A STUDY OF THE ACCURACY OF THE **INSTYMEDS** AUTOMATED PRESCRIPTION DISPENSING SYSTEM

ELIZABETH A. FLYNN, PHD, RPH

The objectives of this study were (1) to determine the accuracy of prescriptions dispensed from the InstyMeds Automated Prescription Dispensing device, pursuant to a prescriber-entered electronic order; and (2) to compare the accuracy of InstyMeds products to that of prescriptions dispensed from typical outpatient and community pharmacies involving pharmacist-inspection of filled prescriptions prior to dispensing to a patient.

The undersigned was the principal investigator (PI) for this study. I am experienced in dispensing accuracy studies (see References and my attached curriculum vitae), and I was awarded the APhA Wiederholt Prize for Outstanding Research in 2010 for a study for which I was primary author, entitled "Dispensing errors and counseling quality in 100 pharmacies" (2009). I am a registered pharmacist, and I currently practice in a community pharmacy on a part-time basis in addition to conducting research. I have first-hand experience with assessing the accuracy of prescriptions in typical pharmacy systems.

Background

The results of a national study of dispensing accuracy found that 50 community pharmacies in six states had an overall accuracy rate of 98.3% on a sample of 4,481 filled prescriptions. Errors were detected using direct observation and inspection of filled prescriptions to optimize validity of the results. Most of the 77 errors involved the label: 52% were wrong instruction errors and other incorrect label information was contained on 14% of the errors. Wrong drug errors occurred on 8% and wrong strength errors occurred on 10% of the 77 incorrect prescriptions. Five of the 77 errors (6.5%) were judged as potentially harmful to patients (Flynn et al., 2003). Dispensing error rates in prescription filling operations measured using observation over the past 30 years range from 2% to 10% when comparable definitions are used (Flynn et al., 2003).

The InstyMeds System

InstyMeds devices are typically located in emergency departments of rural hospitals and contain a limited formulary of urgent care medications. The InstyMeds automated prescription dispensing system workflow starts with a Verified Accredited Wholesale Drug Distributor (VAWD) supplying the bar coded, prepackaged unit of use medications. The bar coded medications are packaged in a bar coded magazine (cartridge) that also tracks lot number, expiration date and pedigree information. The magazine is inserted into the InstyMeds device and catalogued for dispensing to a patient. Following patient treatment by his or her physician, diagnosis, drug review, order entry and patient medication consultation by the treating physician, the patient selects InstyMeds for prescription delivery. A voucher with a code is given to the patient that is accompanied by written counseling information. The patient proceeds to the InstyMeds device (typically in the waiting area of an emergency department or clinic), verifies his or her identity, and enters the code onto the display screen of the device. The voucher and the display screen of the device show the patient

how many containers they will receive from the device. When selection, patient-specific labeling and electronic verification of each prescription ordered is completed, the device releases the product into the bin for removal by the patient. An example of the voucher and drug information given to the patient is located in Appendix A.

Methods

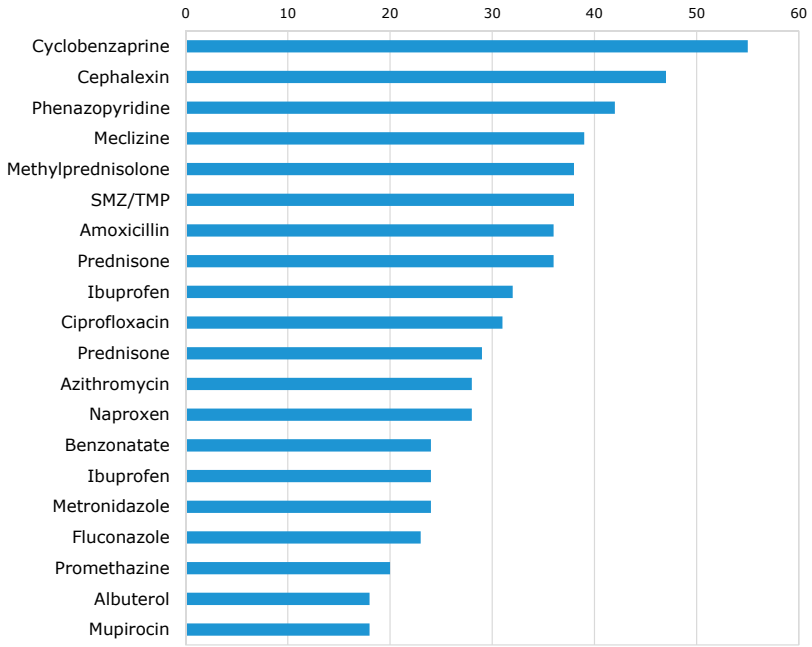
A cross-sectional descriptive study was completed at 41 randomly selected InstyMeds sites that agreed to participate in the study. A letter of introduction to the study (Appendix B) was sent by InstyMeds after development and approval by the PI. Invitation to participate was made by an InstyMeds client manager familiar with the staff at the sites. Appendix C shows a sample email that was sent to sites within a week of agreeing to participate, and following entry of prescriptions into the InstyMeds system at their site by the PI.

A dispensing error was defined as any deviation on the filled prescription from the prescriber's electronic order. Errors were defined in the same way as for the National Dispensing Accuracy study to allow comparison of the results (Flynn et al., 2003). Error categories included wrong drug, wrong strength, wrong form, wrong label instructions, wrong label information (except instructions), wrong quantity and deteriorated drugs. Quantities were assessed for bulk packages, just as in the National Study (oral solids were not double counted to allow comparison to the National Study). Complete definitions are located in Appendix D.

Data Collection Procedures

The principal investigator (PI) logged onto the InstyMeds system as a prescriber and entered 25 prescriptions for 40 sites, and 15 for the 41st site. The InstyMeds sites were located in 12 different states (CO, FL, IA, ID, IL, KS, MI, MN, MO, ND, WI, WY). InstyMeds personnel remotely created six test patients for this study at each site. Four to five prescriptions were entered for each of these six test patients, for a total of 25

FIGURE 1. TOP 20 MEDICATIONS PRESCRIPTION COUNT



prescriptions per site. Medications prescribed were independently selected by the PI from those on the formulary at each site, excluded controlled substances, and represented a variety of drugs and forms available in each device. At no time was any InstyMed's employee involved in the PI's selection of the prescriptions for this study.

The PI communicated the voucher codes directly to the Pharmacy Director or Nurse Manager at each study site. A feature of the InstyMeds technology is that once the prescription information

