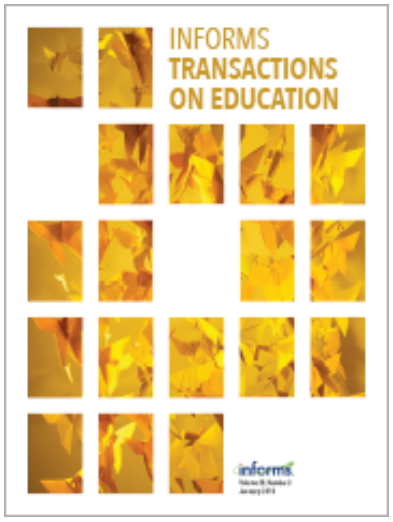
This article was downloaded by: [216.73.217.172] On: 16 November 2026, At: 23:53
Publisher: Institute for Operations Research and the Management Sciences (INFORMS)
INFORMS is located in Maryland, USA



INFORMS Transactions on Education

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Case—Medication Waste Reduction in an In-Hospital Pharmacy, Part B

Gregory Dobson, Vera Tilson

To cite this article:
Gregory Dobson, Vera Tilson (2016) Case—Medication Waste Reduction in an In-Hospital Pharmacy, Part B. INFORMS Transactions on Education 16(2):73-76. https://doi.org/10.1287/ited.2015.0147csB

Full terms and conditions of use: https://pubsonline.informs.org/Publications/Librarians-Portal/PubsOnLine-Terms-and-Conditions

This article may be used only for the purposes of research, teaching, and/or private study. Commercial use or systematic downloading (by robots or other automatic processes) is prohibited without explicit Publisher approval, unless otherwise noted. For more information, contact permissions@informs.org.

The Publisher does not warrant or guarantee the article's accuracy, completeness, merchantability, fitness for a particular purpose, or non-infringement. Descriptions of, or references to, products or publications, or inclusion of an advertisement in this article, neither constitutes nor implies a guarantee, endorsement, or support of claims made of that product, publication, or service.

Copyright © 2016, INFORMS

Please scroll down for article—it is on subsequent pages

With 12,500 members from nearly 90 countries, INFORMS is the largest international association of operations research (O.R.) and analytics professionals and students. INFORMS provides unique networking and learning opportunities for individual professionals, and organizations of all types and sizes, to better understand and use O.R. and analytics tools and methods to transform strategic visions and achieve better outcomes.
For more information on INFORMS, its publications, membership, or meetings visit http://www.informs.org

Vol. 16, No. 2, January 2016, pp. 73–76
ISSN 1532-0545 (online)
INFORMS Transactions on Education

http://dx.doi.org/10.1287/ited.2015.0147csB
© 2016 INFORMS

Downloaded from informs.org by [216.73.217.172] on 16 November 2026, at 23:53 . For personal use only, all rights reserved.

Case

Medication Waste Reduction in an In-Hospital Pharmacy, Part B

Gregory Dobson, Vera Tilson
Simon School of Business, University of Rochester, Rochester, New York 14627
{greg.dobson@simon.rochester.edu, vera.tilson@simon.rochester.edu}

Keywords: developing analytical skills; spreadsheet modeling; teaching with projects; teaching inventory management; teaching healthcare operations
History: Received: August 2015; accepted: September 2015.

Hannah realized that she needed to understand the workings of the pharmacy department where the compounded medications were prepared before she could do anything else. Her knowledge was limited to the outpatient pharmacy that prepared and sold pills but made no compounded medications (IV bags). The "big picture" of the process (Figure 1) was already clear to Hannah: The hospital health-care providers ordered medication; the pharmacists checked and verified the order; the techs created the medication for the patient; and the techs then delivered the medication to the hospital unit, where it was administered to the patient.

But understanding only "the big picture" seemed insufficient. Hannah asked her colleague Sandy for a tour of the department. Hannah then summarized what she learned from Sandy.

Intravenous medications for the hospital's inpatients are compounded in the intravenous pharmacy room (IVA, see Figure 2). The medication doses prepared in IVA are packaged as syringes and IV bags. The IVA operates 24 hours a day, and employs four pharmacists and 36 technicians. Pharmacy-mixed medications are delivered to 48 different hospital units. The IVA staff is also responsible for compounding items for nursing homes, hospital outpatient clinics, operating room stock, and frequently used items that are made in bulk.

