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Using Link Analysis to Explore the Impact of the Physical Environment on Pharmacist Tasks

Corey A Lester, PharmD, MS^a and Michelle A Chui, PharmD, PhD^a

^aUniversity of Wisconsin-Madison, School of Pharmacy

Abstract

Background—National community pharmacy organizations have been redesigning pharmacies to better facilitate direct patient care. However, evidence suggests that changing the physical layout of a pharmacy prior to understanding how the environment impacts pharmacists' work may not achieve the desired benefits. This study describes an objective method to understanding how the physical layout of the pharmacy may affect how pharmacists perform tasks.

Method—Link analysis is a systems engineering method used to describe the influence of the physical environment on task completion. This study used a secondary data set of field notes collected from nine hours of direct observation in one mass merchandise community pharmacy in Wisconsin. A node is an individual location in the environment. A link is the movement between two nodes. Tasks were inventoried and task themes identified. The mean, minimum, and maximum number of links needed to complete each task were then determined and used to construct a link table. A link diagram is a graphical display showing the links in conjunction with the physical layout of the pharmacy.

Results—A total of 92 unique tasks were identified resulting in 221 links. Tasks were sorted into five themes: patient care activities, insurance issues, verifying prescriptions, filling prescriptions, and other. Insurance issues required the greatest number of links with a mean of 4.75. Verifying prescriptions and performing patient care were the most commonly performed tasks with 36 and 30 unique task occurrences, respectively.

Conclusion—Link analysis provides an objective method for identifying how a pharmacist interacts with the physical environment to complete tasks. This method provides designers with useful information to target interventions to improve the effectiveness of pharmacist work. Analysis beyond link analysis should be considered for large scale system redesign.

Background

There has been a nationwide shift within national chain pharmacy organizations to retool themselves as an integral part of the health care system by having pharmacists more involved in the health and wellness of patients. Chain community pharmacies have discontinued the sale of tobacco, added primary care clinics, and redesigned the pharmacy to allow pharmacists to more easily interact with patients.^{1–4} However, studies have shown that

Corresponding Author: Corey A Lester, calester@wisc.edu.

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simply physically remodeling pharmacies does not result in improved pharmacist-patient interaction and patient counseling.⁵⁻⁷ Authors cited interacting system factors such as inadequate personnel training and lack of both pharmacist and patient readiness to increase patient counseling as contributing factors for their study results. Therefore, in order to implement and sustain change, a deep and objective understanding of how current work is performed is necessary to embark in a system redesign.⁸

Few studies have used objective methods for evaluating the work of the pharmacist. A time-motion study tracked the amount of time that pharmacists spent performing tasks.⁹ However, this type of analysis did not address the factors that contribute to where a task is being performed or the order of subtasks required to complete it. Another study presented the results of redesigning two community pharmacies to increase patient counseling by pharmacists.⁷ This study recorded the activities of pharmacy personnel but did not consider the steps needed to complete tasks which can result in pulling the pharmacist away from the intended patient counseling area.

Link analysis is a method used by human factors engineers to objectively identify how humans interact with the physical layout of a workplace, most commonly in manufacturing.² It has also been used to identify the steps required to conduct tasks on the user-interface of computer software.³ More recently, a study found link analysis useful for analyzing the work of a nurse in a hospital unit.⁴ The purpose of this study is describe how link analysis can be used to examine the impact of the community pharmacy physical environment on how pharmacists complete their tasks.

Methods

Secondary qualitative data was used for this study. The primary use of the data was to examine interruptions of pharmacists. Two pharmacists were observed in a mass-merchandise chain pharmacy in Madison, WI during the spring of 2014 over three observation periods. One pharmacist was observed twice while the other was observed once. Nine hours of observations were completed. This length of observation is consistent with a study using link analysis to track nurses' movement on a hospital floor.¹⁰ With the exception of one hour, the pharmacist being observed was the only pharmacist on duty. There were three technicians working with the pharmacist during the observations. Two researchers took field notes simultaneously by hand while at the pharmacy and then typed up their findings within 24 hours of completing the observations. After typing the notes, the researchers met to discuss their notes in order to clarify discrepancies about their observations.