TABLE 1. MEDICATIONS EVALUATED IN STUDY

	Drug Filled	*Prescription Count*	*Strength*
1	Cyclobenzaprine	55	10
2	Cephalexin	47	500
3	Phenazopyridine	42	200
4	Meclizine	39	25
5	Methylprednisolone	38	4
6	SMZ/TMP	38	DS
7	Amoxicillin	36	500
8	Prednisone	36	10
9	Ibuprofen	32	800
10	Ciprofloxacin	31	500
11	Prednisone	29	20
12	Azithromycin	28	250
13	Naproxen	28	500
14	Benzonatate	24	100
15	Ibuprofen	24	600
16	Metronidazole	24	500
17	Fluconazole	23	150
18	Promethazine	20	25
19	Albuterol	18	0.083
20	Mupirocin	18	2
21	Augmentin	17	875
22	Hydroxyzine	17	25
23	Antipyrine, benzocaine, glycerin	16	
24	Cetirizine	16	10
25	Diphenhydramine	16	25
26	Omeprazole	16	20
27	Triamcinolone	16	0.1
28	Cortisporin	15	
29	Hydroxyzine Pamoate	13	25
30	Penicillin VK	13	500
31	Benzonatate	12	200
32	Prednisone	11	5
33	Prochlorperazine	11	10
34	Indomethacin	9	50
35	Nitrofurantoin	9	100
36	Ondansetron ODT	8	4
37	Ranitidine	8	150
38	Amoxicillin	7	875
39	Clindamycin	7	150
40	Clotrimazole	7	1
41	Methocarbamol	7	750
42	Famotidine	6	20
43	Mucinex	6	600
44	Albuterol	5	INHALER
45	Ciprofloxacin	5	250
46	Metoclopramide	5	10
47	Silver Sulfadiazine	6	1
48	Docusate	4	100
49	Nystatin	4	100000
50	Prednisolone	4	15
51	Acyclovir	3	400
52	Amoxicillin	3	250
53	Clindamycin	3	300
54	Gentamicin	3	0.3
55	Indomethacin	3	25
56	Loratadine	3	10
57	Senna-s	3	50
58	Acetaminophen	2	160
59	Acyclovir	2	800
60	Amoxicillin	2	400
61	Amoxicillin chewable	2	250
62	Dexamethasone	2	4
63	Diclofenac DR	2	75
64	Dicyclomine	2	10
65	Diphenhydramine	2	12.5
66	Ibuprofen	2	200
67	Ibuprofen	2	400
68	Ondansetron	2	4
69	Sulfatrim	2	200
70	Acetaminophen	1	500
71	Acyclovir	1	200
72	Amoxil	1	500
73	Augmentin	1	400
74	Betamethasone Dipropionate	1	0.05
75	Cefuroxime	1	500
76	Cephalexin	1	250
77	Corfen DM	1	
78	Docusate - Sennosides	1	50-8.6
79	Fluocinonide	1	0.05
80	Furosemide	1	20
81	Hydrocortisone	1	1
82	Ibuprofen	1	100
83	Ipratropium Bromide	1	0.06
84	Ketoconazole	1	2
85	Ketorolac	1	10
86	Loperamide	1	2
87	Meloxicam	1	7.5
88	Metformin	1	500
89	Mucinex DM	1	1200
90	Nystatin and triamcinolone	1	
91	Ofloxacin	1	0.3
92	Penicillin VK	1	250
93	Phenazopyridine	1	100
94	Prochlorperazine	1	5
95	Promethazine and Dextromethorphan	1	
96	Proventil	1	90
97	Tamsulosin	1	0.4
98	Tobramycin	1	0.3
99	Ventolin HFA inhaler	1	90

is entered and the voucher codes are electronically assigned, they are unable to be altered. The 1001 medications were dispensed from the InstyMeds device at each site by the Pharmacy Director, Nurse Manager, or their designee. The forty-one InstyMeds sites shipped the filled prescriptions directly to the PI as verified by viewing the tracking information for each package. Each dispensed container was evaluated for evidence of tampering – for example, oral solids were packaged in sealed containers. At no time was any InstyMed's employee involved in the shipping of the prescriptions selected by, and shipped to, to the PI. Instead, the shipping of the prescriptions was performed by independent medical staff (e.g., Pharmacy Directors, Nurse Managers, etc.) in the medical facility where the InstyMeds device was located.

Prescriptions were inspected by the PI by opening each container, viewing and entering the tablet or capsule ID code into LexiComp Drug ID program or Drugs.com Pill Identifier app for the iPad2 and determining if the product and strength in the dispensed container matched what the ID code represented. Pre-packaged items were evaluated by comparing the manufacturer's label information to the electronic order. The label information on the dispensed container was then compared to the order entered into the InstyMeds system that matched the patient number and voucher code for the item. Any deviations between the label and the electronic order were considered an error. Data for each prescription was entered into an Access database to facilitate analysis.

The sample size goal of 1,000 was used because this would represent samples of 25 prescriptions from approximately half of all InstyMeds sites at the time of the study. This is the first descriptive study of the accuracy of the InstyMeds device and a sample of 1,000 prescriptions was estimated to provide sufficient evidence to compare to the National Study results.

Results

One thousand and one prescriptions were entered and dispensed by InstyMeds devices at 41 locations in 12 states. Ninety-nine different medication products were dispensed (Table 1). Figure 1 displays the frequency that the top 20 medications were used in dispensed prescriptions for the study, demonstrating the common use of the InstyMeds system in emergent care settings. Table 2 displays the variety of medication forms evaluated in the study.

TABLE 2. MEDICATION FORMS EVALUATED

Form	*Count*	*Percent*
Blister pak	113	11.3%
Inhalant	25	2.5%
Nasal	1	0.1%
Ophthalmic	4	0.4%
Oral liquid	13	1.3%
Oral solid	744	74.3%
Otic	32	3.2%
Powder	6	0.6%
Pre-pack oral solid	7	0.7%
Topical	56	5.6%
	1001	**100.0%**

No dispensing errors of any type were detected. The InstyMeds devices exhibited an accuracy rate of 100%.

Discussion

The national study measured a 98.3% accuracy rate when traditional prescription filling systems involving a pharmacist final verification. The pharmacist performs many other tasks while verifying prescriptions that are well-suited to human expertise and abilities (e.g., drug utilization review), but 100% accurate prescription inspection is still being pursued.

The prescriber order entry system used with the InstyMeds devices may explain the difference in accuracy of the prescription labels compared to the National Study. Wrong label instructions and other label information were the largest error categories in the National Study, but no errors of these types were detected on the InstyMeds products. The InstyMeds prescriber order entry system does not require any additional editing of the order entered or transcription, as many pharmacy systems do.

Conclusion

An accuracy rate of 100% of dispensed prescriptions was achieved by the InstyMeds system on 1,001 dispensed prescriptions. Prescription filling systems that include human inspection have achieved an accuracy rate of 98.3%. The difference of 1.7% in accuracy means that on 300 million prescriptions dispensed in the United States each year, over 5 million prescriptions are filled in error by human systems. In contrast, this study revealed no such errors associated with InstyMeds devices.

Elizabeth Flynn, PhD

APPENDIX A. InstyMeds Voucher and Drug Information Example

InstyMeds Order

Madison Memorial Hospital
450 E. Main St.
Rexburg, ID 83440
Phone: (208) 359-6900

Test Pt 1 TEST October 7, 2013

InstyMeds Code: 1856022

The packages contained within InstyMeds machines comply with federal and state packaging laws. Please note that any packages that have been approved to be in a non-child resistant package yield a "keep out of reach of children" caution for your added protection.

Attention Pharmacies: This is not a valid prescription. Please call 952-653-2568 with any questions.

Order: 2268528 **Prescribed by:** Test Prescriber MD

Rx: 3162047 **Refills:** 0
Phenergan (generic form) Tablet 25 mg (#15)
Take one or two tablets by mouth every six to eight hours as needed for nausea and vomiting.

*** This prescription for Phenergan (generic form) will have 1 container. ***

Rx: 3162046 **Refills:** 0
Albuterol Solution 0.083% premixed vial for neb. (#25)
Mix 1 vial(s) and Nebulize every 4-6 hours as needed for wheezing

*** This prescription for Albuterol will have 1 container. ***

Rx: 3162045 **Refills:** 0
Bactroban (generic form) Ointment 2% (22gm = 1 tube) (#22)
Apply to affected area three times daily

*** This prescription for Bactroban (generic form) will have 1 container. ***

Rx: 3162044 **Refills:** 0
Amoxicillin Chew Tab 250 mg (#30)
Chew 1 tablet orally three times daily for 10 days

*** This prescription for Amoxicillin will have 1 container. ***

Rx: 3162043 **Refills:** 0
SSD Cream 1% (#25)
Apply to affected area(s) twice daily

*** This prescription for SSD will have 1 container. ***

Your order will have 5 container(s).

Test Pt 1 TEST Page 1

Patient Drug Education

Test Pt 1 TEST October 7, 2013
Order: 2268528 **By:** Test Prescriber MD
Rx: 3162047 **Refills:** 0
Phenergan (generic form) Tablet 25 mg (#15)
Take one or two tablets by mouth every six to eight hours as needed for nausea and vomiting.

Read this medicine information sheet carefully each time you get this medicine filled.
This medicine information sheet has been written specifically for male patients.

Promethazine Tablets

Pronunciation:
proe-METH-a-zeen
Brand Name:
Phenergan
Product Dispensed:
Phenergan (generic form) Tablet 25 mg (#15)

This medicine is used for:

Relieving allergy symptoms, including hives or runny nose. It is used to prevent and control nausea and vomiting during and after surgery. It is also used to help produce light sleep; prevent and treat motion sickness; or treat pain after surgery, in combination with other medicines. It may also be used for other conditions as determined by your doctor.

This medicine is a phenothiazine antihistamine. It works by blocking the sites where histamine acts.

