



IMPROVE Study: Impact of a New Automated Dispensing Cabinet System on Medication Administration Timing and Nurse Workflow

INTRODUCTION Hackensack University Medical Center (HackensackUMC) is continually working to improve its medication administration processes. When replacing an older automated medication dispensing system with the Omnicell® Unity platform, pharmacy leadership embarked on a study to determine if the new technology—and related workflow enhancements—would improve efficiency of the medication administration process.

Specifically, HackensackUMC sought to measure the difference in time between scheduled and actual administration time for IV antibiotics, compared with their previous system. Additional factors were also studied, including missing doses and nurse satisfaction with workflow associated with the automated dispensing systems. The data collected in the study is examined in this paper.

Background

In a hospital setting, nursing and pharmacy staff work together to provide accurate and timely dispensing and administration of drugs, as well as to monitor for achieving therapeutic goals, to observe side effects, and to educate patients. Many factors impact the accuracy and timeliness of medication administration by pharmacy and nursing staff, including¹⁻³:

- Electronic medication administration records (eMARs)
- Staffing/resources
- Bar code technology
- Centralized versus decentralized medication distribution systems
- Nurse satisfaction

Automated dispensing cabinets (ADCs)—now ubiquitous in U.S. hospitals—also play a large role in the medication administration process.

Managing Time-Critical Medications

Promoting patient safety includes complying with CMS requirements regarding the medication use process. One of these requirements calls for dispensing and administering time-critical medications within a 30-minute window.² Antibiotics, anticonvulsants, insulin, pain medications, immunosuppressive agents, and anticoagulants, among others, fall under the category of time-critical medications.

HackensackUMC sought to improve its responsiveness in administering time-critical medications (IV antibiotics)—both first doses and subsequent scheduled doses. To determine if the newly installed Omnicell automated dispensing system would shave time off their medication process compared with the previous ADC system, the researchers sought to measure:

- Difference in time to first dose for piperacillin-tazobactam, a time-critical IV antibiotic
- Time to administration for scheduled doses of all IV antibiotics

Named “**IMPROVE**,” the six-month study conducted by Hackensack University Medical Center in Hackensack, New Jersey was completed in January 2015. Results were presented by HackensackUMC at the New Jersey Society of Health-System Pharmacists annual meeting on April 24, 2015. Study authors included:

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STUDY OBJECTIVES

The primary objective of the study was to assess the efficiency of HackensackUMC’s medication administration processes for a time-critical IV antibiotic before and after the new Omnicell ADC system was installed. The study took place in three large patient care areas: the medical-surgical, orthopedic, and oncology units.

There were two primary endpoints:

- Demonstrate a 10% reduction in delay from scheduled dosing times to administration of the first dose for IV piperacillin and tazobactam.
- Demonstrate a 10% reduction in the delay from scheduled time to documented administration time for all doses of all IV antibiotics.

The secondary endpoints for

additional assessments were:

- Medication error rates for heparin and insulin, two time-critical medications
- Missing doses
- Medication labeling
- Nurse satisfaction with the ADC system

STUDY DESIGN

The two-part study included retrospective, single-center data collection to evaluate medication administration processes before and after the installation of the new Omnicell ADC system. The study also included an evaluation of nurse satisfaction with the two systems, based on an adaptation of the Medication Administration System–Nurses Assessment of Satisfaction (MAS-NAS) scale.⁴ Nurses were surveyed twice, six months apart—first on their experience with the older system, and the second time the survey focused on satisfaction after installation of the Omnicell system.

Equipment

The new Omnicell medication dispensing cabinets installed at HackensackUMC included the following functionality:

Integrated medication label printer—prints patient-specific medication labels as nurses remove items from the cabinet.

Advanced biometric ID system—allows nurses to login quickly and securely via fingerprint scan.

Single-dose dispensing system—dispenses each dose individually, virtually eliminating the need for narcotic countbacks.

Anywhere RN™ remote medication management software and interoperability with the Epic electronic health record (EHR)—enables nurses to check medication availability, preselect medications, and document waste remotely from the dispensing cabinet.

SinglePointe™ patient-specific medication management software—provides an automated system for managing patient-specific medications within the cabinet.

