**Abstract**

The implementation of an electronic barcode medication administration system (BCMA) was successfully carried out at a 360-bed at King Hussein Cancer Center (KHCC) in Amman- Jordan, commencing in 2013. The software was specifically designed to enhance medication safety administration accuracy in all aspects, and modified to meet the KHCC policies and Institute for Safe Medication Practices (ISMP) requirements. Through the nationally adopted BCMA software, healthcare providers could electronically confirm that the patient is the right patient, and to verify that the medication is the right medication at the right dose, given at the right time by the right route (5 rights).

The implementation of the new technology commenced in September 2016, gradually. Subsequently, new nursing units were introduced every 3-4 months, allowing ample time for computer installation and training. Each cluster of units consisted of \_\_\_\_ nurses, who devised new workflows to integrate the technology into their practices. Notably, home medications were not subject to scanning. The BCMA implementation was limited to inpatient units and wards only, marking the final phase of the rollout in May 2023.

A multidisciplinary team was convened to implement BCMA technology. This team included pharmacy, nursing, IT, quality and administration. The project was lead to pharmacy as per ASHP recommendation.

The process was divided into six key steps: Exploration, Planning, Installation, Piloting Implementation, Monitoring and Intervention, and Full Implementation. Each step was discussed in depth, highlighting the challenges faced, strategies employed, and outcomes achieved during the BCMA integration.

The aim of this article is to identify how the optimal implementation method should be for BCMA with limited resources and to ensure the benefits are emphasized while the employees’ motivation is in focus. It examines the barriers encountered when attempting to eliminate paper record documentation, as well as the necessary support required by nurses and pharmacists to ensure a safe and seamless transition to electronic barcode medication administration within inpatient setting.

Keyword: Bar Code Medication Administration, Cancer, Medication Sheet, electronic medication administration system,

**Introduction**

All health care institutions seek to reduce medication errors through working on their systems through introducing strategies that helps reduce certain types of errors in order to prevent patient harm.(1) In specific, reduction of administration errors can be aimed by ensuring the five medication rights (patient, drug, dose, route, and time) by relying on people to follow a mental checklist through the process of medication administration.(2) The Bar Code Medications Administration (BCMA) system is considered as one major solution that impact the administration medication errors and help in minimizing them by electronically verifying the “5 rights” of medication administration at the patient’s bedside. In consequence, use of bar-code technology at the bedside of the patient to verify a patient’s information and the medication to be administered is a favorable approach for preventing medication administration errors.+(3)

BCMA verification at the bedside is usually implemented in conjunction with an electronic medication administration system (eMAR), allowing nurses to automatically document the administration of drugs by means of bar-code scanning.(4)

Apart from the absence of conclusive proof that it effectively reduces preventable medication errors, particularly in hospitals where other safety systems, such as computerized prescriber order entry (CPOE). Another obstacle to the extensive acceptance of BCMA technology is the cost.(5-7) from the other side medication errors incur significant costs and result in the inefficient utilization of resources within healthcare organizations.(8)

The conventional medication administration process entails physicians writing medication orders, and nurses subsequently executing these orders by administering medications .(9) Specifically in KHCC process starting from physician ordering medication, order verification by pharmacist, order transcription by nursing and finally medication administration and documentation by nursing.

In order to eradicate patient harm resulting from medication administration errors, KHCC inpatient nursing units adopted bar-code medication administration (BCMA) technology. The main objective of this study is to investigate how the optimal implementation method should be for BCMA with limited resources, to ensure the benefits are emphasized.

**The Setting**

KHCC is a comprehensive cancer center for adult and pediatric located at capital of Jordan Amman, consists of 360 beds. The ordering system structure of the KHCC is encompassed within an interactive electronic database system. The process of medication administration begins when a healthcare provider records a patient's medication orders electronically through Computerized Patient Record System (CPRS) system. These newly entered orders are then transferred to the pharmacy software package on same system for pharmacist review and validation. Subsequently, validated orders become accessible as ready to administer for the nursing for administration and documentation of process.

**Implementation process**

The implementation of BCMA was run across KHCC through six stages: exploration, planning, installation, piloting implementation, monitoring and intervention, full implementation.

1. Exploration:

During the exploration phase, the initiative to integrate BCMA technology at KHCC was instigated by the higher administration, aligning with the strategic objective of enhancing patient safety. This entailed a comprehensive evaluation of the prevailing medication administration protocols, identification of operational challenges and inefficiencies, as well as a thorough examination of the available BCMA solutions within the market. A collaborative team comprising key stakeholders including physicians, nurses, pharmacists, and IT specialists was convened, with their collective insights being harnessed to underscore the imperative for BCMA implementation.