Do NOT use this medicine if:

- you are allergic to any ingredient in this medicine
- you have severe central nervous system depression or are in a coma
- you are also taking astemizole, cisapride, terfenadine, or tramadol

Contact your doctor or health care provider right away if any of these apply to you.

Before using this medicine:

Some medical conditions may interact with this medicine. Tell your doctor or pharmacist if you have any medical conditions, especially if any of the following apply to you:
- if you are taking any prescription or nonprescription medicine, herbal preparation, or dietary supplement
- if you have allergies to medicines, foods, or other substances
- if you have nervous system problems, bone marrow depression, heart problems, a blood disease, glaucoma, increased eye pressure, low blood pressure, liver problems, prostate problems, Parkinson disease, seizures, or Reye syndrome
- if you regularly consume large amounts of alcohol

Some MEDICINES MAY INTERACT with this medicine. Tell your health care provider if you are taking any other medicines, especially any of the following:
- Charcoal or lithium because they may decrease this medicine's effectiveness
- Angiotensin-converting enzyme (ACE) inhibitors (eg, enalapril), astemizole, cisapride, general anesthetics (eg, thiopental), methyldopa, terfenadine, or tramadol because side effects, such as low blood pressure and seizures, may occur
- ACE inhibitors (eg, enalapril), haloperidol, lithium, meperidine, metrizamide, monoamine oxidase inhibitors (MAOIs) (eg, phenelzine), naltrexone, polypeptide antibiotics (eg, actinomycin), or trazodone because the risk of their side effects may be increased by this medicine
- Bromocriptine, epinephrine, levodopa, or pergolide because their effectiveness may be decreased by this medicine

This may not be a complete list of all interactions that may occur. Ask your health care provider if this medicine may interact with other medicines that you take. Check with your health care provider before you start, stop, or change the dose of any medicine.

How to use this medicine:

Use this medicine as directed by your doctor. Check the label on the medicine for exact dosing instructions.
- Take this medicine by mouth with or without food. If stomach upset occurs, take with food to reduce stomach irritation.
- If you are using this medicine for motion sickness, take a dose at least 30 to 60 minutes before you begin traveling.
- If you miss a dose of this medicine and you are using it regularly, take it as soon as possible. If it is almost time for your next dose, skip the missed dose and go back to your regular dosing schedule. Do not take 2 doses at once.

Patient Drug Education Continued

Ask your health care provider any questions you may have about how to use this medicine.

Important safety information about this medicine:

- This medicine may cause drowsiness or dizziness. These effects may be worse if you take it with alcohol or certain medicines. Use this medicine with caution. Do not drive or perform other possibly unsafe tasks until you know how you react to it.
- Do not drink alcohol or use medicines that may cause drowsiness (eg, sleep aids, muscle relaxers) while you are using this medicine; it may add to their effects. Ask your pharmacist if you have questions about which medicines may cause drowsiness.
- Neuroleptic malignant syndrome (NMS) is a possibly fatal syndrome that can be caused by this medicine. Symptoms may include fever; stiff muscles; confusion; abnormal thinking; fast or irregular heartbeat; and sweating. Contact your doctor at once if you have any of these symptoms.
- This medicine may cause you to become sunburned more easily. Avoid the sun, sunlamps, or tanning booths until you know how you react to this medicine. Use a sunscreen or wear protective clothing if you must be outside for more than a short time.
- Use this medicine with extreme caution in the ELDERLY; they may be more sensitive to its effects.
- This medicine should not be used in CHILDREN younger than 2 years old. Serious, and sometimes fatal, side effects (difficult or slowed breathing, drowsiness leading to coma) have occurred when this medicine has been used in children in this age group.
- This medicine should be used with extreme caution in CHILDREN 2 years old or older. The lowest effective dose should be used in children 2 years old or older.

Possible side effects of this medicine:

All medicines may cause side effects, but many people have no, or minor, side effects.

Check with your doctor if any of these most COMMON side effects persist or become bothersome:
Blurred vision; dizziness; drowsiness; dry mouth; nausea; vomiting.

Seek medical attention right away if any of these SEVERE side effects occur:
Severe allergic reactions (rash; hives; itching; difficulty breathing; tightness in the chest; swelling of the mouth, face, lips, or tongue); confusion; excessive sweating; fainting; fever, chills, or sore throat; hallucinations; mental or mood changes (eg, agitation, delirium, exaggerated sense of well-being, excitability, hysteria, nervousness); seizures; severe of persistent dizziness; shortness of breath or trouble breathing; slow or fast heartbeat; tremor; trouble sleeping; uncontrolled muscle movements; unusual brusing or bleeding; yellowing of skin or eyes.

This is not a complete list of all side effects that may occur. If you have questions about side effects, contact your health care provider. Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088. You may also report side effects at http://www.fda.gov/medwatch.

If OVERDOSE is suspected:

Contact 1-800-222-1222 (the American Association of Poison Control Centers), your local poison control center (http://www.aapcc.org), or emergency room immediately. Symptoms may include convulsions; dry mouth; flushing; hallucinations; loss of consciousness; nightmares; seizures; shortness of breath; trouble breathing; unusual drowsiness or restlessness.

Proper storage of this medicine:

Store this medicine at room temperature, between 68 to 77 degrees F (20 to 25 degrees C). Store away from heat, moisture, and light. Do not store in the bathroom. Keep tightly closed. Keep this medicine out of the reach of children and away from pets.

General information:

- If you have any questions about this medicine, please talk with your doctor, pharmacist, or other health care provider.
- This medicine is to be used only by the patient for whom it is prescribed. Do not share it with other people.
- If your symptoms do not improve or if they become worse, check with your doctor.
- Check with your pharmacist about how to dispose of unused medicine.

This information should not be used to decide whether or not to take this medicine or any other medicine. Only your health care provider has the knowledge and training to decide which medicines are right for you. This information does not endorse any medicine as safe, effective, or approved for treating any patient or health condition. This is only a brief summary of general information about this medicine. It does NOT include all information about the possible uses, directions, warnings, precautions, interactions, adverse effects, or risks that may apply to this medicine. This information is not specific medical advice and does not replace information you receive from your health care provider. You must talk with your healthcare provider for complete information about the risks and benefits of using this medicine.

Issue Date: May 1, 2013
Database Edition 13.2.1.002

Questions:

APPENDIX B. Invitation to Participate Letter to Sites from InstyMeds

Dear Valued InstyMeds Partner,

For over ten years, InstyMeds has been helping our InstyMeds partners provide medications to sick patients at the point of care, helping patients get better quicker! In fact, we are closing in on 2 million safe and accurate dispenses to date.

We are very proud of these numbers and now it is time to tell the world! We have commissioned a nationally renowned pharmacy safety expert, Dr. Elizabeth Flynn, to independently validate and document the accuracy, safety, and security of the InstyMeds system.

Over the next couple of weeks, approximately 50 InstyMeds clients will be randomly selected to participate in Dr. Flynn's assessment. If selected, you will receive a phone call from an InstyMeds executive inviting you to participate in the study.

What is involved?

1. We will email or fax you a list of up to 10 voucher codes to be entered into the InstyMeds device at your location.

    - The vouchers will be prescribed for a test patient.
    - Less than an hour of staff time will be needed – anyone on your staff can enter these voucher codes and package the drugs dispensed.
    - You will not be charged for these medications or any associated dispensing fees.
    - Your supply of any one medication will not be depleted – you will receive replacement inventory as needed to replenish the medications dispensed for this study.
    - No controlled substances will be dispensed as a part of this study.

2. You will receive a labeled US Postal Service Mailing Box and tape. Simply place the test samples and paperwork in the mailing box, secure with tape, and mail it directly to Dr. Flynn.

3. As a token of our appreciation for your participation in the study, we will send you a VISA gift card, to use as you wish - perhaps for a staff luncheon.

We thank you in advance for considering this opportunity to demonstrate the accuracy and reliability of the InstyMeds system.

Thank you for your support and use of InstyMeds. We look forward to serving you and your patients in our second decade of service!

APPENDIX C. Email of Instructions Sent to Sites

Dear Mr./Mrs. _____,

Thank you for participating in the independent study of the InstyMeds device!