Data Analysis

A link analysis was performed to describe the pharmacists' movements and the steps necessary to complete a task. A link is the pathway between two locations in the physical layout of the pharmacy. Each location in the pharmacy is called a node and each node can be a source (point of origin) or target (destination). A link is the movement between a source node and target node.

Open-ended content analysis was performed to inventory all of the different tasks that were completed by the pharmacist. Each task was coded into themes. A sketch of the pharmacy's physical layout was made while conducting the observations. The researchers documented all areas in the pharmacy, including the location of the pharmacy counters, computer terminals, registers, and fax machines.

A link table provides a list of all links for each task theme being performed. For example, a pharmacist was verifying prescriptions at verification counter (source) when a patient arrived at the pick-up counter. The pharmacist moved to the pick-up counter (target) to assist the patient. This movement is the link. For the next link, the pick-up counter becomes the source and the target are the will-call scripts to find the patient's prescription. To counsel the patient, the pharmacist moves from the will-call scripts (source) to the register (target). The task theme being completed for each link is documented in a separate column. Table 1 shows a portion of the link table.

The task corresponding to the link is the first movement towards completing a task. The current task ends when the pharmacist moved to begin a new task. If the pharmacist was interrupted while completing the task, a note was made in the link table and the links resumed when the pharmacist returned to the last target associated with the task. The link table identifies the number of unique occurrences of task themes and the average number of links required to complete each task theme.

The link table was used to develop a link diagram to spatially characterize the movements of the pharmacists. The link diagram shows the euclidean distance between two nodes and does not account for physical barriers that the pharmacist might have to walk around in the pharmacy. The diagram was overlaid onto the floorplan and each node was positioned into its corresponding location. The pharmacy layout and link diagram were created using the network analysis software, Gephi (Version 0.8.2).⁹ Due to limitations with the link analysis software, the ability to show directionality of the movements was not possible.

Results

There were a total of 92 unique task occurrences resulting in 221 links. Table 2 provides a summary link table. Five task themes emerged from the content analysis. Tasks related to verifying prescriptions were the most commonly performed task. While handling insurance issues (*e.g., prior authorizations*) were least common. Other tasks included researching drug information and responding to technician questions.

Insurance issues required the highest mean number of movements to complete the tasks. For example, the pharmacist walked from the verification station across the pharmacy to retrieve a patient's prior authorization form in the filing cabinet next to the fax machine. The pharmacist then walked back to the verification station to complete the form. Next, the pharmacist walked to the front counter drawer below printer 1 to get a fax cover sheet. The pharmacist returned to the verification station and moved over to terminal four to retrieve necessary patient demographic and insurance information. The pharmacist then walked back

to the fax machine and faxed the forms. Once this was complete, the pharmacist walked to the front counter and placed the forms in a blue bin at the issues station.

The link diagram in Figure 2 displays the movement of the pharmacist within the pharmacy. The size of the node circle indicates the relative number of times that a pharmacist traveled to that location in the pharmacy. The thickness of the line indicates the relative number of times that a pharmacist traveled between two nodes. Pharmacists most frequently traveled from the verification station to the pick-up window to the will-call prescription area and then to register 1 to counsel patients.

Discussion

The 221 links and 92 unique tasks over a nine hour study period indicates that pharmacists' work is highly mobile. A study using link analysis to track a nurse's movement on a hospital floor found that the nurse had 128 links over a 10 hour observation period.¹⁰ This high number of links by the pharmacist indicates that task switching occurs frequently. Each movement during a task, requires the pharmacist to orient themselves to the new location before continuing. High rates of task switching may negatively impact pharmacist work and increase workload.¹¹

The results of this study indicate that insurance issues require the greatest number of links to complete a task. While insurance issues did not occur frequently, the high number of links indicates that they can be disruptive to the pharmacist's work. One reason for this was the insurance paperwork was at multiple locations in the pharmacy. This means that the pharmacist traveled to multiple locations within the pharmacy to complete the task. One design suggestion might be to create a centralized location within the pharmacy that has a dedicated insurance issue processing workstation.

The link analysis also identified a high number of times that the pharmacist traveled between register one and the verification station/computer terminal four. To do this, the pharmacist travels from the front of the pharmacy to the back of the pharmacy and walk around the counter separating the two. Wisconsin state law requires patient counseling by a pharmacist for all new or refill prescriptions.¹² This means that a pharmacist traveled to the register every time a patient picked up a prescription. The travel time slows down patient care and decreases the ability of the pharmacist to efficiently switch between tasks. A design change would be to move the verification station along with a computer terminal to the counter behind register one. This would allow the pharmacist to more easily switch between these two tasks and decrease the amount of travel time between the work areas.

However, additional considerations of the current work system need to be considered before a large scale redesign can be carried out. In this case, moving the verification station and computer terminal 4 to the front of the pharmacy may decrease the ability of the pharmacist to monitor pharmacy technician activities and decrease communication between them resulting in other issues. The positive and negatives of design changes should be weighed, and individuals must be ready to make additional changes in an iterative approach after implementation to sustain an intervention.^{8,13}

Link analysis provides a useful picture of the pharmacist's interaction with the physical environment of the pharmacy. One advantage of link analysis is the ability to see objectively how and where pharmacists are completing tasks. This technique is relatively simple to learn and does not require substantial training in proper data collection or analysis.¹⁴ Depending on the scope of the project, the time needed to conduct a link analysis is usually minimal. One major disadvantage of link analysis is that it only examines the physical aspects of the pharmacist's work and does not capture the cognitive work that pharmacists perform.¹⁴ Cognitive work examines the thought process of the pharmacist when completing tasks. This might help to better explain why pharmacists are moving between two locations in the pharmacy.

A few important limitations must be considered when evaluating these results. This study only included 9 hours of observation in one pharmacy. This means there is likely not enough data to make conclusive recommendations, especially considering the work patterns of pharmacy technicians have not been studied. This analysis used secondary qualitative data. While pharmacist tasks and the location of those tasks were closely documented, it is likely that some of the tasks were missed. The use of a data collection tool would be helpful to track to movements of the pharmacist more easily.¹⁰ It is also likely that each pharmacy would have different work patterns and require different design strategies. These limitations do not limit the usefulness of link analysis as an objective method for examining how pharmacists interact with the physical environment to complete work tasks.

Future research using link analysis would be useful to help improve pharmacists' ability to conduct clinical activities in community pharmacy. One important aspect to examine would be the work patterns of pharmacy technicians using link analysis as well as how work patterns differ between pharmacists. Changes to the design of a pharmacy could be made and a follow-up link analysis could be done to see if there are noticeable improvements in pharmacists' completion of tasks.

Conclusion

This was the first time that link analysis was conducted in a community pharmacy to examine the interaction between the pharmacist and the physical environment. These findings demonstrate that the physical environment is not always conducive for the pharmacist to work effectively and can be used to help identify improvements to the layout.

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Figure 1. Link Analysis Components

Figure 2. Link Diagram

Note: Size of circle represents the relative number of unique times the pharmacist was at that location (*i.e.*, a *node*). Width of the line represents the relative number of unique times the pharmacist traveled between two nodes (*i.e.*, a *link*).

Table 1**Example Link Table**

Source	Target	Task
Filling_station	Will_call_scripts	Counseling P3
Will_call_scripts	Register_1	Counseling P3
Register_1	Verify_station	Verifying 4
Verify_station	Filling_station	Filling 3
Filling_station	Rx_shelf	Filling 3
Rx_shelf	Filling_station	Filling 3
...	...	...
Filling_station	Verify_station	Verifying 12

Table 2
Summary Link Table

Task Theme	Mean Links	Range of Links	Number of Task Occurrences
Insurance issues (<i>e.g., prior authorization</i>)	4.75	[1 – 7]	4
Patient care-related activities (<i>e.g., counseling</i>)	3	[1 – 9]	30
Filling prescriptions	2.29	[1 – 5]	7
Verifying prescriptions	1.61	[1 – 7]	36
Other	1.53	[1 – 3]	15
Total	2.24	[1 – 9]	92