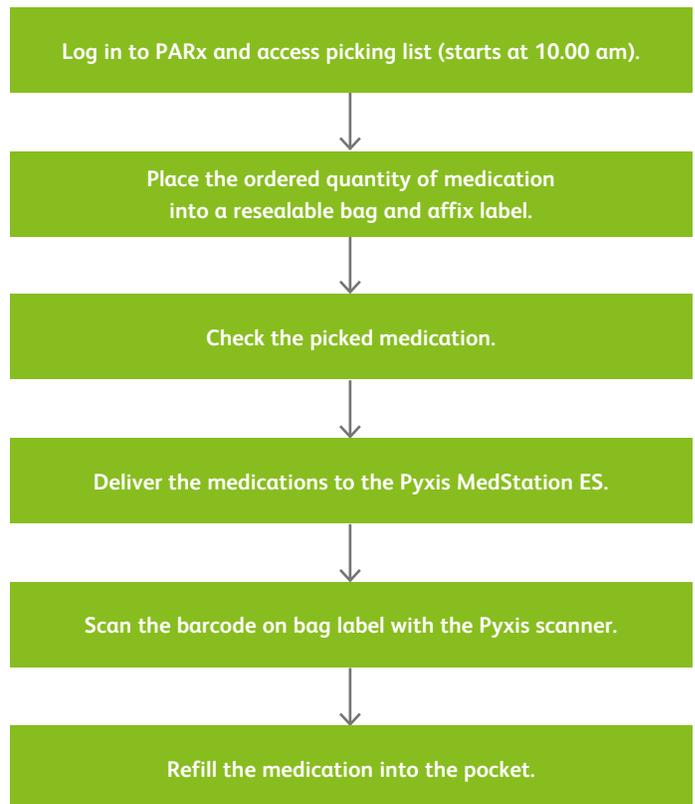
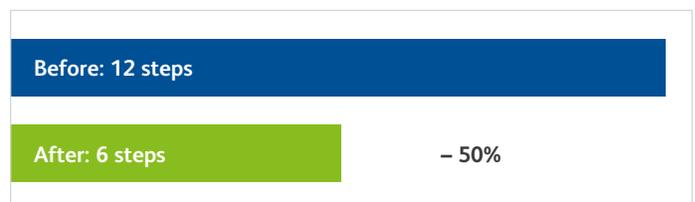


Figure 3.



Reduced turn-around times

Implementation of Pyxis MedStations ES eliminated three of the six steps in the previous workflow. This made it possible for a nurse to remove a medication from a profiled MedStation ES on a care unit almost immediately after a pharmacist verified the order, reducing medication turn-around time by almost 60% (Figures 4 and 5).

