

No Time to Waste: Decreasing Patient Wait Times for Chemotherapy Administration Using Automated Prioritization in an Oncology Pharmacy System

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The number and complexity of chemotherapy dispensed and administered in outpatient settings continue to increase,¹ with added intricacies to its delivery process. Reducing wait time and associated treatment burden has been recognized as an important contributor to patient satisfaction and well-being.²

Patients with cancer experience significant emotional distress, with rates of depression ranging from 14% to 33%.^{3,4} Although the effect of a cancer diagnosis and its implications for mortality are critical, one must consider the contribution of the disease burden on the patient's quality of life.⁵ Uncomfortable waiting areas and the length of wait time for medical test results, appointments, and dispensing of chemotherapy have been identified as a major source of dissatisfaction.⁶⁻⁹ Waiting periods have been linked to a multitude of anxiety-related problems such as anticipatory nausea and vomiting.¹⁰ Long unoccupied wait times may contribute to patient discomfort unnecessarily, thereby increasing psychological burden and contributing to a sense of rejection or abandonment.¹¹ The reduced life expectancy of patients with cancer aggravates this issue.

The use of pagers among patients undergoing outpatient chemotherapy had positive results such as reduction in boredom and increased peace of mind.¹² Patients judge waiting periods of more than 30 minutes as unacceptable.¹³

Realizing the negative effect of wait time on oncology patients, our goals were to implement an automated pharmacy dispensing prioritization system and to evaluate its effect on the timing of dispensing and administration of chemotherapy.

BACKGROUND

We evaluated the effects of modifications in the adult chemotherapy pharmacy dispensing process from March 1, 2005, through March 2, 2006, at the Sidney Kimmel Comprehensive Cancer Center (SKCCC) at

the Johns Hopkins Hospital. The SKCCC sees 2300 new patients with cancer annually and provides more than 12,000 outpatient chemotherapy treatments. Most outpatient chemo-

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Objectives: To implement an automated pharmacy dispensing prioritization system and to evaluate its effect on the timing of dispensing and administration of chemotherapy.

Study Design: An electronic chemotherapy dispensing system that prioritized orders for pharmacy processing based on anticipated patient arrival at the oncology outpatient unit was implemented, followed by an educational intervention for pharmacy staff.

Methods: A time-controlled study evaluating the effect of the electronic chemotherapy dispensing system on late, early, and "within target" dispensing and administration of chemotherapy was conducted.

Results: A total of 13,138 chemotherapies were prepared and released pending medical clearance based on laboratory results (hereafter referred to as pending counts) (8677 [66.0%]) or pending arrival of the patient (hereafter referred to as pending arrival) (4461 [34.0%]) from March 1, 2005, to March 2, 2006. Chemotherapy dispensing and administration times were retrospectively compared with chemotherapy appointment times after adjustment for late patient arrival. Dispensing times continuously decreased from a mean delay in dispensing of 12 minutes after the adjusted chemotherapy appointment time at baseline to dispensing a mean of 5 minutes ahead of the scheduled time by the end of the study. Chemotherapy treatments dispensed within target increased from 62.9% to 74.7% (pending arrival) and from 53.4% to 68.1% (pending counts), and those administered within target increased from 64.9% to 71.8% (pending arrival) and from 56.0% to 70.1% (pending counts).

Conclusion: An automated intervention for synchronizing chemotherapy preparation with anticipated times for administration was associated with significant reduction in wait times.

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therapy administered at the SKCCC is prepared on the day of administration to address chemotherapy stability limitations and financial concerns associated with wasting expensive pharmaceuticals because of late treatment plan changes.

Preparing chemotherapy on the day of administration requires a trigger. The outpatient chemotherapy pharmacy uses 2 triggers, pending counts (PC) and pending arrival (PA). Chemotherapy orders are classified as PC if the medical clearance based on same-day laboratory results will trigger chemotherapy preparation. Chemotherapy orders are classified as PA if physical arrival of the patient to the oncology center is sufficient to trigger preparation. All patients visiting the oncology outpatient unit with PC and PA chemotherapy were included in this study.