The pre-implementation medication administration workflow operated as follows: The process was triggered by healthcare providers electronically recording patient medication orders. These newly input orders were subsequently transmitted to the pharmacy software package for review and validation by pharmacists. Once approved, these orders became accessible to the nursing staff. Nurses transcribed the orders onto the Medication Administration Record (MAR) following the medication administration standards, including Standard medication administration time (SMAT). When medication administration was due based on its SMAT, a registered nurse prepares the prescribed medication within the medication room based on the MAR. The nurse then proceeds to the patient's room for administration, meticulously adhering to the universal "Five Rights" protocol for medication administration. Following successful administration, the nurse signed off the dose on the MAR.

2. Planning:

In the planning phase, collaborative efforts were concentrated on formulating an intricate implementation strategy encompassing the delineation of scope, objectives, timelines, and resource prerequisites. This plan was strategically designed to proactively anticipate and address potential impediments and complexities, thus fostering a risk-mitigation approach. Of paramount significance during this phase was the meticulous tailoring of the BCMA system to seamlessly align with KHCC's distinctive requisites.

An essential focal point during the planning stage was to attain a thorough comprehension of our existing operational environment and pinpoint areas in need of improvement. This approach led to the acquisition of the Barcode Labeling.

The effective operation of BCMA hinges on the meticulous inclusion of each medication's barcode into a designated "synonym" electronic file, establishing a direct linkage to the corresponding formulary barcode. This synchronization enables successful recognition when the handheld scanner used by nursing staff captures the identical barcode affixed to the medication packaging for the unit dose medications, and a system created bar code for each ready to used dose. Instances where complications arise, such as the inability to scan a manufacturer's barcode label or the transition of bulk-packaged items to unit dose packaging by pharmacy personnel, prompt a strategic response. This entails the creation of a pharmacy-generated barcode label, meticulously applied to ensure compatibility with the BCMA system's requisites.

In establishing the timeline, we have given precedence to the floors based on patient criticality and bed capacity. As a result, we initiated the process with the smallest unit, the palliative floor, and concluded with the ICU units, which represents the most critical area. The accompanying figure illustrates the implementation timeline, as observed, the initial phase of implementation featured a longer timeframe between floors compared to the subsequent stages.

|  |  |  |  |
| --- | --- | --- | --- |
| Unit | Date | Number of beds | Number of nurses |
| 2A | November 2013 | 8 | 7 |
| 3C Minor | March 2019 | 12 | 48 for both side |
| 3C Major | July 2019 | 23 | 48 for both side |
| 4C Minor | October 2019 | 12 | 43 for both side |
| LEUKEMIA 9H | January 2020 | 24 | 37 |
| 5H PED | September 2020 | 14 | 22 |
| 4C Major | December 2019 | 21 | 43 for both side |
| 4A | September 2021 | 19 | 38 for 4A & 4B |
| 4B | September 2021 | 19 | 38 for 4A & 4B |
| 6H PED | March 2022 | 24 | 38 |
| 8H MED/SUR | March 2022 | 24 | 36 for 8H & 11H |
| 11H MED/SUR | March 2022 | 11 | 36 for 8H & 11H |
| 10H MED/SUR | March 2022 | 24 | 19 |
| 4H BMT | May 2022 | 15 | 40 |
| 5C NN | June 2022 | 18 | 29 |
| 3A | October 2022 | 17 | 49 for 3A & 3B |
| 3B | October 2022 | 19 | 49 for 3A & 3B |
| 7H BMT | October 2022 | 24 | 42 |
| ICU Salman | January 2023 | 9 | 40 |
| PICU | January 2023 | 9 | 34 |

Highlighting the resources we considered the following:

* A scanner in each patient room
* A computer and computer holder in each patient room
* A computer inside each medication room for medication preparation

These items were added on the budget of hospital as prerequisites resources.

Training

In 2013, a core team of key personnel, comprising an inpatient pharmacist, a supervisory nurse, and a nursing instructor, underwent dedicated BCMA training. Following their successful completion of the program, these individuals were designated as BCMA "Super Users," subsequently available round-the-clock across shifts to provide support and training to staff members. The BCMA orientation training was meticulously rolled out floor by floor within the nursing ward, adhering to the timeline table stipulated.