With in-hospital orders, providers (physicians, physician assistants, nurse practitioners) enter medication orders into the hospital order database. Each order is assigned a unique order number. Information tied to each order includes the order initiation time, the patient's medical record number, the medication specification, the medication administration frequency (e.g., four times a day), the order duration (60 days is the default), and the name of ordering physician. The order entry screen is shown in Figure 3.

Medications are usually prescribed to be administered over multiple days with certain frequency: three times a day, every 8 hours, once every other day, continuously, etc. The distribution of the administration frequencies is shown in Figure 4. The times of the day the doses are to be administered may depend on the time the medication order was issued. With continuous administration, the times the IV doses are needed depend on the rate of infusion, which in turn depends on multiple factors, such as the type of medication, patient's age, and organ function.

The pharmacy information system computes the scheduled administration times for medication doses based on the time an order is placed and on the specified frequency or rate of infusion. The pharmacy then must prepare the needed number of doses, and medication must be labeled so that it is administered to the right patient at the right time. The pharmacy information system generates a work order for each dose in the form of a medication label with the name of the medication, patient, patient location, and scheduled administration time. The printout of a label triggers the compounding of the medication.

From the five-day waste audit, Hannah learned that 94% of doses that were wasted came from batch production. Sandy confirmed that IV *batch* preparation is

Downloaded from informs.org by [216.73.217.172] on 16 November 2026, at 23:53 . For personal use only, all rights reserved.

Figure 1 The "Big Picture" of the Pharmacy Process

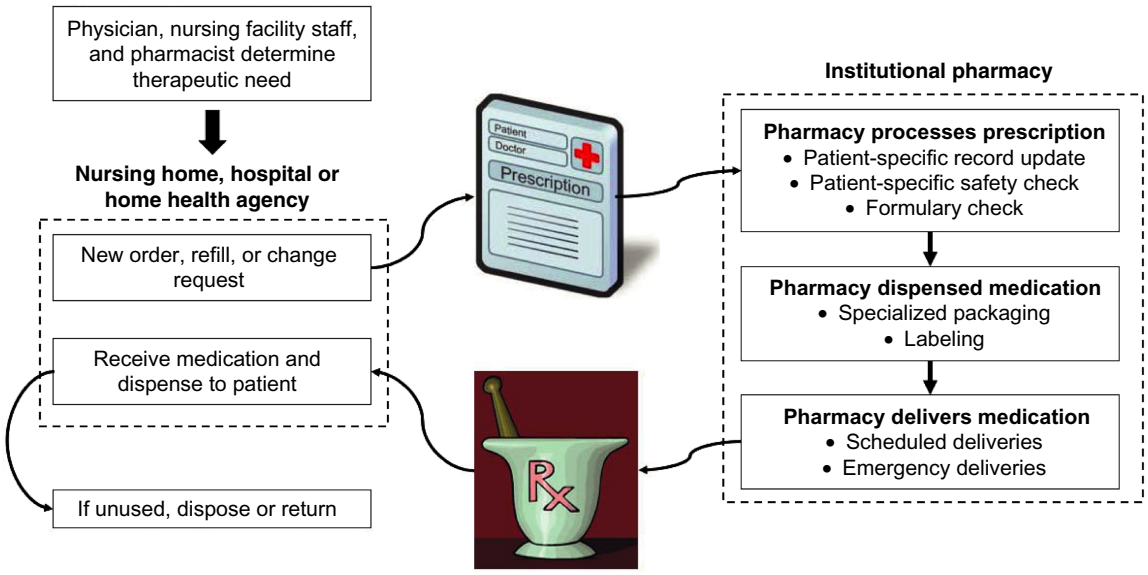
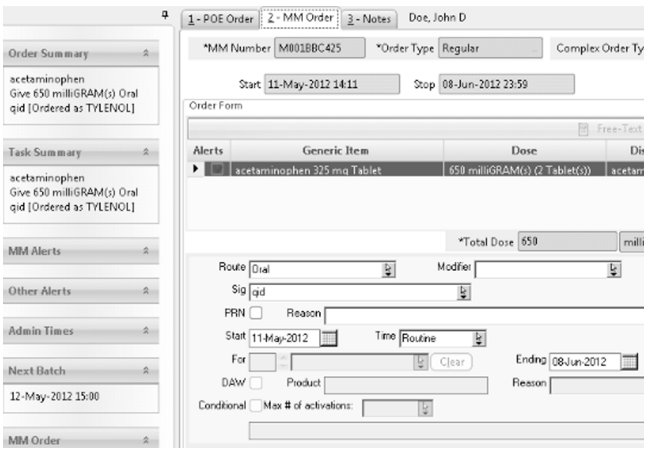


Figure 2 Medication Doses Prepared in the Intravenous Pharmacy Room (IVA)



the largest part of the daily work in IVA. Sandy further explained the three terms that were used in the pharmacy to describe doses prepared as part of this process: IV *batch*, *redispenses*, and *first doses*.

