Utilization of Technology to Improve Efficiency in Investigational Drug Management Processes

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Abstract

Background: Background: An investigational pharmacy is responsible for all tasks related to receiving, storing, and dispensing of any investigational drugs. Traditional methods of inventory and protocol tracking on paper binders are very tedious and could be error-prone. **Objective:** To evaluate the utilization of the IDS to efficiently manage the inventory within an investigational Pharmacy. We hypothesize that the IDS will reduce the drug processing time. **Methods:** Our pharmacy tracked the drug processing time before and after using the IDS including the receiving, dispensing, and inventory. As part of the receiving the study drug pharmacists tracked the time it took a pharmacist to complete the tasks of logging the study drug before and after the implementation of the IDS system. In addition, the pharmacy also timed the process for drug dispensing and a full investigational drug inventory check. Wilcoxon signed-rank test was used to compare the difference in the meantime of total processing before and after the IDS. **Results:** Utilization of the IDS system showed significant reduction in processing time, and improvement of efficiency in inventory management. Additionally, the usability survey of the IDS demonstrated that the IDS system helped pharmacists capture data consistently across every clinical trial. **Conclusion:** Our results demonstrates how technology helps pharmacists to focus on their actual day to day medication-related tasks rather than worrying about other operational aspects. Informatics team continues to further enhance the features such as monitor portal, and features related to finance – generation of invoices, billing reconciliation, etc.

Keywords

Investigational Drug System, investigational pharmacy, clinical trials, informatics, database, integration

Introduction

A clinical research office (CRO) is a department that manages clinical trials focused on preventing or treating diseases across various fields of medicine. A CRO oversees each clinical trial from start to finish,¹ most commonly, the clinical trials that are treatment based utilize a centralized investigational pharmacy to assure safe and efficient conduct of clinical trials regarding the management of drugs being studied. These functions may include receiving, storing, preparing, and dispensing the drugs in an appropriate manner to ensure subject safety and protocol compliance. Aside from drug procurement and handling, an extensive amount of effort stems from maintaining and organizing the protocol information in a manner that is easy for the pharmacy team to follow. Much of the required documentation

such as adverse effects, dosage, patient compliance, and pill count are submitted to the Food and Drug Administration for review and approval release into the market. Ultimately, the goal of the pharmacy when conducting clinical trials is to provide documentation to prove that the drug is effective and safe for human consumption.

There are rules and regulations set by the Food and Drug Administration that CROs must comply with related to

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clinical trials.² Furthermore, sponsors for each clinical trial enforce specific protocol guidelines that a CRO must also adhere to. The complexity and the effort of study drug management, along with conforming to the regulations and standards, varies depending on the phase of the trial, sample size, and the class of drug that is being studied. Many investigational pharmacies use a paper-based approach in maintaining the documentation and protocols. Traditionally, these documents are kept in binders on shelves.³ The volume of these documents can be substantial, and it is common that they require a large amount of space, which pharmacies do not have.

From 2009, there has been an increasing trend in the number of investigational clinical trials being performed.⁴ As the number of clinical trials increases, so too does the time and effort to maintain them. The University of Kansas Medical Center's (KUMC) investigational drug pharmacy has 8 full-time pharmacists and 5 full-time pharmacy technicians to ensure daily operations are smooth and compliant with regulations and standards, including activities such as follow-up of adverse event data collection from participants in these trials.

As processes shift with technological advancement, so should our investigational pharmacy from a paper-based method to an electronic inventory tracking method. The Biostatistics and Informatics Shared Resource (BISR) at KUMC has adopted a software product known as the Investigational Drug System (IDS) to streamline each transaction performed in handling the investigational drug.⁵ The purpose of this article to describe and evaluate the IDS for more efficient management of the drug inventory system at KUMC.

Methods

IDS Technology

The front end of the IDS application has been developed using a Java framework. The back end is housed in an Oracle database. The application supports Oracle XE as well as a free version of the Oracle database. The requirement for the hardware is relatively minimal. There is a requirement of 16 GB of memory and 120 GB of disk space along with 4-core processors.

IDS Build

The IDS is a web-based software product that can be accessed from any of the 3 KUMC investigational pharmacy sites. IDS is a role-based system, which provides system administrators a way to manage and attach roles to appropriate job descriptions and locations. The system was developed with appropriate security that allows only the users who are provisioned with access. The IDS can

be integrated with any authentication system such as Lightweight Directory Access Protocol or Security Assertion Markup Language. This improves data security and enables access rights to be centrally maintained.