Upon successful competency evaluations conducted by the Super Users, the newly trained nurses and pharmacists seamlessly transitioned to on-the-job training. Ongoing refresher training was consistently provided to nursing and pharmacy personnel, ensuring their alignment with program updates and emerging technologies. Leveraging multidisciplinary cross-training approaches further enriched the staff's understanding and proficiency in BCMA protocols. In preparation for BCMA implementation, the imperative of staff attendance in live training sessions was rigorously observed.

From ordering part an innovative approach entailed pharmacists gaining insight into nursing facets of BCMA, while physician delved into pharmacy-specific functionalities through cross-training initiatives. This synergistic approach has garnered exceedingly positive feedback from staff members since its inception.

(Nursing part)

Nursing play an important role to make sure that the medication given to the patient within proper way; through putting the required safety protocol to minimize any medication administration errors may occur.

The successful training on BCMA done through a continuous training process led by informatics nurse. This training aimed to improve the registered nurse with the necessary skills and knowledge to use BCMA in the medication administration process.

**Key Elements of implementing the BCMA Process:**

1. **Training:-**
   1. **Leadership by the Informatics Nurse:**

* The informatics nurse played a major role in holding the BCMA training sessions. Utilizing his expertise in healthcare informatics and the BCMA system, he provided guidance, direction.
  1. **Super User Training:**
* We have selected super users staff to receive intensive training from the informatics nurse. These super users chosen for their ability to train and serve as BCMA experts within their respective units.
  1. **Staff Nurse Training:**
* The informatics nurse developed a checklist sheet to ensure that all important points in the system are covered during the training, this also facilitated the training for all users.

1. **Ongoing Communication and feedback:**

* A clear communication way was established for nurses to be used for any clarification, suggestions and feedback.

1. **Rules and regulations:**
   * A new policy for BCMA system was developed in order to standardizes the administration process for all patients, this policy explains for nurses how they can dealing with all administration scenarios like administer high alert medications, in case of system is down …ect.

3. Installation: (IT part)

The installation phase marked the deployment of the chosen BCMA system at KHCC. This involved the integration of BCMA technology with the existing electronic health record (EHR) system, pharmacy management software, and mobile devices used by healthcare professionals. Hardware, such as barcode scanners and mobile devices, were procured and configured to ensure seamless communication between different components of the BCMA system.

4. Piloting Implementation

To ensure a smooth transition, the BCMA technology was first piloted in each floor as a parallel implementation between BCMA and MAR sheet. Allowing for thorough testing of the BCMA workflow. During this phase, training sessions were conducted for healthcare staff to familiarize them with the new technology, its functionalities, and its impact on their daily tasks. Feedback from the pilot phase was used to fine-tune the system and address any unforeseen challenges.

5. Monitoring and Intervention:

The intervention phase involved continuous oversight of the BCMA system's performance post-pilot. Regular meetings and feedback sessions were held with the healthcare staff to identify areas of improvement and address any issues promptly.

Some challenges were faced regarding the patient own medication (PTOM), the bulk medication and oral solutions. Another challenge raised related to the high alert medications administration process that requires a interdependent double check by other nurse before administration. Handling patients with procedures due for medication at same time , missing doses administration were other challenges. The table below shows the interventions done for each challenge to be solved:

|  |  |
| --- | --- |
| The challenge | The intervention |
| Lose clarity of bar code on label, due to multiple potential causes | We create a List of virtual bar code for each single medication by generic (IEN list) |
| A patient has brought their own medication, which could be non-formulary or a different brand from what the hospital provides (PTOM) | We created an item on IEN list called PTOM and the nurse shall document the information on nursing note every dose |
| The multi-used oral solution | We began the process of preparing oral solution in oral syringe unit form, including a label with the medication's barcode for each dose. |
| High alert medication that need to be checked by two nurses. | We agreed to add a comment on BCMA for each medication with the name and ID number of the second checker. |
| The work around using the IEN list by nurse | We agreed to review the compliance to administration reports through IEN and barcode regularly to improve process |
| Floor stock medication | We agreed with pharmacy main store to label each item dispensed with a bar code label |
| Extemporaneous medication | We create a GTN for each type of preparation, and this shall be fixed by the pharmacist staff upon preparation |
| Vomited or refused dose | We agreed to add a comment on BCMA for the vomited or refused dose. |
| Epidural order as continuous infusion with PRN boluses | We agreed to separate the order into two orders one for continuous infusion and one for the PRN order |

6. Full Implementation:

After successful piloting and refinement all medication sheets (MAR) were withdrawn from the floor and the BCMA system become the official way to administer and record patient medication doses and the reference for any healthcare provider for any administration history, with ongoing support and troubleshooting mechanisms were put in place to assist staff during the initial stages of full implementation.

Discussion: