# Using Human Factors Engineering to Prevent Pharmacy Dispensing Errors

**Patricia J. Vadney**

**QAS 515, Spring 2003**

Preventing medication errors is essential to patient safety. According to the 1999 Institute of Medicine (IOM) report *To Error is Human: Building a Safer Health System*, medication errors alone account for over 7,000 deaths annually. Preventable adverse drug events affecting hospitalized patients are estimated at $2 billion per year. (Corrigan, Donaldson & Kohn, 1999) However, the largest proportion of patients receiving medications is in the outpatient or ambulatory setting, therefore these figures underestimate the total costs of injury and death associated with medication errors. Utilizing the elements of human factors engineering may prevent medication errors specifically in the dispensing of medications through the pharmacy where 11-14% of medication errors occur. (Bates, Cullen, Laird, et al., 1995) For the purpose of this paper, two pharmacies in a military medical group were analyzed. One is located in a small rural hospital and the other in a busy ambulatory clinic. The volume of prescriptions is approximately 10,000 per month. The amount of medication errors reported averages 17 per year. Many more errors occur, but they are considered "latent errors" (Burstin, 2002) that did not result in injury. They were near misses that were prevented from reaching the patient and were not reported. The human factor areas identified for improvement were environmental, task functions and job responsibilities.

The hospital pharmacy is in a building built in 1952. It was converted from a cafeteria into a pharmacy. It has high ceilings and an abundance of space. The clinic pharmacy is in a building built in 1953. It is smaller than the hospital pharmacy although it provides two-thirds of the total volume of prescriptions. There is a staff of 8 technicians and 1 pharmacist who rotate work at both pharmacies.

Illumination in the hospital pharmacy is inadequate. The hospital pharmacy as stated above is a very large room with shelves of pharmaceutical supplies, a Baker Cell machine with multiple bins of different pills, and a front counter area where prescriptions are received and processed. Work areas are located on the perimeter of the room. There are fluorescent lights in the high ceilings located throughout the room. The floors are painted blue and the walls are beige. There are no windows in the pharmacy room. The illumination of the room appears to be less than appropriate for the task of counting small pills, reading prescriptions and preparing mixtures. An early study proves there is a direct relationship between a higher dispensing error rate associated with low illumination levels. The study used three different levels of illumination: 45, 102 and 146 foot-candles. The lowest error rate was 2.6% using 146 foot-candles versus 3.8% using the baseline level of 45 foot-candles. (Buchannon, Barker, Gibson, Jiang, Pearson, 1991). The hospital pharmacy needs a bioengineering assessment of the actual illumination in the room. The room illumination needs to be at least 1,000 Lux for the visual needs of seeing small pills and the print on labels. Improvement recommendations are to either increase the lux in the current fluorescent lights or provide supplemental lamps at the front counter and above the shelves.

Noise and distractions are problems at both pharmacy locations. The hospital pharmacy has a noticeable noise distraction that has become part of the ambient noise for staff. The noise emanates from a laminar flow hood. The flow hood is used to maintain a sterile environment for mixing intravenous drugs. Although the flow hood is located in the back, the noise can be heard clearly throughout the pharmacy. The flow hood is kept on constantly because it takes at least 30 min for the old machine to become functional after it is activated. Intravenous mixtures must be immediately available upon request. The best recommendation is to buy a new machine; however, the most practical recommendation is to house the machine in a separate room within the pharmacy area.

The clinic pharmacy is very noise from an observer standpoint. The pharmacy waiting room located in front of the pharmacy windows is small and usually packed with people. The sound of people talking and babies crying can be heard in the pharmacy clearly (see Figure 1). There is a TV in the waiting room as well as a radio playing music in the pharmacy area. The pharmacy is located by the main parking lot, again with the sound of cars coming and going heard through the windows. The constant noise and activity in the waiting room as well as the loud overhead pages are distractions for the staff. Interruptions include frequent phone calls at the front counter and physicians who enter the pharmacy and request immediate information. These interruptions may interfere with the information processing related to memory and decision-making while filling the prescriptions. It is apparent that the staff in this clinic pharmacy is at risk of visual and auditory distractions from their task of filling prescriptions. In a related study of an ambulatory clinic pharmacy, interruptions and distractions were associated with overall dispensing error rates of 3 – 6%. Wrong label information was the most common type of error (80% of detected errors). (Flynn, Barker, Gibson, Pearson, Berger, 1999) One recommendation is to install a counter window that insulates the pharmacy staff from the noise of the waiting room. They could communicate through a small window or speaker for intake of prescriptions. Of course, there would have to be an open window or moveable bin for the delivery of the drugs to the patient. A more practical idea would be to move the waiting area to another section close to the pharmacy. Each person could take a number at the pharmacy and then wait at the other location until their medications are available for pick-up and their number is announced, much like a fast food waiting line. The phone should be moved away from the front desk and answered by a staff member who is not filling prescriptions. Physician interruptions should be directed to the technician or pharmacist who is not at the counter filling prescriptions. The overhead paging system needs to be turned down as well as the radio in the pharmacy.

The clinic pharmacy is very small and cramped. The front area between the desk and the shelves measures approximately 4 feet wide by 10 feet in length. There are three staff members who normally work the front counter. As an observer, it was obvious that the individuals consciously avoided colliding with each other as they crossed paths in filling the scripts. Short of building a new pharmacy, they have divided the tasks to minimize the problems of movement in a small space. One person is kept on the computer inputting data, while the other two are filling and distributing medications. Another recommendation would be to re-arrange the current shelves to allow more room near the front counter to maneuver comfortably as they do their tasks.

Both the hospital and clinic pharmacies have a problem with supply space on the shelves directly above the front counter. These drugs are meant for unit supplies (e.g. tubes of ointment, ear drops, etc…). The drugs near the front counter are easily accessible within an arm's reach. However, due to the limited shelf area many of the fast moving drugs and supplies are located on nearby shelves. This involves more steps and increased response time for the filling of prescriptions. It was also noted as a significant frustration among the staff members. The front counter shelf space is a hindrance to the efficient and timely filling of prescriptions. It reflects a common problem in pharmacies that have not changed their design to meet service needs. In a survey of hospital pharmacists, at least 30% of the hospitals had not altered their facility design within the preceding 10 years. (Alexander & Barker, 1986) Concurrently, there has been a rapid increase in the amount of new medications approved for use by the FDA. There is not enough shelf space for the high volume unit supply drugs prescribed. An improvement recommendation is to increase the shelving space at the front desks of the hospital and clinic pharmacies to accommodate the high demand medications.

Filling medication prescriptions is a task that requires attention to detail. One of the most frequent causes of errors is sound-alike and look-alike drug names, labels, and containers. There are no FDA rules for standardizing drug label names. Many times drug companies try to come up with catchy names. The number of new registered drug names has quadrupled from 744 in 1988 to 3,038 in 1998. (Adams, 2000) Many of the drugs come in multiple strengths. Drug names, labels and packages are not selected and designed in accordance with human factor principles. (Kenagy and Stein, 2001) As an example, the FDA received 53 reports of adverse drug events related to dispensing errors involving three sound-alike drugs Celebrex, an arthritis drug, Cerebyx used for treatment of seizures and Celexa, an anti-depressant. (Adams, 2000) While the hospital pharmacy had implemented some human factor changes in bin and shelf labeling, these were not apparent in the ambulatory clinic pharmacy. The clinic pharmacy had shelves with labels that were typed in10 font black ink on white labels 2 inches wide that also included a bar code for supply purposes. The labels on the bottom shelf and the container labels were not visible unless you stooped down low to see them up close.

Several recommendations to reduce medication errors with sound-alike, look-alike drugs were issued through the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) in a sentinel alert issue 19. (JCAHO, 2001) The clinic implemented one of the recommended solutions by separating the same drug in different strengths by putting another medication in between the different strengths of drugs.

There are several human factor recommendations that might reduce the potential of errors. First, it may be beneficial to limit the number of strengths of a drug provided. This action reduces the number of choices or opportunities for error. The clinic should adopt the hospital's policy of color-coding the strengths of medications. Black labels are printed for single strength medications. Medications in multiple strengths are color coded in sequence from the lowest strength in blue print to the highest strength in red print (see Figure 2).

Another necessary improvement is the labeling of the shelves and containers. The labels should be easy to distinguish differences in the drugs and strengths. In other words, colors, shading and exaggerated lettering should be used to provide clear, unambiguous labels as seen in Figure 3. (Schneider, 2002) Labels on the bottom shelves and containers should be printed in larger type font so that they are more easily read from a distance without having to bend down low to read them. For some drugs and supplies, different colored bins may be used on the shelves to physically separate the items. These actions should decrease the reliance on individual memory for the location of the drugs and decrease confusion with similar drug names, multiple strengths of the same drug, and drugs in similar packaging.