Figure 4.
Cart-fill vs. Pyxis ES Workflow

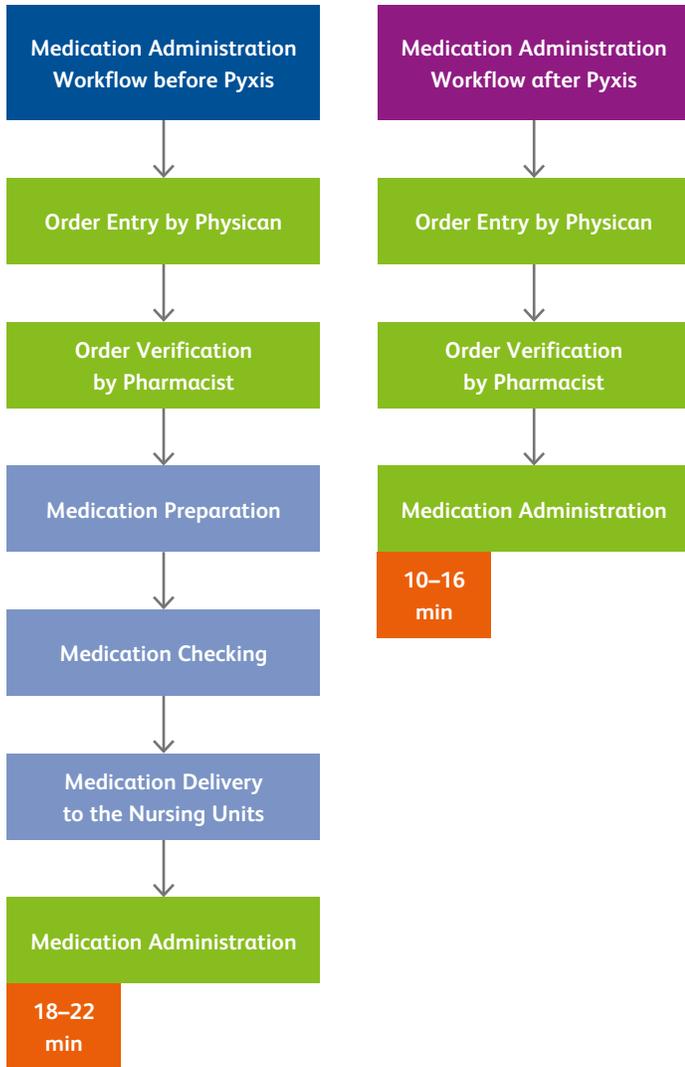
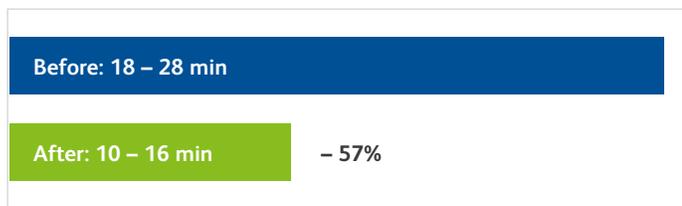


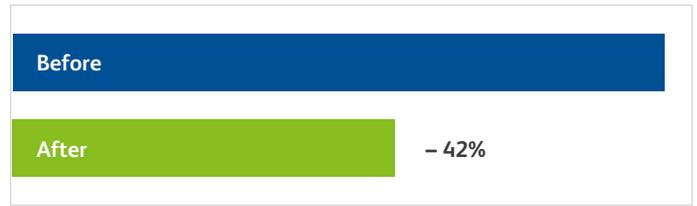
Figure 5.
Pyxis ES Impact on Average Turn-around Time



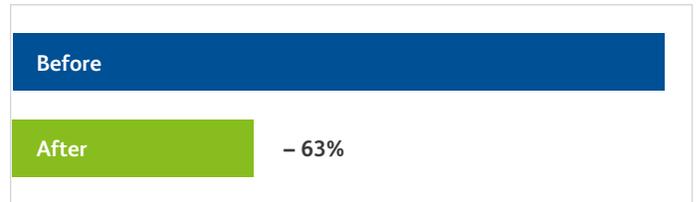
Improved medication management and safety

Data from 2013 (before Pyxis ES implementation) and 2014 (after Pyxis implementation) were collected electronically from KFSH-Jeddah systems. Comparison of before and after data showed that Pyxis ES implementation greatly decreased medication errors, delays in delivery of medications, and medications delivered to the wrong location (Figure 6).

Figure 6. Pyxis ES Impact on Replenishment
Dispensed Wrong Medication



Delayed Delivery of Medication



Dispensed Wrong Location



Benefits

In addition to the quantitative results given above, the implementation of Pyxis ES has improved clinical care in many ways.

“Medications are appropriately and securely stored in Pyxis MedStations ES based on established standards, and inventory control on nursing units is certainly enhanced.”

Dr. Mohammad Elfaour,
Head of Pharmaceutical Care Division, KFSH&RC-Jeddah

Reliable medication availability

Reliable availability of medication for timely administration to the patient has helped improve clinicians’ satisfaction and perceived quality of care. This is particularly true in critical situations when a medication is needed urgently.

Authorized access anywhere, anytime

Demands on pharmacy staff are never-ending: add formulary items, investigate missing doses, address non-formulary prescribing, add passwords for new hires, follow up on stock-outs, and more. With the Pyxis ES server, authorized staff can make such changes from any hospital computer or browser with no limit to the number of users who can be on the system at any one time. If a technician needs to reconfigure a Pyxis MedStation ES, s/he can log in at the closest network workstation and make the change in minutes, without having to go back to pharmacy, lose time, disrupt workflow or possibly forget. Accurate, more reliable medication availability improves nursing satisfaction, as well.

Simplified formulary management

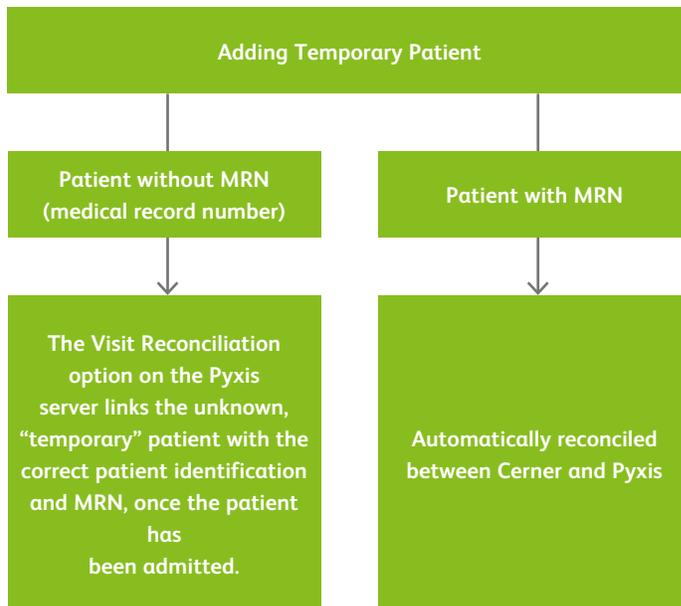
Integration between the Pyxis ES Server and the EMR results in one formulary synchronized for the entire enterprise, which can be customized or revised as needed. For example, a drug shortage can mean that routine medications are not available, so pharmacy has to substitute one formulary line item for another. Even small differences in the drug name can mean extensive work: discontinuing orders, unloading medications, changing the database, re-entering orders and loading pockets. Previously, making the necessary changes required extensive time and effort. With Pyxis ES, the pharmacist can go to any hospital computer, make a simple name edit, propagate the change to every part of the hospital, and be confident that the change has been made correctly in every part of the system.

Patient Visit Reconciliation

At KFSH&RC-Jeddah a primary objective is to maintain accurate patient records. A major advantage of the Pyxis technologies is apparent if there is a delay in receiving a patient's admission-discharge-transfer (ADT) information. This forces the nurse to create a temporary patient visit, in order to remove needed medications from the MedStation ES. After the patient is admitted, the dispensing system does not know that "temporary" and "admitted" are the same patient. The Pyxis reconciliation function consolidates the "temporary" transactions into the permanent patient file. Patient visit reconciliation can be used if a patient has multiple hospital visits with different transactions or if a patient needs to receive treatment before ADT information has been received (Figure 7).

Figure 7.

Patient Visit Reconciliation



Improved control of N&C medication use

Pharmacy technicians now use the Pyxis C¹¹Safe system in central pharmacy to easily monitor inventories of N&C medications throughout the hospital, and print a list of all medications needed to replenish inventories to minimum "par" levels. Medications prepared by a technician are bar code scanned and double-checked by a pharmacist to help avert medication errors and ensure on-time loading into the ADC.

A C¹¹Safe delivery sheet helps ensure accurate delivery of medications to the nursing units, and bar code scanning helps ensure accurate loading into the MedStation ES. Only an authorized nurse can remove an N&C medication, and then only the doses and medication for a specific patient, as ordered.

After replenishment, the technician returns empty ampoules from the external return bin and any unused, full ampoules from the internal bin. Upon their return to central pharmacy, the C¹¹Safe system automatically records the transaction for verification and documentation by the pharmacist in charge of N&C medications.

On care units, the MedStations ES alerts nursing to any discrepancy between the N&C medication count and the count expected by the system based on previous usage. The Pyxis ES systems enable pharmacists to resolve discrepancies almost immediately by running a number of reports and reviewing easily recognizable icons that highlight possible diversion.