Statistics

A one-sided Wilcoxon rank sum test was used to compare the differences between scheduled time and administration time before and after the new ADC system was installed. The comparison of medication error rates, in-basket messages, and medication labeling was performed using Poisson regression analysis using the PROC GENMOD in Statistical Analysis Software (SAS v9.4). Ordinal logistic regression with generalized estimating equations (GEE) was used to evaluate nurse satisfaction with the new ADC system.

RESULTS

First Dose Administration Time

The IMPROVE study showed a 40% reduction in time to first dose for piperacillin-tazobactam after the Omnicell system was installed.

The time from the scheduled dose to first dose administration of piperacillin and tazobactam was significantly reduced after the Omnicell ADC installation as compared to the same measure using the previous ADC system in the medical-surgical, oncology, and orthopedic units as well as all units combined (**Figure 1**). The majority of doses were administered in the medical-surgical unit. The largest percent decreases were observed in the oncology and orthopedic units (**Table 1**).

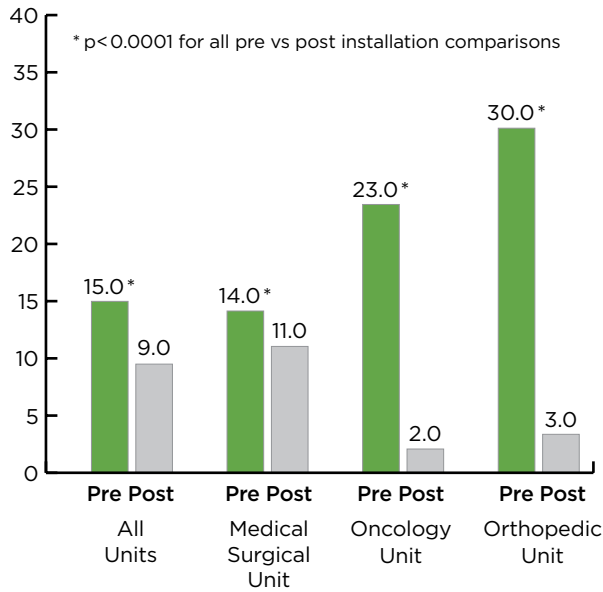


Figure 1. Difference Between Scheduled Time and First Dose Administration of Piperacillin-Tazobactam

This graph shows the difference (in minutes) between scheduled time and actual time of administration of first doses of piperacillin and tazobactam in the medical-surgical, oncology, and orthopedic units, and all units combined before and after installation of the new ADCs.

	PREVIOUS ADC	NEW ADC	CHANGE (%)	P-VALUE
ALL UNITS	8,607	8,051		
Median Time	15.0	9.0	6.0 (40.0%)	<0.0001
25 th to 75 th Percentile	-3.0 to 49.0	-18.0 to 44.0		
Minimum, Maximum	-120.0, 3,858.0	115.0, 324.0		
MEDICAL-SURGICAL UNIT	6,948	6,023		
Median Time	14.0	11.0	3.0 (21.4%)	<0.0001
25 th to 75 th Percentile	-1.0, 48.0	-16.0, 47.0		
Minimum, Maximum	-120.0, 3,858.0	-75.0, 324.0		
ONCOLOGY UNIT	1,298	1,642		
Median Time	23.0	2.0	21.0 (91.3%)	<0.0001
25 th to 75 th Percentile	-21.0, 59.0	-22.0, 35.0		
Minimum, Maximum	-83.0, 312.0	-60.0, 284.0		
ORTHOPEDIC UNIT	361	386		
Median Time	30.0	3.0	27.0 (90.0%)	<0.0001
25 th to 75 th Percentile	0, 52.0	-23.0, 39.0		
Minimum, Maximum	-60.0, 450.0	-115.0, 277.0		

Table 1. Difference Between Scheduled Time and First Dose Administration of Piperacillin-Tazobactam

Difference (minutes) between scheduled time and administration time of first dose of piperacillin and tazobactam in the medical-surgical, oncology, and orthopedic units and all units combined. A negative difference indicates that the medication had been administered earlier than the scheduled time, and a positive difference indicates that the medication had been administered later than the scheduled time.

Scheduled Dose Administration Time

The IMPROVE study showed a 13.3% reduction in scheduled time to administration time for all IV antibiotics.

The time difference between the scheduled dose and the actual administration for all IV antibiotics was significantly reduced after the new ADC installation in the oncology and orthopedic units as well as all units combined (Figure 2). In the medical-surgical unit, the

reduction in delay from scheduled dosing time to actual administration was not statistically significant (Table 2).