During the baseline period from March 1, 2005, to May 5, 2005, chemotherapy orders were prepared in the oncology pharmacy in chronologic order based on patient arrival time (PA) or the time of medical clearance (PC). This chronologic order was communicated to the pharmacist electronically via a point-of-service computer system. This system avoided the preparation of chemotherapy for patients who failed to show for an appointment or who failed medical clearance.

After preparation and quality control, the pharmacist logged the chemotherapy as dispensed in the information system, and it was transported to the oncology outpatient unit via a conveyer belt. At the oncology unit, the chemotherapy administration followed an appointment schedule. A chemotherapy appointment time was assigned to each patient in advance based on protocol requirements, patient preference, and provider and space availability. To reduce the number of

SKCCC visits, patients were frequently scheduled to see their medical provider, undergo diagnostic testing, or receive radiation therapy on the day of chemotherapy administration.

In the baseline first-come, first-serve system, chemotherapy delivered to the oncology outpatient unit in the morning was often not administered until late in the afternoon because of patient unavailability. Meanwhile, chemotherapy needed early for patients waiting at the oncology unit often would not arrive until hours later. This system resulted in prolonged patient wait times, decreased patient satisfaction, frequent telephone calls, and increased stress levels for nurses and pharmacists.

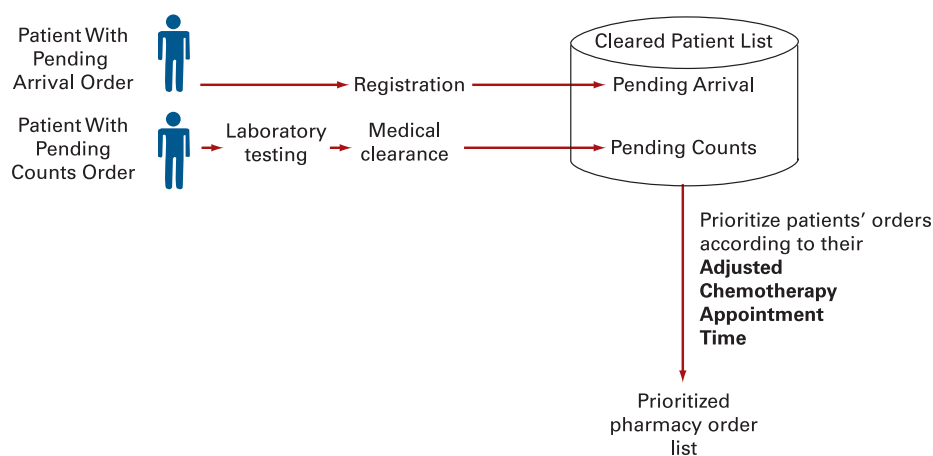
METHODS

Intervention

To reduce wait times and intervals between dispensing and administration of chemotherapy, an electronic chemotherapy dispensing system was introduced that prioritized dispensing based on anticipated patient arrival at the oncology outpatient unit. Previously, dispensing had been prioritized based on the chronologic order of the patient's arrival to the institution and the time of medical clearance to receive chemotherapy. Following the modification of the order queue in the electronic dispensing system, the pharmacy staff was educated in a 1-hour session on the importance of avoiding order batching and on the need to prioritize chemotherapy orders as indicated by the electronic dispensing system.¹⁴ Visual reminders were posted in the work area as reinforcement.

The implementation and evaluation order was as follows. Baseline performance was measured from March 1, 2005, to May 5, 2005. The intervention was implemented in 3 phases. Phase 1 began May 6, 2005, and included introduction of a basic version of the electronic chemotherapy dispensing system that prioritized chemotherapy orders for pharmacist processing based on the prescheduled appointment time without accounting for late patient arrival. Phase 2 began September 29, 2005, when the electronic dispensing system was refined to account for late patient arrival and to modify chemotherapy order priority accordingly. Phase 3 began February 6, 2006, when the

■ **Figure 1.** Design of the Electronic Chemotherapy Dispensing System



The adjusted chemotherapy appointment time is the prescheduled chemotherapy appointment time adjusted for late patient arrival.