Streamlined pharmacy workflow

Most commonly used medications, floor stock and all N&C medications are now loaded in MedStation ES systems. The pharmacy prepares medications needed for refill based on the pre-established “par” (minimum) levels for typical use, and technicians make scheduled deliveries using bar code technology to help ensure accurate loading. Par levels are regularly reviewed and updated, helping to ensure the availability of needed medications and minimizing the possibility of missing doses and stock-outs. Bar code scanning helps reduce the risk of medication errors on removal and during replenishment.

Streamlined anesthesia workflow

In surgical areas, when anesthesia providers require access to medication for a patient during a case, the Pyxis Anesthesia ES system enables them to select it right where they are in the Patient Case screen, without interrupting their workflow.

Patient-centered nursing workflow

Before Pyxis ES, a nurse would get a list of all the medications that had been ordered for a patient. But finding out when they were due required calling up that same patient’s electronic medication administration record (eMAR) on a hospital computer and cross-referencing the drugs in the medication cassette with the information on the eMAR—a time-consuming, potentially error-prone process. Now the Pyxis ES system provides a patient-centric user interface that bridges information in the PIS.

Needed medications and patient information are located in one place, helping save valuable nursing time. A medication is available for a specified patient almost immediately once a pharmacist verifies the physician’s order, greatly reducing the time to initial dose (TTID). The advanced biometric fingerprint reader on the MedStation ES reduces the time needed to log in. The “My Patients” list allows nurses to customize their screen with less time wasted scrolling through the patient list or searching for their patients during each medication administration. The “Due Now” feature shows when medications are due. Nurses no longer have to go back and forth to the eMAR. All the information is in one place, organized the same way as in the eMAR. Clinical data categories (CDCs) on the MedStations ES electronically display needed information for clinicians. Safety enhancements, such as clearly highlighting patients with the same last name, help make it easier to avoid potentially harmful medication errors and potential adverse

drug events. Innovative software provides warnings and reminders during medication removal and electronically documents waste and returns as part of the nursing workflow.

More clinician time to focus on patients

The time nurses previously spent following up with pharmacy can now be devoted to patient care. If a patient is in pain, a nurse can remove the “as needed” medication from the MedStation and administer the dose to the patient in minutes, improving the quality of care and increasing patient satisfaction. Pharmacists no longer have to check manually filled medication carts and first doses. They can assess the system from wherever their work takes them, enabling them to spend more time helping clinicians deliver the best and safest patient care. Fewer telephone calls from the units also means less stress and more time for pharmacists to focus on orders verification and patient-related tasks.