Figure 3 Example of a Medication Order Screen



• Doses prepared as part of the regular IV *batch* are doses for the medication that has already been verified by a pharmacist to be safe and appropriate for the patient. The IV *batch* includes doses scheduled to be administered to patients over 24 hours at times starting between 4 P.M. of the current day and 3:59 P.M. the following day. The IV *batch* doses are prepared daily between 6 A.M. and 2 P.M. and delivered to the hospital units in a batch delivery.

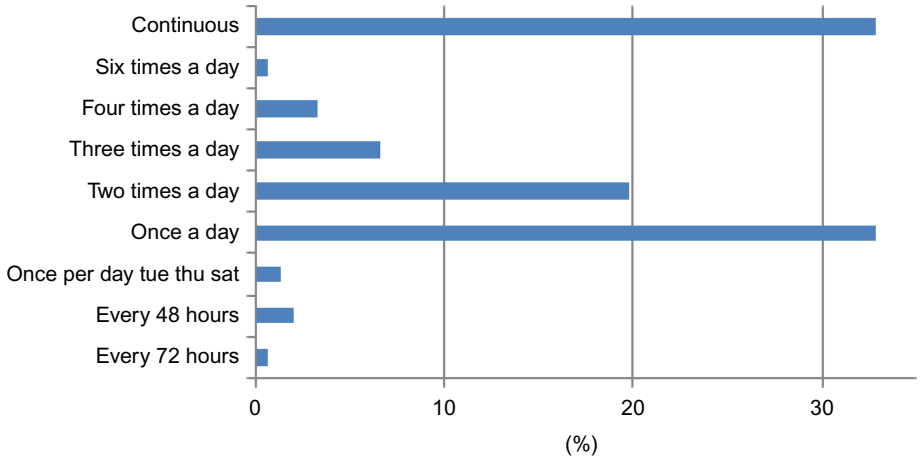
• *Redispenses* are doses that have to be prepared to handle missing doses due to misplacement of the original doses in hospital units or insufficient number of doses supplied by the pharmacy.

• *First doses* refers to the doses prepared outside the IV *batch* process following the initial placement of a medication order. After a medication order is entered into the hospital's computerized order entry system by a health-care provider (physician, physician's assistant, nurse practitioner, etc.), a pharmacist must verify that the order is safe and appropriate, i.e., the drug is suitable for the diagnosis and the dosage is safe for the weight of the patient. Once the verification is done, the pharmacy prepares enough doses to last until the doses for this order can be prepared as part of the daily IV *batch* process.

Hannah sketched out an example of *first dose* scheduling (Figure 5): A medication order is placed at 6 P.M. on Monday with daily dose administering times scheduled for 8 P.M., 4 A.M., and noon. The first three doses (administering times: 8 P.M. Monday, 4 A.M. Tuesday, and noon Tuesday) are prepared as *first doses*, because the preparation and delivery of Monday's IV *batch* has already been completed by the time the medication order is verified by the pharmacist. The pharmacy uses the pneumatic tube system

Downloaded from informs.org by [216.73.217.172] on 16 November 2026, at 23:53 . For personal use only, all rights reserved.

Figure 4 Distribution of Ordered Administration Frequencies



of the hospital to deliver first doses. The doses to be administered at 8 P.M. Tuesday, 4 A.M. Wednesday, and noon Wednesday are then prepared as part of Tuesday's IV *batch*. These are delivered as a batch by a tech using a cart.

The basic process of compounding and subsequent checking of the medication by pharmacist is the same whether the dose is prepared as part of an IV *batch*, as a *redispense* or as a *first dose*. Hannah recorded the steps involved in the IV *batch* process.

1. At 6 A.M., the information system generates a list of medication doses with scheduled administering start times between 4 P.M. of the current day and 3:59 P.M. of the following day. This list is printed in the IVA in the form of medication labels (Figure 6). "Update" labels for new medications that were ordered and verified between 6 A.M. and right before noon are printed at noon.

2. Label orders are then organized by a technician into products that are not administered continuously but typically run over a set period of time (small-volume), and IV medications that are running continuously at a set drip rate (large-volume). Small-volume and large-volume items are further separated into different categories, including a separation between pediatric and adult orders.