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■ **Table 1.** Comparison of the Distribution of All Chemotherapies Dispensed and Those Included in the Analysis by Study Phase^a

Variable	Dates	All Chemotherapies			Chemotherapies With Complete Data		
		Total	Pending Arrival	Pending Counts	Total	Pending Arrival	Pending Counts
Baseline	3/1/2005 to 5/5/2005	2042	630 (30.9)	1412 (69.1)	1348	442 (32.8)	906 (67.2)
Phase 1	5/6/2005 to 9/28/2005	4710	1578 (33.5)	3132 (66.5)	3106	1039 (33.5)	2067 (66.5)
Phase 2	9/29/2005 to 2/5/2006	4445	1520 (34.2)	2925 (65.8)	3075	1118 (36.4)	1957 (63.6)
Phase 3	2/6/2006 to 3/31/2006	1941	733 (37.8)	1208 (62.2)	1941	733 (37.8)	1208 (62.2)

^aData are given as number (percentage).

already described educational intervention for pharmacy staff was conducted.

Figure 1 shows the final design of the electronic chemotherapy dispensing system. On arrival (PA) or medical clearance (PC), the patient's order is ranked according to an adjusted chemotherapy appointment time calculated as the original chemotherapy appointment time plus an adjustment period for late patient arrival. The adjusted period is calculated as the difference between a patient's first appointment of the day and his or her registration time on arrival. (For example, if the patient's first appointment is at 8:30 AM and his or her registration time is at 8:40 AM, the adjusted chemotherapy appointment time would be 10 minutes later than the prescheduled chemotherapy appointment time.) No adjustment is made when a patient arrives or is registered early or on time.

Measures

To evaluate the effectiveness of the interventions, 2 outcome measures were used throughout. These included chemotherapy dispense interval (dispense time minus adjusted chemotherapy appointment time) and chemotherapy administration interval (administration time minus adjusted chemotherapy appointment time). A negative value indicates that the chemotherapy was dispensed or administered before the adjusted chemotherapy appointment time. Chemotherapy dispense time was defined as the time the pharmacist electronically labeled the chemotherapy as dispensed. Chemotherapy administration time was defined as the start time of the first chemotherapy infusion.

Data Collection

The oncology clinical information system (OCIS) at the Johns Hopkins Hospital¹⁵ tracks appointment times, patient arrivals, medical clearance times (if applicable), and chemo-

therapy dispensing and administration times. Data are logged automatically (on arrival through bar-coded card swipe at a kiosk) and by the staff in real time. The OCIS functions as an electronic communication tool among admission, pharmacy, and oncology staff providing up-to-the-minute information on patient status.

From March 1, 2005, to March 2, 2006, all patients with PC and PA chemotherapy orders were included. Data were retrieved from the OCIS for each outpatient visit, including the patient's appointments, time of registration, time of medical clearance if applicable, time of chemotherapy dispensing, and time of chemotherapy administration. All visits missing 1 or more of the data points were excluded from the study sample.

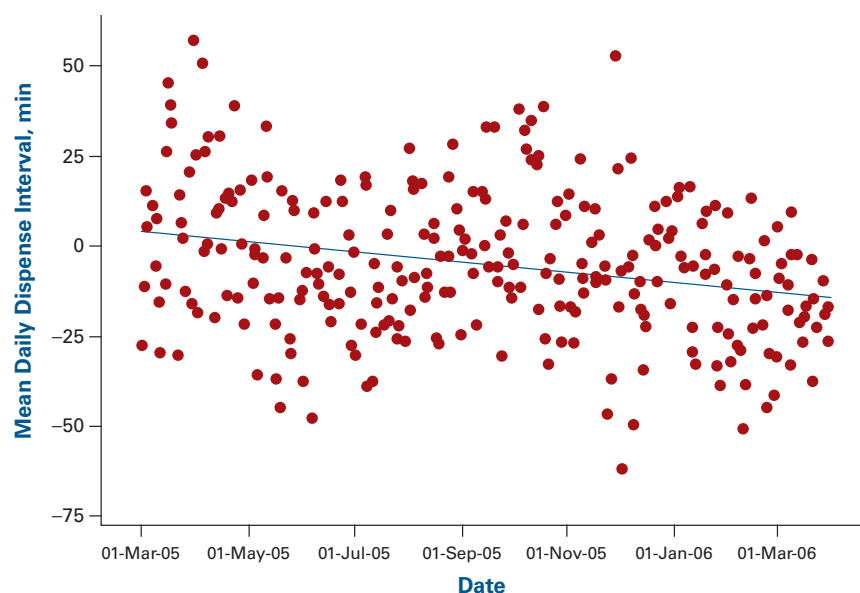
No patient identifiers or information on staff performance was collected. This quality improvement project was performed with departmental and institutional leadership approval.