At your convenience in the next week, please enter the following voucher codes in the InstyMeds device and place all of the containers dispensed in the shipping containers provided by InstyMeds:

679 6131 - 4 containers

142 6871 - 4 containers

319 9548 - 4 containers

626 9939 - 4 containers

194 4564 - 4 containers

485 6369 - 5 containers

Use January 1 as each patient's date of birth. You should see a zero co-pay – no charge to anyone.

I inserted a space in each code to make it easier to read and enter – you do not have to enter a space.

If you have any questions or problems you are welcome to call or text me at 575.317.3108 – or email me and Julie Geason at InstyMeds.

Kind regards,

Betsy Flynn

APPENDIX D. Dispensing Error Category Definitions (Buchanan et al., 1991)

1. *Wrong drug:* A medication that is different from what the prescriber wrote on the prescription or, for refill prescriptions, what is printed on the prescription label.

2. *Wrong strength:* A dosage unit containing a different amount of medication than the prescriber specified is dispensed without an adjustment to the dosing instructions to the patient.

3. *Wrong dosage form (correct drug):* The form of the medication used to fill the prescription is different from what the prescriber wrote on the prescription. Examples of this type of error include filling a prescription with an enteric coated tablet when it was not ordered as such, and using a sustained release product when it was not ordered.

4. *Wrong quantity* (in the national community pharmacy study, quantity dispensed was excluded for oral solids due to the difficulty in accurately collecting this data in a timely and unobtrusive manner unless there was a difference that could be determined without counting on a tray). Quantity was determined in the current study in the same way as for the national study where pre-packaged items were evaluated for quantity. The quantity for bulk packages or oral solids were not double counted so this study's results would be comparable to the national study. Liquid volumes and the weights of topical agents were assessed. If quantity or volume of liquid could not be determined, the prescription was classified as "no error", if there were not errors in any other categories.

5. *Wrong prescription label information* (excluding instructions) was defined to include one or more of the following deviations from any one of the federal or state requirements for label contents, whichever was more strict (Fink, 1985):

- Name and address of device (pharmacy).
- Serial number of prescription.
- Date of prescription or date of filling.
- Name of prescriber.
- Name of patient, if stated in the prescription.
- Drug name
- Drug strength (if more than one strength was available)
- Quantity dispensed
- Expiration date
- Manufacturer or distributor (principal labeler)

6. *Wrong label instructions:* The directions on the prescription label deviated in one or more ways from what was prescribed, except for changes made based on good pharmaceutical practice. (Note that auxiliary label information included on the package by the pharmacist that was not required by the physician was not evaluated in this study.) For example, if "for 14 days" was added at the end of the directions for an antibiotic that should be taken for a complete course of therapy, an error was not counted. However, if the physician wrote "for 14 days" on the prescription and this was omitted from the label instructions, a wrong label instruction error was counted.

7. *Deteriorated drug:* A medication that has exceeded its expiration date is used to fill a prescription, or a medication that is stored in a location that is not in accordance with the manufacturer's recommendations (for example, outside a refrigerator).

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Dr. Flynn was a member of the Institute of Medicine's Committee on Identifying and Preventing Medication Errors (2005-2006) and the United States Pharmacopeia Safe Medication Use Expert Committee (2005-2010).

1. EDUCATION

Auburn University, Auburn, Alabama. Post-doctoral Fellow, Department of Pharmacy Care Systems. Completed September 30, 2000.

Auburn University, Auburn, Alabama. Doctor of Philosophy, Pharmaceutical Sciences. Major: Pharmacy Care Systems. Dissertation title: *Relationships Among Facility Design Variables and Medication Errors in a Pharmacy.* June 8, 1994.

University of North Carolina, Chapel Hill, North Carolina, School of Pharmacy. Master of Science, Hospital Pharmacy. Major Project title: *Improvement in the Prescribing of Cimetidine and Ranitidine for Ambulatory Patients through Pharmacist-conducted Concurrent Drug Utilization Review.* May 12, 1985.

Hospital Pharmacy Resident, The North Carolina Memorial Hospital, University of North Carolina, July, 1983 to June, 1985.

University of Florida, Gainesville, Florida. Bachelor of Science in Pharmacy. December 18, 1982.

2. HONORS AND AWARDS

1. Wiederholt Prize, American Pharmacists Association, March 14, 2010.
2. Dorothy Dillon Memorial Lecture Award, New Mexico Society of Health-System Pharmacists, 2001.
3. Cheers Award, Institute for Safe Medication Practices, for research on medication error prevention, 1999.
4. "Springboard to Teaching" Fellowship, American Foundation for Pharmaceutical Education, 1994, $15,000.

5. Fellow of the American Foundation for Pharmaceutical Education, 1990-93, $22,500.
6. Outstanding Doctoral Graduate Student: Awarded by the Graduate Council Honors Committee, Auburn University, May 18, 1994.
7. Student of the Year, Graduate School: Student Government Association, Auburn University, February 21, 1994.
8. Rho Chi Professional Honor Society, 1985.
9. Lemmon Company Award, Outstanding Graduating Senior, University of Florida, 1983.
10. Omicron Delta Kappa, National Honorary Leadership Society, 1982.
11. "Who's Who Among Students in American Universities and Colleges," 1982.

3. SCHOLARLY CONTRIBUTIONS

A. TEACHING EXPERIENCE

University of Florida (2008 to present)
Affiliate Clinical Associate Professor, Patient Safety Program Evaluation, Master of Science in Pharmacy, Major in Risk Management and Patient Safety. Distance Education program.

Auburn University
Graduate Teaching Assistant in these courses:
Drug Literature Analysis, Institutional Pharmacy I, Drugs and Your Health, Introduction to Medication Information Systems, History and Orientation

University of North Carolina (1983-1985)
Teaching Assistant: Drugs, the Pharmacist, and the Health Care System, Ambulatory Care Pharmacy Practice

Teaching: Graduate students whose work has been completed.
Ranjani Varadarajan, committee member, Master of Science
Achilles Hamilothoris, committee member, Master of Science
Ranjani Varadarajan, committee member, Doctor of Philosophy
Qian Ding, committee member, Doctor of Philosophy

4. RESEARCH AND CREATIVE WORK

BOOKS AND BOOK CHAPTERS

1. Flynn EA. Chapter 13. Using Technology in the Quality Improvement Process. In Warholak TL and David Nau eds. Pharmacy Quality: Improving the Safety and Effectiveness of Pharmacy Services. New York: McGraw Hill Medical. 2010.
2. Flynn EA, Schell KL and Rickles JO. A Psychosocial Approach to Medication Errors. In: Rickles NM, Wertheimer AI, Smith MC, eds., Social and behavioral aspects of pharmaceutical care. 2nd ed. Boston: Jones and Bartlett. 2010.

3. Flynn EA. Pharmacy Automation Technologies. In: Felder R, Alwan M., Zhang M, eds., Systems engineering approach to medical automation. Boston: Artech House. Sept. 2008.
4. Flynn EA (80%), Barker KN. Medication error research. In: Cohen MR, ed., Medication Errors. Washington, DC: American Pharmaceutical Association. 2006.
5. Committee on Identifying and Preventing Medication Errors. Preventing medication errors. Washington, DC: The National Academies Press. 2006.
6. Barker KN, Flynn EA (40%), Kvancz D. Facilities planning and design. In: Brown TR, ed. Handbook of institutional pharmacy practice. 4th ed. Bethesda, MD: American Society of Health-System Pharmacists. 2005.
7. Flynn EA (80%), Barker KN. Medication error research. In: Cohen MR, ed., Medication Errors. Washington, DC: American Pharmaceutical Association. 1999, pgs. 6.1-6.30.
8. Barker KN, Allan EL (30%), Lin AC, Pearson RE. Facilities planning and design. In: Brown TR, ed. Handbook of institutional pharmacy practice. 3rd ed. Bethesda, MD: American Society of Hospital Pharmacists. 1992, pgs. 149-163.