Another area that appears to be problematic is the workflow design. “Mura” is a concept used for continuous improvement, it involves reducing discrepancies and variation. It might be useful for both the clinic and hospital pharmacies to conduct a step-by-step work flow process. There may be redundant steps that can be eliminated. Based on review of the known medication errors, there is variation in processes between the hospital and clinic pharmacies. For example, verifications of individuals picking up prescriptions differ between the two pharmacies. A way to reduce variation is to standardize the process and educate the staff. The processes should be the same at both locations. Reminder cards should be placed at workstations to reduce reliance on memory for key steps.

Lastly, the issue of loading might be a factor in work performance and related medication errors. The organization “hired” new staff who graduated from a technical school with little to no experience in a pharmacy. This practice leads to extra work and stress placed on the rest of the pharmacy staff. The new trainees must be mentored until they are certified to work independently. It adds additional responsibility to the assigned mentor who must not only complete his/her tasks, but must supervise the trainee. The trainee is not available for on-call duties. The rest of the staff must rotate on-call duty in the place of the trainee until he/she is certified. In talking with the staff, there is always an increased chance of errors with an individual who is learning a new task. It is especially evident in pharmacy when attention to detail and strict adherence to policies are critical in daily operations. In order to improve the loading of the staff, it is recommended that the organization reduce the number of “trainees” sent to a rural pharmacy location with limited staff or increase the number of experienced staff available to provide the time needed to mentor the trainees.

Human factors can be applied to improve medication-use and patient safety by reducing the potential of dispensing errors in the pharmacy. Recommendations for pharmacy improvements include: increased illumination in the hospital pharmacy, decrease of noise and distractions, redesign of workspace and equipment, reduction of response choices by clear drug and shelf labeling, standardization of task processes between the hospital and clinic pharmacies and revision of staff hiring criteria. It is unfortunate that human factors engineering is not included in most health care curricula. However, with the recent emphasis on improving patient safety, it is important that health care organizations provide human factors training for their staff and that they enlist the expertise of human factor engineer experts when designing and redesigning work space areas such as the pharmacy.

## REFERENCES

Adams, C. (2000). What's in a Name? When it Comes to Drugs – *The National Coalition on Health Care, The Institute for Healthcare Improvement.* Retrieved online February 12, 2003 from http://www.nhc.org/releases/Medical_errors.pdf

Barker, K.N. and Alexander, V.B. (1986). National Survey of Hospital Pharmacy Facilities. *American Journal of Hospital Pharmacy,* 43, 321-324. Abstract retrieved March 13, 2003 from Air Force Virtual Library online via access: https://www.afms. Mil/ knowledge_center

Bates, D.W., Cullen, D.J., Laird, N., Peterson, L.A., Small, S., Servi, D., e. al. (1995) "Incidence of adverse drug events and potential adverse drug events: Implications for prevention." *Journal of the American Medical Association, 274, 29-34.*

Buchanan, T.L., Barker, K.N., Gibson, J.T., Jiang, B.C., & Pearson, R.E. (1991). Illumination and errors in dispensing. *American Journal of Hospital Pharmacy,* 48, 2137-45.

Burstin, H. (2002). "Crossing the Quality Chasm" in Emergency Medicine. *Academic Emergency Medicine*, 9, 1074. Retrieved February 11, 2003 from Air Force Virtual Library online via access: https://www.afms.mil/knowledge_center

Corrigan, J.M., Donaldson, M.S. & Kohn, L.T. (1999). *To Error is Human: Building a Safer Health System.* Washing D.C., National Academy Press, 1999.

Joint Commission on Accreditation of Healthcare Organizations. (2001). Sentinel Event Alert #19 – Look-alike, sound-alike drug names. Retrieved March 16, 2002, from http://www.jcaho.org/about+us/news+letters/sentinel+event+alert/sea_19.htm

Kenagy, J.W., and Stein, G.C. (2001). Naming, labeling and packing of pharmaceuticals. *American Journal of Health-System Pharmacy,* 58, 2033-2041. Abstract retrieved February 11, 2003 from the Air Force Virtual Library via access: https://www.afms.mil/knowledge_center

Schneider, P.J. (2002). Applying human factors in improving medication-use safety. *American Journal of Health-Systems Pharmacists,* 59, 1155-1159.

**Figure 1**

*Figure 1.* Clinic Pharmacy Design Layout showing waiting room located next to pharmacy windows. The design adds noise and distraction for the pharmacy staff.