Data Analysis

Data were retrieved retrospectively from the OCIS. The chemotherapy administration and dispense intervals were calculated for each visit. Dispense time earlier than 90 minutes before the adjusted chemotherapy appointment time was considered early and more than 30 minutes after the adjusted chemotherapy appointment time was considered late. Administration time earlier than 45 minutes before the adjusted chemotherapy appointment time was considered early and more than 75 minutes after the adjusted chemotherapy appointment time was considered late. Administration and dispense intervals that did not meet time criteria for early or late were considered "within target."

A daily mean of dispense intervals was calculated for all chemotherapy orders (PC and PA), and a regression analysis across the study period was performed. Data were analyzed

■ **Figure 2.** Trend of Daily Averages for Dispense Intervals During the Study Period



released PC (8677 [66.0%]) or PA (4461 [34.0%]) (Table 1).

One hundred twelve different chemotherapy agents or chemotherapy combinations were dispensed for 1807 unique patients. Combined chemotherapy agents (such as cyclophosphamide, doxorubicin, vincristine, and prednisone) accounted for 1595 (12.1%) of all dispensed chemotherapies. The number of chemotherapies dispensed ranged from 1 to 57 per patient (mean, 7.3; median, 5).

Times for appointment, registration, dispensing, and chemotherapy administration were available for 8976 chemotherapies (68.3%). There was no significant difference between the distribution of all

using Minitab statistical software (Minitab Inc, State College, Pennsylvania).

chemotherapies and of those for which administration and dispense times were available.

RESULTS

From March 1, 2005, to March 31, 2006, 13,138 chemotherapies were prepared in the SKCCC pharmacy. These were

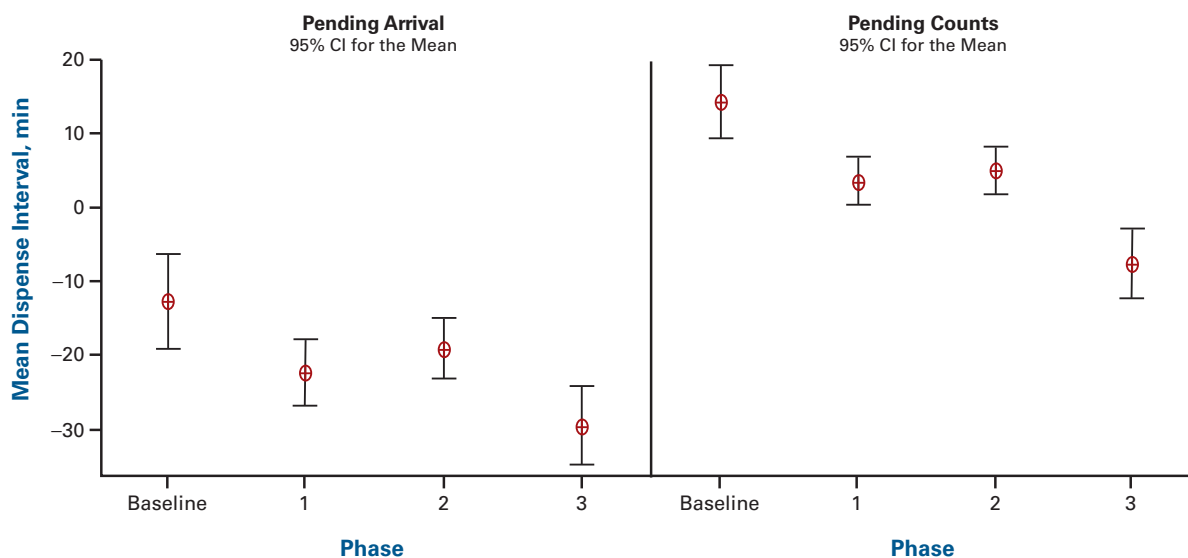
From March 1, 2005, to March 31, 2006, chemotherapy dispense intervals decreased from a mean delay in dispensing of 12 minutes after the adjusted chemotherapy appointment time at baseline to dispensing 5 minutes ahead of the scheduled time by the end of the study. Figure 2 shows the