ARTICLE-LENGTH PUBLICATIONS

REFEREED JOURNALS

1. Hugener Seibert H, Maddox R, Williams C, Flynn EA. Effect of Bar Code Technology with Electronic Medication Administration Record on Medication Error Rates, *Am J Health-Syst Pharm*. 2013 in press.
2. Flynn EA, Barker KN, Berger BA, Braxton-Lloyd K, Brackett PD. Dispensing errors and counseling quality in 100 pharmacies. *J Am Pharm Assoc*. 2009;49:171-180
3. Flynn EA, Oppenheim BA, Barbabietola G, Marciniak A, Roberts CS, Barker KN. A multi-center comparison of nursing staff time required for the preparation and administration of liposomal amphotericin B and amphotericin B deoxycholate to voriconazole. *Journal of Clinical Nursing*. 2009;18:1168-1179.
4. Varadarajan R, Barker KN, Flynn EA, Thomas RE. Comparison of two error-detection methods in a mail service pharmacy serving health facilities. *J Am Pharm Assoc*. 2008; 48: 371-8.
5. Flynn EA (75%), Barker KN. Effect of an automated dispensing system on errors in two pharmacies. *J Am Pharm Assoc*. 2006; 46:613-15.
6. Carnahan BJ, Maghsoodloo S, Flynn EA (20%), Barker KN. Statistical Modeling of Prescription Dispensing Error Risk Using a Geometric Probability Distribution. *Am J Health-Syst Pharm*. 2006; 63:1056-61.
7. Greengold NL, Shane R, Schneider PJ, Flynn EA (10%), et al. The Impact of Dedicated Medication Nurses on the Medication Administration Error Rate: A Randomized, Controlled Trial. *Arch Intern Med*. 2003;163:2359-2367.

8. Flynn EA (70%), Barker KN, Carnahan BJ. National observational study of prescription dispensing accuracy and safety in 50 pharmacies. *J Am Pharm Assoc*. 2003; 43: 191-200.
9. Barker KN, Flynn EA (35%), Pepper GA. Observation method of detecting medication errors. *Am J Health-Syst Pharm*. 2002; 59:2314-6.
10. Flynn EA (50%), Dorris NT, Holman GT, Carnahan BJ, Barker KN. Medication dispensing errors in community pharmacies: A nationwide study. 46th Annual Meeting of the Human Factors and Ergonomics Society Proceedings. Baltimore, MD. Oct 2, 2002.
11. Barker KN, Flynn EA (65%), Pepper GA, Bates DW, Mikeal RL. Medication errors observed in 36 healthcare facilities. *Arch Intern Med*. 2002; 162(16): 1897-1903.
12. Flynn EA (70%), Barker KN, Pepper GA, Bates DW, Mikeal RL. Comparison of methods for detecting medication errors in 36 hospitals and skilled-nursing facilities. *Am J Health-Syst Pharm*. 2002; 59: 436-46.
13. Bates DW, Cousins DD, Flynn E (20%), Gosbee JW, Schneider PJ. Consensus Development Conference Statement on the Safety of Intravenous Drug Delivery Systems: balancing safety and cost. *Hospital Pharmacy*. 2000; 35(Feb): p 150-152, 155.
14. Flynn EA (90%), Barker KN, Gibson JT, Pearson RE, Berger BA, Smith LA. Impact of interruptions and distractions on dispensing errors in an ambulatory care pharmacy. *Am J Health-Syst Pharm*. 1999; 56:1319-25.
15. Felkey BG, Flynn EA (40%), Barker KN, Carper JL. Automation and information technology: Satisfying pharmacy's needs while complying with state board regulations. *NABP and US Pharm*. 1999.
16. Barker KN, Felkey BG, Flynn EA (40%), Carper JL. White paper on automation in pharmacy. *Consult Pharm*. 1998 (Mar); 13:256-293.
17. Flynn EA (90%), Pearson RE, Barker KN. Observational study of accuracy in compounding i.v. admixtures at five hospitals. *Am J Health-Syst Pharm*. 1997; 54:904-12.
18. Lin AC, Jang R, Sedani D, Thomas S, Barker KN, Flynn EA (10%). Re-engineering a pharmacy work system and layout to facilitate patient counseling. *Am J Health-Syst Pharm*. 1996; 53:1558-64.
19. Flynn EA (90%), Barker KN, Gibson JT, Pearson RE, Smith LA, Berger BA. Relationships between ambient sounds and the accuracy of pharmacists' prescription-filling performance. *Human Factors: Special Section on Human Factors in Health Care.* 1996; 38(4):614-622.
20. Dean BS, Allan EL (35%), Barber ND, and Barker KN. Comparison of medication errors in an American and a British hospital. *Am J Health-Syst Pharm*. 1995;52:2543-9.
21. Allan EL (75%), Barker KN, Severson RW et al. Design and evaluation of a sterile compounding facility. *Am J Health-Syst Pharm*. 1995;52:1421-7.
22. Barker KN, Allan EL (50%). Research on drug-use-system errors. Proceedings,

Conference on Understanding and Preventing Drug Misadventures, Chantilly, VA, October 21-23, 1994. *Am J Health-Syst Pharm*. 1995;52:400-3.

23. Allan EL (80%), Barker KN, Malloy MJ, and Heller WM. Dispensing errors and counseling in community practice. *Am Pharm.* 1995 (Dec);NS35:25-33.
24. Pearson RE, Allan EL (50%). (Analysis of) Subjects presented at ASHP Midyear Clinical Meetings, 1967-90. *Am J Hosp Pharm.* 1994;51:1788-92.
25. Allan EL (60%), Suchanek-Hudmon KL, Berger BA, Eiland SA. Patient treatment adherence: Facility design and counseling skills. *Journal of Pharmacy Technology.* November-December, 1992;8: 242-51.
26. Allan EL (85%), Barker KN. Fundamentals of medication error research. *Am J Hosp Pharm.* 1990;47:555-71.
27. Barker KN, Swensson ES, Allan EL (40%). Effect of technological changes in information transfer on the delivery of pharmacy services. *Am J Pharm Educ.* 1989;53(Winter Suppl):27S-40S.

OTHER PUBLICATIONS

1. Flynn EA (100%). Troubling amine. AHRQ Web M&M. Invited Expert discussant. September, 2006.
2. Flynn EA (100%). Medicine: Shake well. AHRQ Web M&M. Invited Expert discussant. September, 2003.
3. Flynn EA (80%), Carper JL. Basic bibliography: Automation in pharmacy. *Hosp Pharm*. 1999 (Apr); 34:506-507.
4. Barker KN, Flynn EA (50%). Basic bibliography: Facility design. *Hosp Pharm*. 1999 (Feb); 34: 250.
5. Allan EL (100%). A pharmacy manager's guide to successful facility design. *Pharm Times.* 1989;55(May):3HPT-5HPT.

PAPERS, POSTERS, OR LECTURES, REFEREED OR INVITED

1. Flynn EA. Medication Safety in Community Pharmacy. New Mexico Pharmacists Association Mid-Winter Meeting, February 3, 2008. Invited.
2. Flynn EA. Medication Safety Issues in Hospital and Community Settings. Physician's Assistants Fall Conference. Albuquerque, NM. September 15, 2007. Invited.
3. Flynn EA and Barker KN. Public View of Pharmacy: The Research Behind the 20/20 Report on Dispensing Errors. University Hospitals Consortium Pharmacy Directors Council. Palm Springs, CA. October 16, 2007. Invited.
4. Flynn EA "Error detection methods: Beyond incident reports. " Presentation. Fall Madison Institute: Conference Addressing the Institute of Medicine Report – Preventing Medication Errors. Madison, WI. November 16, 2006. Invited.
5. Flynn EA. "Preventing medication errors. " Presentation. Lectures on Research on Medication Errors in Hospitals, Auburn University, AL. October 25, 2006. Invited.
6. Flynn EA. "Preventing medication errors. " Presentation. United States Pharmacopeia Patient Safety Stakeholder Forum. Rockville, MD. October 11, 2006.

PAPERS, POSTERS, OR LECTURES, REFEREED OR INVITED

Invited.