The majority of the antibiotics administered prior to the new ADC were anti-infectives (54%) followed by cephalosporins (23.6%). After the new ADC system was installed, the majority of the antibiotic administrations were anti-infectives (34.3%), followed by the penicillins (28%) and cephalosporins (24.5%).

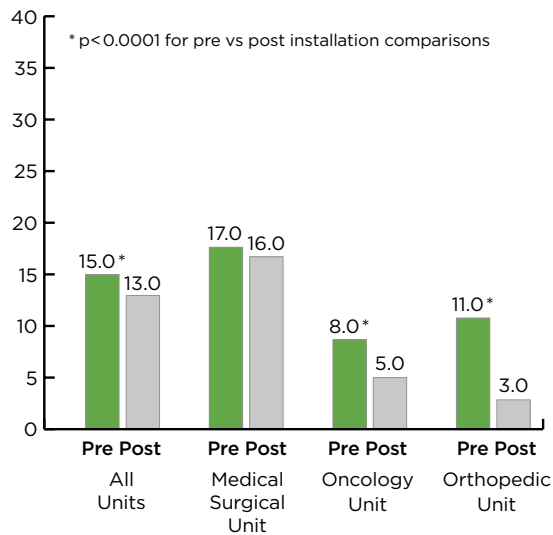


Figure 2. Difference Between Scheduled Time and Administration of All IV Antibiotics

Difference (in minutes) between scheduled time and actual administration time of all doses of IV antibiotics in the medical-surgical, oncology, and orthopedic units and all units combined before and after installation of the new ADCs.

	PREVIOUS ADC	NEW ADC	CHANGE (%)	P-VALUE
ALL UNITS – n	49,077	47,470		
Median Time (Minutes)	15.0	13.0	2.0 (13.31%)	<0.0001
25 th to 75 th Percentile	-8.0, 53.0	-13.0, 50.0		
Minimum, Maximum	-1,380.0, 3858.0	-270.0, 574.0		
MEDICAL-SURGICAL – n	34,856	33,549		
Median Time (Minutes)	17.0	16.0	1.0 (5.9%)	0.4184
25 th to 75 th Percentile	-8.0, 53.0	-10.0, 55.0		
Minimum, Maximum	-1,380.0, 3,858.0	-241.0, 574.0		
ONCOLOGY – n	8,962	7,903		
Median Time (Minutes)	8.0	5.0	3.0 (37.5%)	<0.001
25 th to 75 th Percentile	-9.0, 54.0	-21.0, 39.0		
Minimum, Maximum	-165.0, 484.0	-270.0, 357.0		
ORTHOPEDIC – n	5,259	6,018		
Median Time (Minutes)	11.0	3.0	8.0 (72.7%)	<0.0001
25 th to 75 th Percentile	-4.0, 45.0	-13.0, 33.0		
Minimum, Maximum	-120.0, 2,090.0	-180.0, 383.0		

Table 2. Difference Between Scheduled Time and Administration of All IV Antibiotics

Difference (in minutes) between scheduled time and administration time for all IV antibiotics in the medical-surgical, oncology, and orthopedic units and all units combined. A one-sided Wilcoxon rank sum test was used to compare the differences between administration time and scheduled time with the new and previous ADC systems.

Medication Error Rates

The medication error rate for insulin prior to the installation of the new ADC system was 5 occurrences, and after the new ADC installation 1 occurrence was documented. This difference was not statistically significant, with an incidence rate ratio (IRR) of 0.34 and 95% confidence interval (CI) of 0.04 – 2.79 (p = 0.3136). For heparin, there were 3 errors reported prior to the new ADC system and 5 after. This difference was not statistically significant (IRR=1.1938, 95% CI: 0.2859 to 4.9954, p=0.8083).

In-Basket Messages (Missing Medications)

In-basket messages occur when a nurse sends a message regarding a missing medication to the pharmacy. The information (alert) is captured in the electronic medical record (EMR) system by patient and by medication. The analysis of in-basket messages showed a significant reduction in the number of in-basket messages over a 90-day period after the new ADC installation as compared with a 90-day period with the previous ADC system (IRR = 0.82, CI = 0.80 – 0.83, p< 0.0001) (**Table 3**).