3. The technicians gather the raw materials (medication and diluents), place the labels and materials in plastic bins, and organize the bins for compounding by other technicians in an IV hood (Figure 7).

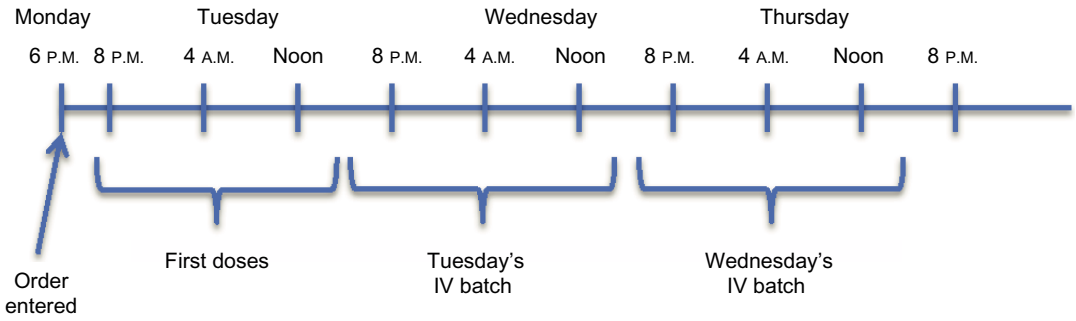
4. For the IV *batch*, all doses are prepared in the order in which the techs deliver them: first Neonatal Intensive Care unit (NICU), then adult, then pediatrics.

5. After the medication doses are compounded, a pharmacist checks each one for accuracy and safety. If the medication dose is deemed safe and correctly prepared, it is placed by the pharmacist into one of the various holding bins awaiting delivery to patient care units. The name of dispensing pharmacist is recorded on each dose.

6. Technicians deliver the medications, using carts. Medications for the NICU are delivered to the NICU starting at 2 P.M.; medications for the adult units are delivered starting at 2:30 P.M.; and delivery of medications for the pediatric units starts at 3 P.M. A nurse or a designated person receives the medication in each hospital unit.

A physician or a nurse sometimes changes or discontinues a medication order. When an order is discontinued, the system prints a *discontinue label* in the

Figure 5 Sketch of Dose Production Scheduling



Downloaded from informs.org by [216.73.217.172] on 16 November 2026, at 23:53 . For personal use only, all rights reserved.

Figure 6 Sorting of Dose Labels in the IVA



Figure 7 Pharmacy Technicians Compounding Medication in IV Hoods



pharmacy. A pharmacy technician must notice the discontinue label, find the technician who is working on the order, and, if the doses have not been compounded, remove the corresponding bin. The technicians in the pharmacy frequently do not follow this process, especially later on in the day, because they assume that the doses for a canceled medication order have already been prepared.

Sandy mentioned to Hannah that the pharmacy management was considering purchasing a new pharmacy work-management system. One of the features of this system is a virtual queue for the technicians, which prints labels individually just before a dose is made. Sandy also mentioned that some hospital pharmacies split their work into multiple batches in a 24-hour period. This keeps prepared medications inventory levels lower, and therefore reduces waste due to order cancellations. However, there is not a clear understanding in the industry as to the optimal way of splitting up daily batches. Any reduction in waste must be weighed against a potential increase in labor hours, since producing more batches would require more deliveries and would require technicians and pharmacists to work additional shifts.

A pharmacy IT specialist was able to run a report to provide Hannah with some data on orders and cancellations. The report was delivered to Hannah in a spreadsheet (available as supplemental material at http://dx.doi.org/10.1287/ited.2015.0147csB). The report is a sample of 11 drugs, which represent about 50% of orders, and also 50% in both the dose and dollar volume of drugs dispensed in the IV *batch* process. Under the tab named "Drug Prices," the report lists a numeric identifier for each of the 11 drugs, the name of the drug, and the cost per dose. Under the tab named "Orders," the report lists orders for a year: Each record is one order. Each record contains an order number, a drug identifier, the day and hour the drug was ordered, the frequency with which the drug doses were to be administered, the ending date for the order, the date and hour that the order was canceled, and how many doses were *redispensed* for the order. The IT specialist explained to Hannah that if no cancellation date is specified in a record, then the pharmacy generates doses for the order until the ending date. All patient identifiers were removed from the report to protect patient privacy.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/ited.2015.0147csB.