7. Flynn EA. "Preventing medication errors. " Presentation. Annual meeting of the New Mexico Society of Health-System Pharmacists. Albuquerque, NM. October 10, 2006. Invited.
8. Flynn EA, Oppenheim BA, Ribaud P, Barbabietola G, Démarez V, Marciniak A, Roberts CS, Barker KN. "A multi-center comparison of nursing staff time required for the preparation and administration of liposomal amphotericin B and amphotericin B deoxycholate to voriconazole." Poster. 16th European Congress of Clinical Microbiology and Infectious Diseases (ECCMID), Nice, France, April 4, 2006. Contributed.
9. Flynn EA. "Research-based Strategies to Reduce Medication Errors in Hospitals and Community Pharmacies." Presentation. Medication Safety Forum, Lausanne, Switzerland, March 30, 2006. Invited.
10. Varadarajan R, Barker KN, Flynn EA, Carnahan BA. "An Exploratory Comparison of Two Methods of Detecting Dispensing Errors". Poster. APhA Annual Meeting, San Francisco, CA, March 18, 2006. Contributed.
11. Flynn EA. "Errors in Community Pharmacy Practice". Presentation. North Carolina Pharmacy Leaders Conference, Greensboro, NC, February 6, 2006. Invited.
12. Flynn EA. "Technology to Reduce Medication Administration Errors". Meeting of the Medication Error and Technologies Analysis group, London, United Kingdom. September 12, 2005. Invited.
13. Barker KN, Flynn EA. "Center for Pharmacy Operations and Designs: On the Effects of Pharmacy Operations and Facilities Design on Medication Errors". Presentation. Pharmacy Society of Wisconsin Annual Meeting, Green Bay, WI, September 16, 2004. Invited.
14. Flynn EA, Barker KN. "On The Problem of Dispensing Errors: What Do We Really Know (Based on Research)?" Presentation. National Healthcare Conference and Exposition, AmeriSourceBergen, Las Vegas, NV. July 15, 2004. Invited.
15. Varadarajan R, Barker KN, Flynn EA, Carnahan BJ. "An Exploratory Comparison of Two Methods of Detecting Dispensing Errors". Southern Meeting on Social and Administrative Pharmacy, Nova, Ft. Lauderdale, FL. June 11, 2004.
16. Flynn EA. "Medication Safety: The Pharmacist as Guardian Angel". Presentation. Christian Pharmacists Fellowship International Annual Meeting, Colorado Springs, CO. June 15, 2004. Invited.
17. Flynn EA, Barker KN. "Striving for Perfection: Strategies to Minimize Risk for Medication Errors - Research Evidence." Presentation. American Pharmacists Association Annual Meeting, Seattle, Wash., March 29, 2004. Invited.
18. Flynn EA, Barker KN. "Research-based Strategies to Reduce Medication Errors in Community Pharmacy and Hospitals." Presentation. Medication Safety Summit, New Mexico Society of Health-System Pharmacists, Albuquerque, NM, April 24, 2004. Invited.
19. Flynn EA, Barker KN. "Effect of an Automated Prescription Filling System and Inspection Enhancement Tool on Dispensing Accuracy." Presentation. American Pharmacists Association Annual Meeting, Seattle, Wash., March 27, 2004.

PAPERS, POSTERS, OR LECTURES, REFEREED OR INVITED

Contributed.

20. Flynn EA, Barker KN, Carnahan BJ. "National observational study of dispensing accuracy and safety in 50 pharmacies". Presentation. Virginia Pharmacists Association Annual Meeting, Virginia Beach, VA: 2003 Aug 5. Invited.
21. Flynn EA, Barker KN, Carnahan BJ. "National observational study of dispensing accuracy and safety in 50 pharmacies". Presentation. National Council of State Pharmacy Association Executives, New Orleans, LA: 2003 Apr 1.
22. Flynn EA, Barker KN, Carnahan BJ. "Observational study of factors associated with prescription dispensing errors in 50 pharmacies". Presentation. American Pharmaceutical Association Annual Meeting, New Orleans, LA: 2003 Mar 30.
23. Flynn EA, Barker KN. "Improvement of Medication Administration Accuracy Rates after Implementation of an Observation-based Error Detection System". *ASHP Midyear Clinical Meeting*, Atlanta, GA. 37(Dec 12): 2002.
24. Flynn EA, Dorris NT, Holman GT, Carnahan BJ, Barker KN. "Medication dispensing errors in community pharmacies: A nationwide study". 46th Annual Meeting of the Human Factors and Ergonomics Society. Baltimore, MD. Oct 2, 2002.
25. Barker KN, Flynn EA, Pepper GA. "Observation technique". Measuring Medication Safety in Hospitals: A multidisciplinary Invitational Conference. ASHP and Latiolais Leadership Program. Tucson, AZ. April 8, 2002. Invited.
26. Flynn EA and Barker KN. "National Study of Prescription Dispensing Accuracy: Technology Implications". APhA Sesquicentennial Stepping Stone Summit: The Best Use of Technology. Feb 26 2002. Invited.
27. Flynn EA and Barker KN. "Detecting errors using observation". *ASHP Midyear Clinical Meeting,* New Orleans, LA. 36(Dec 4): 2001. Invited.
28. Flynn EA. "Errors in Community Pharmacy." Lecture. Special meeting: Medication Error Management for the Proactive Practitioner. University of Maryland School of Pharmacy, Annapolis, MD, April 27, 2001. Invited.
29. Flynn EA. "Case Studies in Errors in Community Pharmacy". Roundtable discussions. Special meeting: Medication Error Management for the Proactive Practitioner. University of Maryland School of Pharmacy, Annapolis, MD, April 27, 2001. Invited.
30. Flynn EA. "Patient Safety: A Proactive Approach". Lecture. Food Marketing Institute 2001 Supermarket Pharmacy Conference, Dallas, TX, April 2, 2001.
31. Pepper GA, Flynn EA, Barker KN, et al. Comparison of three measures of medication administration accuracy. *Western Institute of Nursing*. Seattle, WA, April 2001.
32. Pepper GA, Flynn EA, Barker KN, et al. Comparison of three methods of detecting medication errors. 12th Rocky Mountain Interdisciplinary Research Conference. Denver, CO, January, 2001.
33. Barker KN, Flynn EA, Pearson RE. Observation based error detection system that works. ASHP Midyear Clinical Meeting. 35(Dec): p PPR-4. 2000.
34. Flynn EA, Barker KN, Pepper GA, Bates DW, Leape LL. Comparison of error detection methods in 36 hospitals and skilled nursing facilities. Presentation. ASHP Midyear Clinical Meeting. 35(Dec): p PPR-16. 2000.

PAPERS, POSTERS, OR LECTURES, REFEREED OR INVITED

35. Flynn EA, Barker KN. Medication Error Case Studies. New Mexico Society of Health-System Pharmacists Annual Meeting and Balloon Fiesta Symposium; Albuquerque, NM: 2000 Oct 9. Invited.
36. Barker KN, Flynn EA, Pearson RE. An affordable observation-based method of monitoring error rates and reducing errors. Patient Safety Initiative 2000, National Patient Safety Foundation and Joint Commission on Accreditation of Healthcare Organizations; Chicago, IL: 2000 Oct 6. Award.
37. Barker KN, Flynn EA, Pepper GA, Leape LL, Bates DW. Analysis of medication errors in 36 hospitals and skilled nursing facilities. Presentation. ASHP Midyear Clinical Meeting. 35(Dec): p PPR-17. 2000.
38. Barker KN, Flynn EA. Second General Session: From medication errors to patient safety – The senior care pharmacist's challenge. Senior Care Pharmacy 2000, American Society of Consultant Pharmacists. Boston, MA. 2000 Nov 3. Invited.
39. Barker KN, Flynn EA, Sedani D et al. Integrating technology in patient care. National Association of Chain Drug Stores (NACDS) Pharmacy, Managed Care and Technology Conference; San Diego, CA: 2000 Aug 28.
40. Barker KN, Flynn EA, Sedani D et al. Enabling pharmacists to focus on patient care. Third Annual Forum for Senior Pharmacy Executives, Boards of Pharmacy, Educators, and Pharmacy Associations, NACDS: San Diego, CA. 2000 Aug 26.
41. Flynn EA, Barker KN, Gibson JT et al. Associations between interruptions, distractions and dispensing errors in an ambulatory pharmacy. NMSHP-NMPhA 2nd Annual Collaborative Midwinter Meeting: Albuquerque, NM: 2000 Jan 22. Poster.
42. Flynn EA. System design to address workload issues. University of Florida Pharmacy Law and Management Conference: Pharmacist workload: Defining the problem and meeting the challenge; Orlando, FL: 1999 Oct 24.
43. Flynn EA. An affordable, observation-based method for monitoring error rates and reducing errors: Development and validation of the methodology and results. American Society of Health-System Pharmacists (ASHP) Midyear Clinical Meeting, Las Vegas, NV: 1998 Dec 9.
44. Flynn EA, Barker KN. National study of error detection methods. ASHP Midyear Clinical Meeting, Las Vegas, NV: 1998 Dec 8.
45. Carper JL, Barker KN, Flynn EA et al. Methodology for determining how pharmacy automation decisions are made. ASHP Midyear Clinical Meeting, Las Vegas, NV. 33(Dec): PPR-1. 1998.
46. Carper JL, Barker KN, Flynn EA et al. Factors that determine pharmacy automation purchasing decisions. ASHP Midyear Clinical Meeting, Las Vegas, NV. 33(Dec): P-285E. 1998.
47. Flynn EA, Barker KN. Evaluation of automation in a reengineering project. Presentation. American Society of Health-System Pharmacists (ASHP) Annual Meeting, Minneapolis, MN: 1997 Jun 2.
48. Barker KN, Flynn EA. Strategy for re-engineering pharmacy via automation. ASHP