■ **Table 2.** Dispense and Administration Intervals and Distribution for Pending Arrival Orders by Study Phase^a

Study Phase	No.	Mean, min	Early	Within Target	Late
Dispense Interval (Dispense Time Minus Adjusted Chemotherapy Appointment Time)					
Baseline	442	-12.6	47 (10.6)	278 (62.9)	117 (26.5)
Phase 1	1093	-22.2	149 (13.6)	718 (65.7)	226 (20.7)
Phase 2	1118	-18.8	125 (11.1)	781 (69.9)	212 (19.0)
Phase 3	574	-29.1	73 (12.7)	429 (74.7)	72 (12.5)
Administration Interval (Administration Time Minus Adjusted Chemotherapy Appointment Time)					
Baseline	442	37.1	37 (8.4)	287 (64.9)	118 (26.7)
Phase 1	1093	34.7	89 (8.1)	743 (68.0)	261 (23.9)
Phase 2	1118	36.1	94 (8.4)	769 (68.8)	255 (22.8)
Phase 3	574	32.0	40 (7.0)	412 (71.8)	122 (21.3)

^aData are given as number (percentage). The adjusted chemotherapy appointment time is the prescheduled chemotherapy appointment time adjusted for late patient arrival. Pending arrival orders are chemotherapy orders that do not require waiting for any laboratory test results before processing can be started in the pharmacy.

■ **Figure 3.** Dispense Intervals by Phase



CI indicates confidence interval.

reduction in dispense intervals based on daily means (regression coefficient [SE], -0.05 [0.01]; $P < .001$).

Further analysis was performed in the 2 major groups (PA and PC). The outcome measures for all interventions were the proportions of chemotherapy dispensed and administered within the desired period (within target).

Pending Arrival

Table 2 gives the PA dispense intervals. There was a significant difference in the dispense interval between groups ($\chi^2_6 = 39.9$, $P < .001$). **Figure 3** shows the dispense intervals by phase. Each subsequent phase was associated with increases in percentages for chemotherapy dispensed within target.

Table 2 also gives the PA administration intervals. There was no difference in the administration interval for chemotherapy between baseline, phase 1, and phase 2. There was a significant difference between phase 3 and baseline ($\chi^2_2 = 39.7$, $P < .001$).

Pending Counts

Table 3 gives the PC dispense intervals. There was a significant difference in the dispense interval between groups ($\chi^2_6 = 59.9$, $P < .001$). **Figure 3** shows the dispense intervals by phase. While at baseline only one-half of the chemotherapies were dispensed within target, during phase 3 this had increased to more than two-thirds.

Table 3 also gives the PC administration intervals. There was a significant difference in the administration interval between groups ($\chi^2_6 = 43.7$, $P < .001$). **Figure 4** shows the

administration intervals by phase. As with chemotherapy dispense intervals, we saw an improvement in chemotherapy administration intervals from baseline to phase 1, a slight drop in performance during phase 2, and again a significant performance improvement during phase 3.

DISCUSSION

Chemotherapy delivery in the ambulatory setting is becoming increasingly complex.¹ The high numbers of patients and progressively more intricate treatment regimens lead to increased demand on pharmacy services that may translate into prolonged patient waiting. Waiting has been associated with decreased patient satisfaction and can be a source of anxiety and stress to oncology patients.^{6,7,10}

Patient wait times during chemotherapy treatment are the result of therapeutic indications (eg, infusion times) and process delays. Chemotherapy administration is always associated with variable periods of waiting dependent on the time required for hydration and chemotherapy infusions. As complicated combination regimens become the norm for most oncologic diagnoses, these issues will become more problematic in the future.