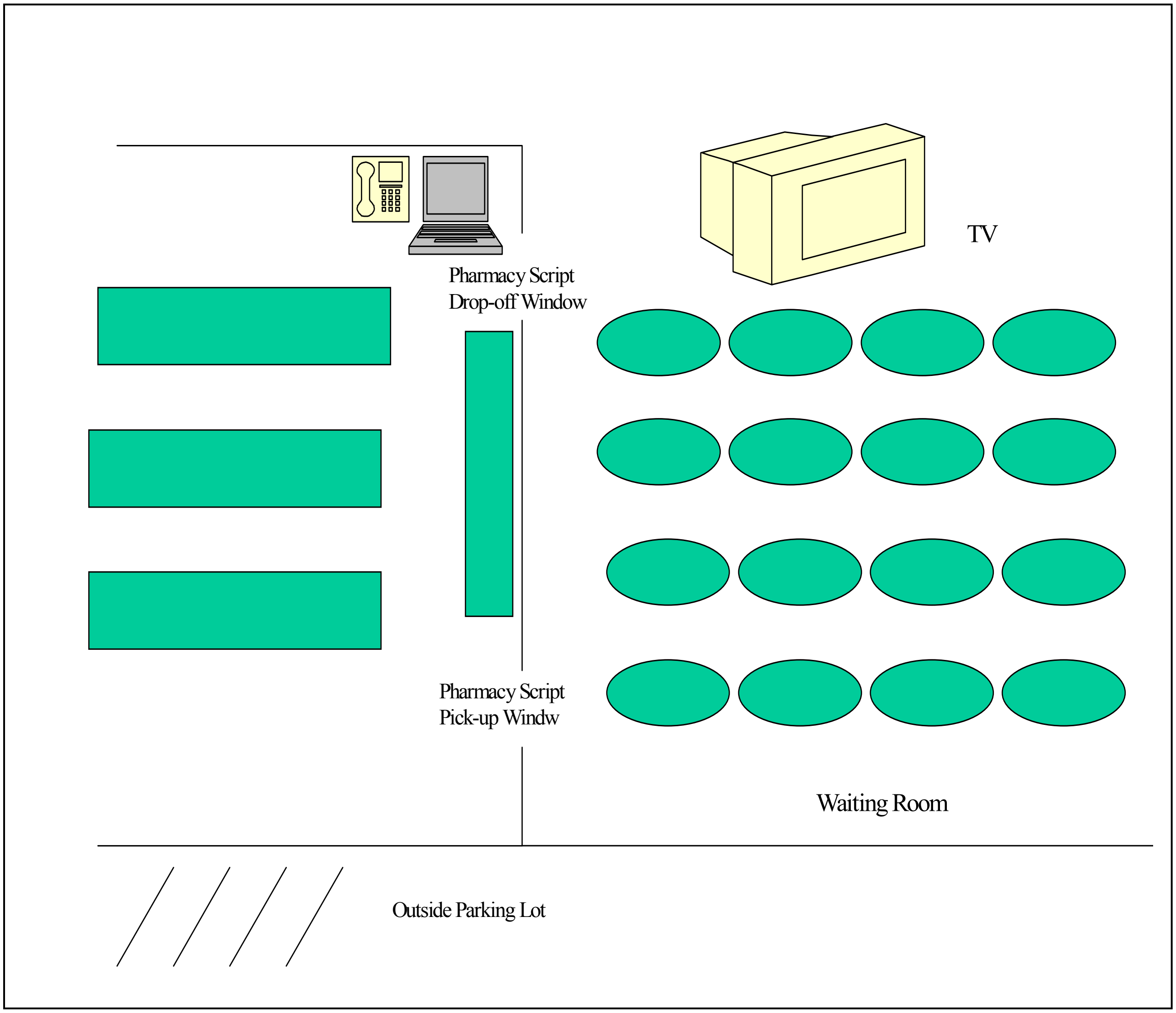

**Figure 2**

*Figure 2.* Bin labeling - Example of the same drug printed in different colors according to strength level.

**Figure 3**

*Figure 3.* Example of different types of labels for similar sounding drugs

| | |
|---|---|
| Celexa 20 mg | *Cele*brex 200 mg |
| **Hydr*alazine*** | Hydr***oxyzine*** |
| ***Ortho***-Cyclen 28 | Ortho ***Tri***-Cyclen 28 |