Annual Meeting, Minneapolis, MN. 54(Jun): p PI-77. 1997.

49. Flynn EA, Carper JL. Performance Indicators in Evaluating Effectiveness. Institute on the Evaluation of Pharmacy Automation. Auburn University Executive Management Institute, The Emory University Hotel and Conference Center, Atlanta, GA. March 1, 1997.
50. Flynn EA, Barker KN. Comparison of Key Features: Automated Drug Distribution Systems. Institute on the Evaluation of Pharmacy Automation. Auburn University Executive Management Institute, The Emory University Hotel and Conference Center, Atlanta, GA. March 1, 1997.
51. Flynn EA. Medication Errors and Automation: Preventing Medication Errors. New Mexico Society of Health-System Pharmacists Mid-Winter Meeting, Ruidoso, NM, February 22, 1997.
52. Barker KN, Flynn EA, Carper JL. Critical issues for users of automated dispensing systems. ASHP Midyear Clinical Meeting. 31(Dec): p PI-19. 1996.
53. Flynn EA. Competence or conditions: When errors occur in the pharmacy. National Association of Boards of Pharmacy Health Law Officers Conference, Savannah, GA. November 12, 1996.
54. Flynn EA. Pharmacy and fail-safe systems. Clinical Skills and Technology - Creating Foundations for the Future. Ohio Society of Health-System Pharmacists 1996 Annual Meeting, Toledo, OH. 1996 May 9.
55. Flynn EA. Medication errors and the facility: A Look at the practice environment. University of Rhode Island College of Pharmacy, Seminar by the Sea, Newport, RI: 1996 Mar 21.
56. Allan EL. A study of IV compounding accuracy by observation in five hospitals. Presentation. ASHP Annual Midyear Clinical Meeting, Las Vegas, NV: 1995 Dec 4.
57. Allan EL. Review of research on automation and medication errors. Presentation. ASHP Annual Midyear Clinical Meeting, Las Vegas, NV: 1995 Dec 4.
58. Allan EL. Pharmacy Designs for Pharmaceutical Care. Presentation. Twelfth Annual Symposium for Pharmacy Association Executives, Indian Wells, CA, Zeneca and American Druggist, November 10, 1995.
59. Allan EL. Error potential of automated systems. Presentation. ASHP Annual Meeting, Philadelphia, PA: 1995 Jun 8.
60. Allan EL. Preventing medication errors: Research on dispensing errors. Presentation. American Pharmaceutical Association Annual Meeting, Orlando, FL: 1995 Mar 18.
61. Barker KN, Allan EL, Felkey BG. Drug therapy and drug use systems: Their implications for the health care facility of the future. Healthcare 2000: Facilities in change. 1995 Symposium, College of Architecture and Planning, University of Tennessee, Nashville, TN: 1995 Mar 31.
62. Allan EL, Barker KN, Gibson JT et al. Analysis of medication dispensing errors in an ambulatory pharmacy as detected by observation. Management Case Study. ASHP

PAPERS, POSTERS, OR LECTURES, REFEREED OR INVITED

Midyear Clinical Meeting, Miami, FL: 1994 Dec 8.

63. Barker KN, Allan EL. Low cost - high impact: Redesigning for patient focused practice. National Association of Retail Druggists 96th Annual Convention, Boston, MA: 1994 Oct 18.
64. Allan EL. Quality assurance in prescription dispensing. National Association of Chain Drug Stores Pharmacy Conference, Orlando, FL, August 24, 1994.
65. Allan EL. Effects of selected facility design variables on medication dispensing errors in a pharmacy serving ambulatory patients. Southern Pharmacy Administration Conference, University of Florida, Gainesville, Florida, June 5, 1994.
66. Dean BD, Barber ND, Allan EL et al. Medication errors - A Transatlantic study. Poster. United Kingdom Clinical Pharmacy Association Spring Meeting, Harrogate, England: 1994.
67. Allan EL, Barker KN, Felkey BG. Health Care System of the Future. United States Pharmacopeia Strategic Visions Conference. Jan 19, 1994.
68. Allan EL. New research results: Effects of environmental factors. ASHP Annual Meeting, Denver, CO: 1993 Jun 10.
69. Allan EL. Effect of facilities design on patient outcomes. ASHP Annual Meeting, Denver, CO: 1993 Jun 10.
70. Pearson RE, Allan EL. Study of topics presented at ASHP Midyear Clinical Meetings, 1967-1990. Poster. ASHP Midyear Clinical Meeting, Orlando, FL: 1992 Dec 8.
71. Barker KN, Allan EL. Quality improvement indicators and facility design. 1992 Air Force Pharmacy Officer Seminar, Quality Improvement Indicators: Framework for Assessing Quality of Care. San Antonio, TX: 1992 Aug 10.
72. Barker KN, Allan EL, Lin AC. Pharmacy facilities planning and design. Voluntary Hospitals of America Supply Company Executive Management Institute, Auburn University, AL: January, 1990; September, 1990; September, 1991; February, 1992.
73. Allan EL. Pharmacy layout and design strategies. "Making the Americans with Disabilities Act of 1990 Work for You" Workshop. University of Georgia, Athens, GA: 1991 Oct 13.
74. Allan EL. Case studies in facilities planning and design: An evaluation of human factors problems in an inpatient pharmacy. ASHP Annual Meeting. San Diego, CA: 1991 Jun 6.
75. Barker KN, Allan EL, Lin AC. The functional planning process. ASHP Annual Meeting. San Diego, CA: 1991 Jun 6.
76. Allan EL. Effects of facility design on the quality of ambulatory pharmacy care. Southern Pharmacy Administration Conference. Auburn University, AL: 1991 May 25.
77. Barker KN, Allan EL, Lin AC. Pharmacy facilities planning: A process approach. ASHP Annual Meeting. Boston, MA: 1990 Jun 5.
78. Barker KN, Allan EL, Lin AC. Facilities planning update. ASHP Annual Meeting. Boston, MA: 1990 Jun 5.

PAPERS, POSTERS, OR LECTURES, REFEREED OR INVITED

79. Barker KN, Allan EL. Automation in pharmacy. Voluntary Hospitals of America Supply Company Executive Management Institute, Auburn University, January 24, 1990.
80. Allan EL. An evaluation of environmental conditions in a hospital pharmacy department and their potential relationship to performance. Poster. ASHP Annual Meeting. Nashville, TN: 1989 Jun 8.
81. Barker KN, Allan EL, Lin AC et al. Developing a master facilities plan to justify a continuing modernization program. ASHP Annual Meeting. Nashville, TN: 1989 Jun 5.
82. Allan EL. Research on the design of pharmacy facilities. Southeast Region Pharmacy Administration Conference, University of Georgia, Athens, GA, May 1987.
83. Allan EL. When drug utilization reviews become irrational: A cimetidine case stud*y.* Paper presented to the Southeastern Residents Conference, Athens, Georgia, March 1985.
84. Allan EL, Proctor R, Hughes T et al. *Pharmacist impact on cimetidine and ranitidine therapy in ambulatory patients.* Poster. ASHP Midyear Clinical Meeting. Dallas, TX: 1984 Dec 4.
85. Gresham C, Allan EL. Audit of drug sample handling in outpatient clinics: Recommendations for pharmacy-based control. Poster. ASHP Midyear Clinical Meeting, Dallas, TX: 1984 Dec 5.