Ideally, oncology patients should not need to wait for their chemotherapy to be prepared for administration. However, in view of high drug costs¹⁶ and chemical stability characteristics,^{17,18} most chemotherapy treatments are prepared on the day of administration, thereby increasing the likelihood of patient wait times. In addition, many chemotherapy agents

■ **Table 3.** Dispense and Administration Intervals and Distribution for Pending Counts Orders by Study Phase^a

Study Phase	No.	Mean, min	Early	Within Target	Late
Dispense Interval (Dispense Time Minus Adjusted Chemotherapy Appointment Time)					
Baseline	906	14.5	50 (5.5)	484 (53.4)	372 (41.1)
Phase 1	2067	3.9	133 (6.4)	1261 (61.0)	673 (32.6)
Phase 2	1957	5.4	138 (7.1)	1158 (59.2)	661 (33.8)
Phase 3	819	-7.2	66 (8.1)	558 (68.1)	195 (23.8)
Administration Interval (Administration Time Minus Adjusted Chemotherapy Appointment Time)					
Baseline	906	53.2	51 (5.6)	507 (56.0)	348 (38.4)
Phase 1	2067	44.4	118 (5.7)	1334 (64.5)	615 (29.8)
Phase 2	1957	52.3	111 (5.7)	1205 (61.6)	641 (32.8)
Phase 3	819	41.3	41 (5.0)	574 (70.1)	204 (24.9)

^aData are given as number (percentage). The adjusted chemotherapy appointment time is the prescheduled chemotherapy appointment time adjusted for late patient arrival. Pending counts orders are chemotherapy orders that require waiting for laboratory test results before chemotherapy preparation can be started in the pharmacy.

must be infused slowly during several hours. This may create prolonged turnaround times for available beds in chemotherapy units, resulting in efficiency challenges.

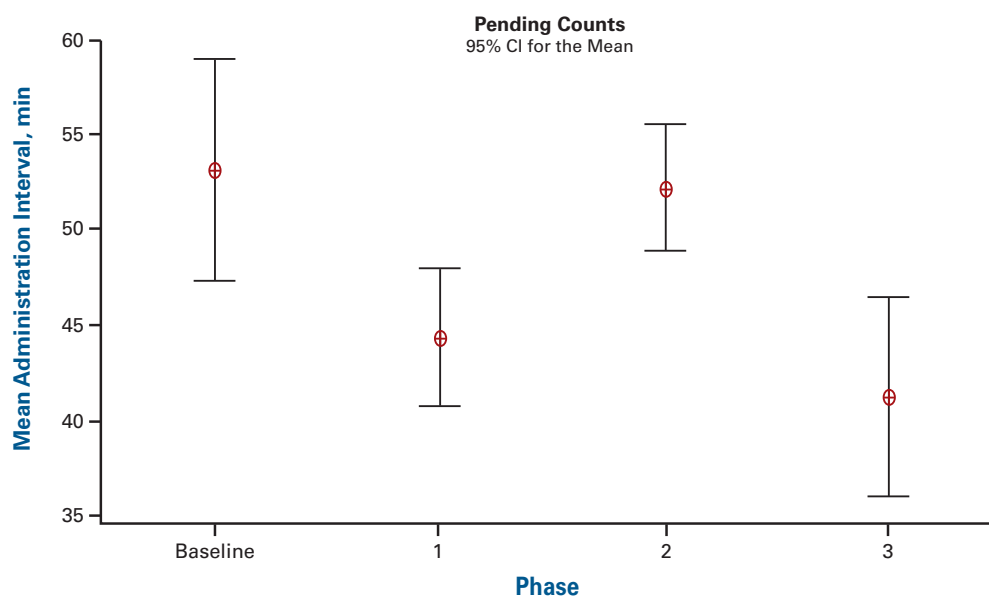
In fact, many ambulatory chemotherapy regimens need to be started early in the day to assure completion by the end of business hours. This results in a peak demand for pharmacy services in the morning hours. The demands for same-day

preparation in addition to peak morning hour demands place a significant burden on the chemotherapy delivery units and the pharmacy staff and may delay chemotherapy administration or lead to errors. At our institution, a baseline time study of the chemotherapy delivery process before implementation of this intervention revealed that many of the delays encountered by our patients are due to prolonged

waits for their chemotherapy to arrive at the chemotherapy unit from the pharmacy (data not shown). Our hypothesis was that prioritization of chemotherapy dispensing from the pharmacy based on anticipated patient arrival times at the chemotherapy unit would reduce the wait times.