Integration

All the protocols and relevant patient information flows into the IDS via the Clinical Trial Management System while it is being captured in real time. The link between both systems is the participant study identification, which is the unique identifier assigned by the sponsor. This is particularly important due to the possible threat of a breach of the information.⁶ Maintaining safety for the participants involved in the studies is a top priority. The centralized database can be accessed at each of the 3 locations helping the pharmacy staff organize the trials they are managing. By utilizing the medication catalog, pharmacy staff can build the drug into the IDS database during the trial start-up phase by supplying the name, strength/concentration, and unit of measurement. It is then associated with the protocol in which it is being studied. This allows the pharmacist to easily select the appropriate drug during the dispensing period.

Workflow

Regarding the dispensing of the treatment drug, the electronic process, unlike the paper format, automatically ensures that the drug information is accurate and is associated with the correct patient before the medication can be dispensed. Due to the possibility of human error, having to manually check these fields can be slow, inefficient, and more error-prone, a potential concern with the traditional paper-based approach. The system alerts the user if the medication is expired or will expire before the patient finishes the prescription and provides specific instructions relative to the protocol. In a single step, a prescription label is generated, and the inventory and accountability logs are updated resulting in a more efficient workflow.⁷

With the use of this new technology, the electronic method has proven to be a more efficient and more precise way of handling inventory.⁸ The technicians can review inventory in real time. This assists in maintaining adequate drug stock for current and potential patients to avoid delays in enrolling and treating a research participant. The system also provides pharmacy staff the exact storage location and condition along with the ability to quarantine drug, which has been deemed to no longer acceptable for use. This is beneficial for bigger operations where multiple pharmacists are working on the same clinical trial.⁹ Finding solutions to problems concerning medical inventory is nothing new as medical professionals have been trying to tackle these issues for decades.¹⁰ With advancement in technology, there are new solutions to old problems.

Figure 1. Investigational pharmacy workflow.

As shown in Figure 1, the IDS is a comprehensive system for an investigational pharmacy's duties and responsibilities. A pharmacist can track the chain of custody and maintain a perpetual inventory of the study drug. Since the information is continuously recorded, various reports from multiple sites can be generated from centralized locations that help with operations, regulatory compliance, audit processes, and study monitoring. Drug accountability reports are exportable in various formats to support study monitors. Export options include the NCI formats, columns for patient return tracking, and one-click de-identified reports to prevent cumbersome manual redaction. There is also increased accuracy as IDS prevents transcribing errors, illegibility issues, and errors in data entry through less manual manipulation.

Evaluation

To observe the efficiency of the IDS, our pharmacy timed the process of receiving study drug into the system once it has arrived in the pharmacy (this was done across 10 studies individually) and a pharmacist must label a container and record the transaction in a log to inventory. The time it took to complete this process was recorded before and after the implementation of the IDS. Then, Wilcoxon signed rank test was used to compare the mean time of drug processing during receiving, dispensing, and inventory.

Before the implementation of the IDS, pharmacists and technicians recorded the amount of time it took to receive a

shipment, to dispense a drug, and to complete a full investigational drug inventory check. The receiving process began when the shipment of investigational drugs arrives at its respective investigational pharmacy and was prepped to be logged into inventory. With each shipment came a set of tasks that had to be completed. Some of the tasks included, but not limited to, communicating with the sponsor, logging the investigational drug into inventory, and placing them in their designated location.

About the dispensing process, there are many laborious tasks. Some of the tasks include counting the amount of the drugs, labeling, verifying the order, and logging out of the inventory. The inventory process was for all studies and involved retrieving each study binder, looking at each accountability log, counting drugs, and confirming that inventory matched the accountability logs.

After the implementation of IDS with an adjustment period, the pharmacists and technicians recorded the times for receiving the receipts, dispensing, and inventory repeatedly. Across the same studies the respective tasks were timed. However, the IDS would replace the binders with electronic accountability logs, labeling processes, and digital inventory tracking processes.

Results

Ever since the system went live in July 2018, it has been accessed by 8 pharmacists and 5 technicians across 3 different

Table 1. Time Saved After Implementation of the IDS System (Areas Specifically to Receiving Drugs, Dispensing Drugs, and Overall Inventory Management).