	PREVIOUS ADC	NEW ADC	CHANGE (%)	P-VALUE
Number of Messages	30,357	24,989		
Daily Median	62.5	51.0	11.5 (18.4%)	<0.0001
Minimum, Maximum	7, 319	13, 73		

Table 3. Difference in Number of In-Basket Messages

Difference in the number of in-basket messages during a 90-day period before and after the new ADC was installed.

Medication Labeling Errors

The rate of medication labeling errors by the nurses after installation of the new ADC system was not significantly different than the rate with the previous ADC system (IRR = 1.22, CI = 0.80 - 1.85, p = 0.3592).

Results of Medication Administration System–Nurses Assessment of Satisfaction

In the prospective phase of the study, an adaptation of the Medication Administration System–Nurses Assessment of Satisfaction (MAS-NAS) questionnaire was administered using a 6-point Likert scale (strongly agree, agree, somewhat agree, somewhat disagree, disagree, and strongly disagree). The questionnaire was completed by 122 nurses at two time points six months apart: one time to

survey the nurses related to the old ADC system, and six months later to survey the nurses regarding the Omnicell system.

The analysis showed statistically significant improvement in nurse satisfaction with the Omnicell system with regard to several categories: efficiency of medication administration, effectiveness in reducing and preventing medication errors, ease of checking active medication orders before administering medications, drug alert feature, availability of information on drug actions and possible side effects, need for stashes of medications, and availability of information on how to treat adverse reactions to a medication (**Table 4**).

DOMAIN	ODDS RATIO ^a	95% CONFIDENCE INTERVAL	P-VALUE
Efficiency of medication administration	1.96	1.34, 2.87	p = 0.0005
Effectiveness in reducing and preventing medication errors	1.58	1.07, 2.33	p = 0.0225
Ease of checking active medication orders before administering medications	1.55	1.04, 2.30	p = 0.0298
Drug alert feature	1.53	1.04, 2.26	p = 0.0295
Availability of information on drug actions and possible side effects	1.53	1.04, 2.26	p = 0.0314
Need for stashes of medications	0.69 ^b	0.48, 0.99	p = 0.0426
Availability of information on how to treat adverse reactions to a medication	1.49	1.04, 2.14	p = 0.0310

^a The odds ratio indicates the likelihood of a response of “strongly agree.”

^b For this item, an odds ratio less than 1 indicates improvement (decreased need to stash medication).

Table 4. Results from Medication Administration System–Nurses Assessment of Satisfaction

Analysis of responses to the Medication Administration System–Nurses Assessment of Satisfaction Scale completed by 122 nurses before and after the installation of the new ADC system.

DISCUSSION

Medication Administration Timing

After replacing their previous automated dispensing cabinets with the Omnicell system, HackensackUMC saw a significant decrease in the time from scheduled dose to actual administration of time-critical IV antibiotics.

As stated in the CMS Manual System, “...scheduled medications identified under the hospital’s policies and procedures as time-critical must be administered within thirty minutes before or after their scheduled dosing time...”² Joint Commission-accredited hospitals are evaluated against these CMS requirements, and quality reports by these accredited hospitals are published compared to other accredited hospitals.

HackensackUMC consistently strives to meet the 30-minute window for time-critical medications. As a prominent academic medical center with Magnet status, they are particularly focused on quality measures and continuous improvement, and were therefore motivated to further improve their medication administration timing, even if only incremental improvement could be attained.

As indicated by the primary endpoints of the IMPROVE study, the researchers expected to see a 10% reduction in the time from scheduled administration to actual administration time of IV antibiotics. The results far surpassed the expectations for both primary endpoints, showing a 40% reduction for first doses of piperacillin-tazobactam, and a 13.3% reduction for scheduled doses of all IV antibiotics.

This improved timing was likely due in part to the increased availability of IV antibiotics on the nursing floors enabled by the Omnicell system. Other elements of the new ADC system also helped increase efficiency of the overall medication process.

Missing Dose Analysis

Although it was a secondary aspect of the study, the missing dose analysis—measured by in-basket messages via the EHR—revealed a substantial reduction in missing medications. When a nurse cannot locate the medication needed for the patient, it interrupts workflow for the nurse. It also takes extra time for pharmacy,

which must research the issue and respond to nursing. In some cases, this results in preparing and delivering the dose again.