Our intervention synchronized chemotherapy dispensing in the outpatient pharmacy with the anticipated chemotherapy administration time at the unit. Because our

■ **Figure 4.** Administration Intervals by Phase



CI indicates confidence interval.

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intervention focused on modifying a process queue, it was easy to implement and sustain and did not require intensive staff training.

Our intervention was associated with a significant increase in chemotherapy dispensed within target range for the PA and PC groups. There was also a significant increase in chemotherapy administered within target range for both groups.

The following limitations are acknowledged. We collected data retrospectively from an existing chemotherapy management system. The study design is a time-controlled study and is subject to bias based on other changes to the delivery system of chemotherapy. However, there were no other interventions affecting pharmacy processing during the study period (such as change in scheduling policies or change in staffing patterns). The demand for pharmacy services (measured in the number of doses dispensed) during the study period remained stable.

This study measured the effect on patient care as reflected in the dispensing and administration times. Unfortunately, we were unable to complement the data in this study with patient satisfaction data from before and after the intervention. However, anecdotal reports from our medical providers and nursing staff reflected fewer episodes of patient or family complaints about prolonged waits for chemotherapy, a matter that unfortunately used to occur with predictable frequency before our intervention.

Some of our patients did not have a complete set of data that included dispensing and administration times and had to be dropped from the analysis. However, the characteristics of these patients were not significantly different from those of patients with complete data sets.

Another limitation of this study is the reliance on pharmacists and nurses to self-report the chemotherapy dispense and administration times. Those times are entered in real time as part of an existing information system, decreasing any chances of recall bias. We have no reason to believe that times are being erroneously or selectively entered for patients.

Because of the unique issues related to the administration of chemotherapy, the findings of this study cannot be generalized to all medication delivery systems. However, our findings may be generalized to other institutions with similar chemotherapy delivery processes characterized by same-day chemotherapy preparation and a high demand on pharmacy services.

We demonstrated that a simple intervention in an electronic dispensing system for chemotherapy agents can have a significant effect on delivery and administration times. Such

Take-away Points

Extensive wait times for chemotherapy are a major cause of dissatisfaction for oncology patients. Waiting periods have been linked to anxiety-related problems such as anticipatory nausea and vomiting.

- This vulnerable population with decreased immunity and little time to waste is often required to wait in public areas for chemotherapy to be prepared.
- We describe a simple technique that involved the reordering of the chemotherapy queue in an outpatient pharmacy system that reduced wait times substantially.

an intervention may have widespread applications for reducing patient wait times in oncology and other healthcare delivery settings where orchestration of multiple services during short periods is required for patient care.

Future research is needed on additional interventions to reduce oncology patient wait times. Innovative approaches for increasing efficiency of the chemotherapy delivery process, while reducing opportunities for medication errors, should be studied. Patient and provider scheduling preferences for diagnostic and treatment services are other determinants of patient wait times that require further examination.

CONCLUSIONS

Patients receiving chemotherapy have ranked the length of time the treatment takes as more important on satisfaction scores than medical problems such as feeling anxious or tense.¹⁹ The wait time for dispensing of chemotherapy has been identified as a major source of dissatisfaction.^{20,21}

This study evaluated the effect on wait time of an automated intervention for synchronizing patients' chemotherapy preparation with anticipated times for administration. The intervention was easy to implement and was associated with a significant reduction in patient wait time for chemotherapy dispensing and administration. Further research on innovative ways for improving efficiency of chemotherapy processing and administration, while reducing opportunities for medication errors, is needed.

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