Study	Before (Minutes)	After (Minutes)	Change (Minutes)
Dispensing			
TCDI4678	14.05	4.07	9.98
20110203	15.00	6.10	8.90
CLN-PXT3003-03	24.58	18.62	5.96
CAP1015A2201J	11.02	8.12	2.90
RA101495-02.201	6.38	3.80	2.58
H8A-MC-LZAZ	8.88	6.57	2.31
M15-566	5.55	4.93	0.62
RRAD	16.75	16.42	0.33
221AD301	8.13	8.93	-0.80
INCB50465	3.28	6.38	-3.10
Mean	11.36	8.39	2.97
<i>Mean change with 95% confidence interval = -2.97 (-0.024 to 5.96)</i>			
Receiving			
RRAD	15.00	7.63	7.37
SGN22E-002	26.53	10.90	15.63
H8A-MC-LZAZ	29.78	24.42	5.36
Mean	23.77	14.32	9.45
<i>Mean change with 95% confidence interval = 9.45 (-4.07 to 22.97)</i>			
Inventory	Before (h:min:s)	After (h:min:s)	Change (h:min:s)
	07:38:46	03:05:15	04:33:31

Abbreviation: IDS, Investigational Drug System.

sites. Collectively, they have been able to access the central IDS to dispense medications for more than 400 clinical trials, which consists of both cancer and noncancer trials, with more than 900 different medications. Table 1 demonstrates that there is a notable amount of time saved for the pharmacists and technicians. Because of the small sample, we used the nonparametric Wilcoxon signed rank test¹¹ to compare the mean of the time spent before and after implementation of the IDS. There is a marginally significant mean change in saving the time of around 3 minutes for dispensing when IDS is utilized.

Table 1 documents the time saved across 10 different studies for the drug receiving process and across 3 different studies for the drug dispensing activities—before and after implementation. Most of these studies handled multiple containers of their respective study drug to process, so the average time to perform these tasks of receiving and dispensing for each one was tracked. Depending on the sample size of the study, the time saved to complete these tasks is substantial. Additionally, a complete inventory check is done, which is also documented in Table 1. After implementation, the time to complete the inventory check was less than half the time spent before implementation. The complete inventory check for investigational drugs is performed at least twice a year. Since Table 1 only represent time savings for individual drug received

per study and time saved to dispense single drug per participant per visit, when we generalize the time saving across multiple studies and multiple participants across longitudinal data points the time saving is significant. Since all the information is centralized, report generation or a spot audit could easily be performed. Figure 2 displays the benefits of IDS within each of these individual processes.

Additionally, all the users who have been using the IDS (which included 7 pharmacists and 2 technicians) were given a 19-question survey to evaluate IDS usability. The usability survey was developed by the BISIR team at KUMC based on the IBM Computer Usability Satisfaction Questionnaire (<https://garyperelman.com/quest/quest.cgi>) developed by Lewis¹² to capture how the pharmacists feel about using the IDS such as effectiveness, user-friendliness, efficiency, interface, and so on. Research Electronic Data Capture (REDCap) web application¹³ was used as the data capture tool. Overall, the responses were exceptionally positive. Out of the 10 users, 9 responded with 8 giving positive responses. The positive responses expressed that IDS was easy to use, effective, increased productivity, and overall satisfactory (Figure 3). In an open-ended question, pharmacists mentioned that the IDS “reduced dispensing times immediately,” “added security,” and “[made it] easy to generate logs.”

Figure 2. Comparison of drug receiving, drug dispensing, and inventory check processes.

Discussion

It is evident that the IDS has been very helpful to the pharmacists in their day-to-day operations. Additionally, the informatics and pharmacy teams have been collaborating to enhance further features that make the processes for pharmacists more effective and time-efficient. Between each study, there are different tasks that might require more time than others due to different protocol methods. From one pharmacist's feedback, the 2 studies in which the time was

not saved mentioned that there could have been other variables that slowed down the process that was unrelated to IDS. Overall, the feedback was positive in that time for dispensing and receiving would be saved whether the time was subjectively minor or significant. From the previously mentioned survey, the pharmacists were asked what the negative aspects of the IDS were. It was mentioned that the user interface layout is not "the most fluid or intuitive" and that there is a "lack of study monitor (CRA) access." These and other design issues are a priority for improvement in the

Figure 3. Usability survey response.

next update. There are also additional features such as financial tracking and metrics dashboard, which are on the product roadmap for the near future.

Conclusions

By modernizing the methods in which our investigational pharmacies organize and maintain relevant clinical trial information, among other benefits, there is a noticeable improvement in the efficiency and time saved in receiving and dispensing drugs. Over time, with more feedback from the pharmacists that use the system, IDS will continue to improve, and there will be more ease when it comes to handling the information vital to each unique clinical trial.

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Author Contributions

DPM and CC oversaw all aspects of drafting, revision, and final approval of the manuscript. LC and BG lead the process of drafting and revising the manuscript, along with tracking all the metrics before and after implementation of the IDS. LC and BG also led the effort on collecting all the survey responses. JH, JW, and BG contributed to the IDS usability survey and participated in the drafting and revising of the manuscript. JT and DCK participated in the drafting and revising of the manuscript. RAJ and MSM provided advice on design, development, and operational issues related to IDS implementation and participated in the drafting and revising of the manuscript.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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