The reduction in missing doses seen after the Omnicell system was installed may be attributed to the SinglePointe system for managing patient-specific medications within the ADC. The ability to stock more medications at the point of care, so there is less need to wait for pharmacy to deliver medications, may have also played a role in the missing dose reduction.

Medication Errors

While the study did not show a significant reduction in medication errors related to two time-sensitive medications (heparin and insulin) following installation of the new ADC system, nurses indicated an improved “effectiveness in reducing and preventing medication errors” via the MAS-NAS survey. This may suggest that nurses felt greater confidence in avoiding errors when using the new ADC system.

How Were the Improvements Achieved?

Under the previous automated dispensing system, IV antibiotics were prepared and labeled in the pharmacy, and then delivered to the unit. As many clinicians can attest, this process often results in delays, errors, and missing doses.

The Omnicell system enabled a completely new workflow, as depicted in **Figure 3**. The IV antibiotics can now be stocked in the ADCs due to the integrated Medication Label Printer. As nurses remove IV bags from the cabinet, a patient-specific label is automatically printed to apply to the medication.

Other aspects of the Omnicell system have also contributed to nurse efficiency at HackensackUMC:

- Patient-specific medications are automatically managed through the cabinet, which reduces the number of places nurses have to go to acquire medications.
- A system for remotely queuing medications shortens time spent at the cabinet.
- A single-dose dispensing module virtually eliminates the need to conduct countbacks of controlled substances.

In addition, HackensackUMC also deployed Omnicell’s interoperability with the Epic EHR, which allows nurses to manage medications

within the Epic system. This helps reduce the amount of time nurses need to spend at the automated dispensing cabinets.

Rather than stemming from a single advantage of the Omnicell technology, the study results were likely achieved through a combination of functionality that enabled HackensackUMC to refine their medication process and nurse workflow. The IMPROVE study validated that the changes they made resulted in significant improvements to nurse satisfaction and patient care. ■

“The administration time for antibiotics is critically important for preventing infection and promptly treating infection. The Omnicell medication dispensing system enabled us to refine our processes and get medications to patients faster—and that allows us to improve patient care.”

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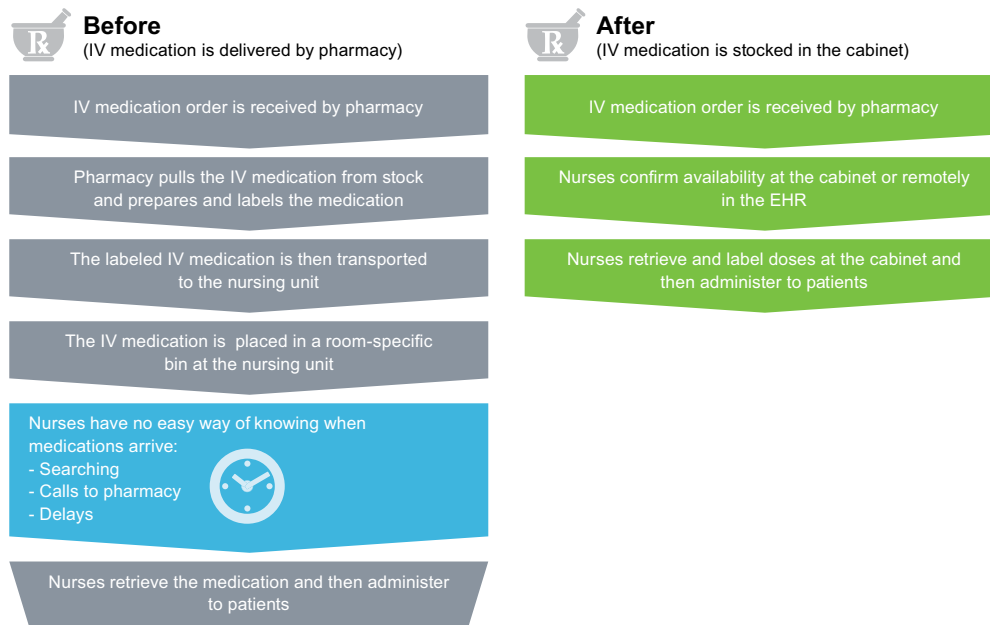


Figure 3. IV Medication Process Before and After New ADC