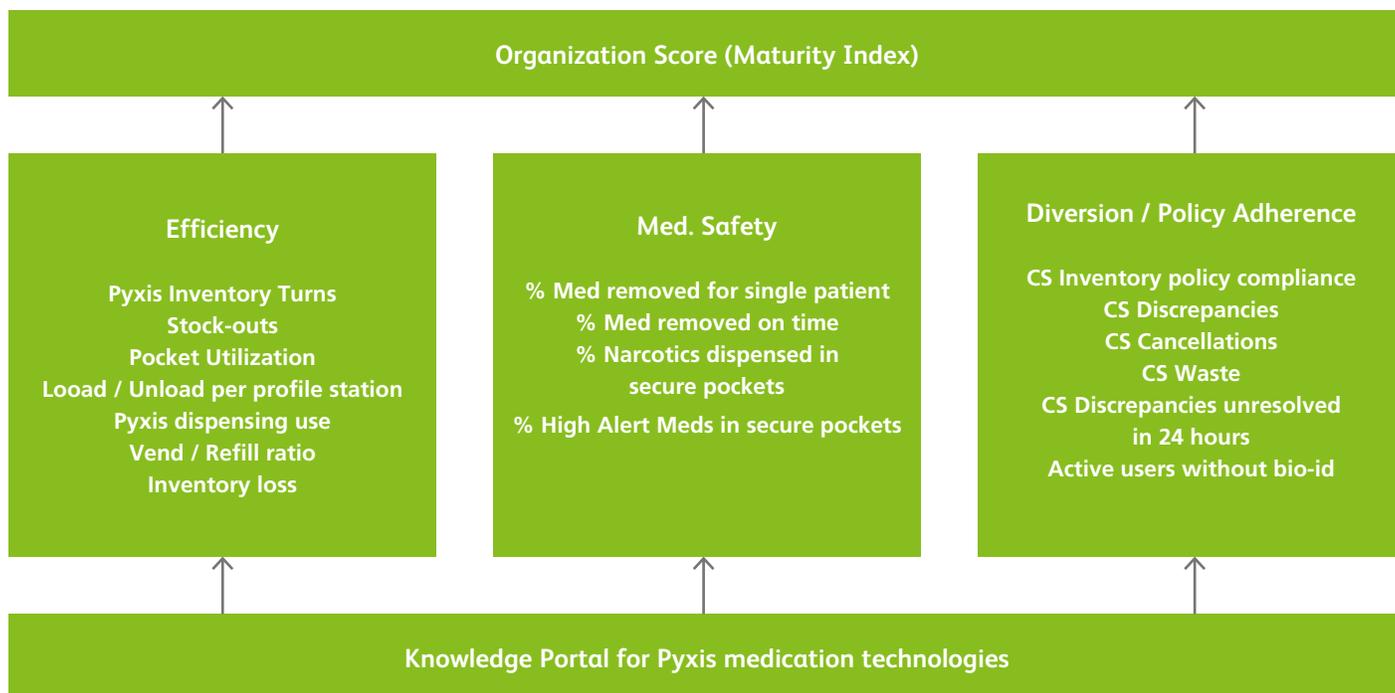
Optimized data-driven inventory

Using data and analytics from the Knowledge Portal for Pyxis medication technologies helps staff members identify challenges such as slow-moving medications and inventory turns. They can quickly identify medications due to expire, see what medications are not being used, and create space for those medications that are constantly being refilled. Inventory optimization can help staff work towards storing more medications in the Pyxis MedStation system and potentially realize significant cost savings.

Less system support required

The flexible deployment, greater security, back-up and domain capabilities of the Pyxis ES Solution meet key needs of the IT department. Built on the latest technologies and designed for increased uptime, Pyxis ES provides more options while requiring less IT support. System management is highly configurable. Roles can be defined at the hospital level and efficiently implemented and adjusted as needed, saving time and helping standardize processes. By integrating with the Active Directory, the Pyxis ES system enables IT to manage user access, so that pharmacy can focus on managing user privileges. The BD Coordination Engine, a software-based interface engine enabling centralized integration between Pyxis technologies and the hospital information system (HIS), allows the hospital to add functionality to the Pyxis system as needed or as opportunities arise.

Figure 8. Key performance indicators: Examples



Ongoing monitoring and enhancement

Pharmacists continue to use the Knowledge Portal for Pyxis medication technologies to monitor transactions at both the end-user and MedStation ES level to help track compliance and identify opportunities for improvement. The Knowledge Portal dashboard displays key performance indicators (KPIs) in categories such as cost, productivity, and diversion/compliance (Figure 8, Table 4). Within a particular category, staff can review individual KPIs such as “Controlled Substances Discrepancies” and “Resolution of Controlled Substances Discrepancies within 24 hours” to help identify possible diversion and opportunities for improvement. Customizable reports let staff benchmark individual care areas and monitor performance and compliance. “Days unused” reports help determine whether infrequently used drugs can be removed from a particular MedStation ES to make room for more frequently used medications.

Table 4.

Key Performance Indicators for Pyxis

Process	Measurement
Drug Distribution	<ul style="list-style-type: none"> Pyxis stock-out rate, Pyxis override rate, Pyxis actions performed for pharmacy (refills/loads/unloads)
Order Management	<ul style="list-style-type: none"> Orders reviewed (entered) per period, Order review (entry) turnaround time
Workload	<ul style="list-style-type: none"> Work force hours per worked unit of service, Ratio of staffed versus filled positions, Total 100 workload units

These and other benefits are summarized in Table 5.

Table 5.

Pyxis ES Benefits

- The Pyxis ES system is reliable and includes highly secure configuration options for customers.
- In the care units, almost all patient medications are in one location, close to patients and nurse stations.
- Staff is more confident that right medications will be available when needed and that the right dose will be dispensed for the right patient.
- STAT orders are available almost immediately, improving medication safety and care.
- Workflow is more centered on the patient and on performing best clinical practices.
- By streamlining workflows, Pyxis ES enables staff to focus more attention on clinical tasks.
- Nursing-pharmacy communication is more effective, with fewer disruptions or problems to be solved.
- N&C medications are easier to obtain, highly secured and accurately dispensed.
- Fewer expired and unused medications are stored in the MedStations ES, helping reduce costs.
- The use of bar code scanning in medication preparation, checking and refilling of the MedStations ES has streamlined workflow and reduced the possibility of medication errors.
- Highly configurable system management saves time and standardizes processes.
- The software-based interface engine enabling Pyxis ES-EMR integration allows the hospital to add functionality, devices and new technologies as needs arise.

Conclusion

The Pyxis ES platform provides simple, safe clinical workflows centered on the patient; minimizes disruptions, delays and risk of medication errors; leverages centralized configuration across the enterprise; and enables meaningful integration with the EMR. Pyxis ES technologies support centralized control of medication dispensing and provide clinicians with the data they need for immediate decision-making and actionable information for continuous improvement efforts, both of which are essential to providing the highest level of patient care and safety at KFSH&RC-Jeddah.

Implementation of multiple Pyxis ES components (Sidebar, last page) has eliminated many error-prone, manual processes and multiple steps in preparing, checking and delivering medications. Pharmacy staff can now complete medication fulfillment, verification and restocking more safely and efficiently. Bar code scanning of both medication and MedStation ES pocket helps ensure accuracy during replenishment. MedStation ES provides patient and medication information all in one place and helps ensure that a nurse removes the right medication, dose and strength for the right patient. Knowledge Portal analytics help identify opportunities for continuous improvement and generate standard reports that are very easy to run.

“Implementation of the Pyxis ES system has helped us revamp our inpatient medication distribution system. The feedback from stakeholders in Pharmaceutical Care and Nursing has been very positive.”

Dr. Mohammad Elfaour,
Head of Pharmaceutical Care Division,
KFSH&RC-Jeddah

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Table 6.

Pyxis ES components implemented at KFSH&RC-Jeddah

Pyxis ES Server - enables rapid, accurate, secure data sharing between the Pyxis ES System and the electronic medical record (EMR) and hospital information system (HIS).

Pyxis MedStation™ ES system – 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 Anesthesia ES system – provides secure, quick access and electronic documentation for medication and waste in surgical areas; automates charge and cost capture; and supports patient-centric workflow. When anesthesia providers require access to a medication for a patient during a case, they can select it right where they are in the Patient Case screen without interrupting their workflow.

Pyxis C¹Safe™ system - enhances the value of the MedStation ES system by storing, tracking and monitoring narcotic and controlled (N&C) medication inventory across the hospital, as well as compliance and possible diversion. Streamlining documentation from the pharmacy to the nursing floor virtually eliminates time-consuming and error-prone manual recordkeeping, helps ensure regulatory compliance, and makes it easier to quickly spot discrepancies or possible diversion.

Pyxis PARx™ system - uses bar code scanning to help monitor the pick-check-delivery process, verify that the right medication gets to the right location, create a closed-loop replenishment system, and avert medication errors.

Pyxis ES Link - allows nurses to remotely pre-select medications for removal from the MedStation ES system and document medication waste, using any computer station. Nurses can ask patients about “as needed” medications during patient assessments, helping ensure that patients promptly receive pain and anti-nausea medications.

Knowledge Portal for Pyxis medication technologies - allows staff to easily manage data from the Pyxis ES systems and quickly view, work with and report key metrics on medication use, diversion and auditing. The inventory management section provides suggestions for key areas of opportunity such as modification of par levels to reduce stock-outs and increase the vend/refill ratio.