PATENTS AND COPYRIGHTS

1. Auburn University Medication Error Detection System (AU MEDS). Barker KN, Flynn EA, Pearson RE. Copyright - applied 1998.

GRANTS AND CONTRACTS

Title/Funding Source	Faculty Involvement	Year Awarded	Amount
1. AU MEDS observer certification workshops: St. Jude Children's Research Hospital, Memphis, TN and Flagler Hospital, St. Augustine, FL.	Instructor	2008	(see MedAccuracy contract)
2. Dispensing Errors and Counseling Quality in 100 Pharmacies: A Followup Study (ABC News 20/20)	Co-PI	2007	$32,024
3. AU MEDS observer certification workshop - renewal (Lancaster General Hospital)	PI	2007	$30,000
4. AU MEDS observer certification workshop - renewal (DCH Health System)	PI	2007	$30,000
5. Effect of premixed IV drugs on medication errors and costs (Baxter Healthcare)	Co-PI	2006	$670,411
6. Pharmacy Design for a Home Infusion Pharmacy (VitalCare)	Co-PI	2006	$90,000
7. Auburn University Medication Error Detection System (AU MEDS) observer certification workshop - renewal (East Alabama Medical Center)	Co-PI	2006	$30,000
8. Evaluating technology for Improving Dosage Calculations (InformMed)	Co-PI	2006	$110,808
9. AU MEDS observer certification workshop - renewal (Lancaster General Hospital)	Co-PI	2006	$30,000
10. Training and Technical Support for AU MEDS (MedAccuracy LLC)	Co-PI	2006	$126,000
11. AU MEDS renewal (DCH Health System)	Co-PI	2006	$30,000
12. Development and Evaluation of Sterile Preparations Fixtures for Hospital Pharmacy (MMI of Mississippi)	Co-PI	2005	$208,368
13. Study to Evaluate Alabama Mental Health Pharmacy System (Alabama Department of Mental Health & Mental Retardation)	Co-investigator	2005	$179,411

Title/Funding Source	Faculty Involvement	Year Awarded	Amount
14. AU Meds renewal (Lancaster General Hospital)	Co-PI	2005	$30,000
15. AU Meds Observer Training (Johns Hopkins Hospital)	Co-PI	2005	$30,000
16. AU Meds renewal (Northeast Georgia Medical Center)	Co-PI	2005	$30,000
17. AU Meds renewal (HealthEast System, MN)	Co-PI	2005	$30,000
18. Training and Technical Support for AUMEDS (MedAccuracy LLC)	Co-PI	2005	$93,751
19. AU Meds renewal (Lancaster General Hospital)	Co-PI	2004	$30,000
20. Commercialization of AU MEDS; Training and Technical Support (MedAccuracy LLC)	Co-PI	2004	$315,000
21. Study of PharmaCorr Dispensing Systems (Bryan Cave)	Co-PI	2004	$50,000
22. AU Meds Medication Observer Training (Lancaster General Hospital)	Co-PI	2003	$30,000
23. AU Meds Medication Observer Training (DCH, Tuscaloosa)	Co-PI	2003	$30,000
24. AU Meds renewal (HealthEast)	Co-PI	2002	$20,000
25. AU Meds Medication Observer Training (HealthEast)	Co-PI	2001	$20,000
26. ScriptPro Automated Dispensing: National study of dispensing accuracy; Development and Evaluation of Telepharmacy Automation	Co-PI	1999-2004	$334,561
27. Evaluation of NextRx System (NextRx)	Co-PI	2000	$204,964
28. Development and Evaluation of NextRx System (NextRx)	Co-PI	1999	$170,000
29. Cost of Administration Study of Voriconazole in five hospitals in Italy, France and the United Kingdom (Pfizer Limited)	Co-PI	1999-2005	$374,964

Title/Funding Source	Faculty Involvement	Year Awarded	Amount
30. Study to Develop an Electronic Medication Management Information and Telepharmacy Center (MMI of Mississippi)	Co-PI	1998	$120,000
31. Study to Identify the Most Effective and Efficient Medication Error Detection Method in Hospitals and Skilled Nursing Facilities. (Alabama Quality Assurance Foundation, Health Care Financing Administration)	Co-PI	1998	$469,008
32. A System to Identify Causes of Medication Errors (Health System Requested Anonymity)	Co-PI	1997	$70,000
33. Reengineering a Large Chain-Store Pharmacy	Co-Inv.	1996	$382,472
34. Institute for Evaluation of Pharmacy Automation (Automated Healthcare, Inc)	Co-PI	1996	$288,409
35. Development and Evaluation of the ScriptPro Automated Drug Dispensing Device (ScriptPro)	Co-PI	1995	$262,964
36. A Medication Error Monitoring System for Two Hospitals (Health System Requested Anonymity)	Co-PI.	1995	$64,163
37. A Study of IV Compounding Accuracy in Hospitals (Central Admixture Pharmacy Service)	PI	1995	$58,036
38. Design of a Sterile Compounding Center for the Future (Central Admixture Pharmacy Service)	PI	1995	$101,262
39. "Oracle" Strategic Information Research Service: Drug Therapy of the Future and the Health Care System of the Future (Earl Swensson Associates)	Co-Inv.	1994	$70,000
40. Study to Develop the Sterile Compounding Center of the Future and Evaluation of a Frozen Intravenous Product Thawing Unit (MMI of MS)	Co-PI	1992	$35,808
41. The Effects of the MEDSTATION ™ System on Nursing and Pharmacy Time: A Demonstration Study with Evaluation at Baylor University Medical Center, Dallas, TX (Pyxis Corporation)	Res. Assoc.	1989	$75,427

Title/Funding Source	Faculty Involvement	Year Awarded	Amount
42. A simulation study of the effects of the MEDSTATION ™ System on personnel time involving medications and the personnel-system interface at Baylor University Medical Center, Dallas, TX. (Pyxis Corporation)	Res. Assoc.	1989	$18,596
43. Grant for Facilities Design Research (Auburn University School of Pharmacy Alumni)	PI	1992	$5,000
TOTAL			$5,381,407

3. UNIVERSITY OUTREACH

1. Instructional activities.
   1. AU Meds Observer Training Workshop, three days, developer and presenter, target audience is hospital nurses and pharmacists, lecture, interactive video, practical experience, presented more than 25 times, with over 100 observers trained.

2. Technical assistance.
   1. Consultant: Assessment of Safety Culture in Indiana Community Pharmacies. Purdue University PharmaTAP. 2008-2009.
   2. Functional Program for Hospital Pharmacy designs: These projects involved the development of written specifications for new hospital pharmacy facilities based on on-site observations and assessments of existing physical space. A Functional Program describes the following details for hospital pharmacies: Functions, Work Flows, Work Areas, Workload, Equipment, Storage Requirements, Special Work Area Requirements, Arrangement of Work Areas, Space Requirements, Diagrammatic Plans, and Ergonomic Requirements. The details provided by the program enable an architect to spend more time developing functional and efficient work spaces that incorporate the latest research results on the effects of the work environment and facilities on medication errors and performance. Functional Programs were developed for the following clients:

      a. William Beaumont Hospital Department of Pharmacy, Detroit, Michigan
      b. Cleveland Clinic Foundation Department of Pharmacy, Cleveland, Ohio
      c. St. Mary's Hospital Department of Pharmacy, Huntington, West Virginia
      d. Beth Israel Deaconess Medical Center, Boston, Massachusetts
      e. Crawford Long Hospital of Emory University, Atlanta, Georgia
      f. Kaiser Permanente, Mid-Atlantic States Region

g. Maine Medical Center, Portland, Maine
h. University Hospital, Augusta, Georgia
i. Baptist Hospital of Miami, Florida
j. Queen's Medical Center, Honolulu, Hawaii
k. Long Beach Memorial Medical Center, California

3. Consultation on research projects and medication observer training for data collection: Technical assistance was provided on the following projects:
   a. Study of the Accuracy of the InstyMeds Device, November, 2012 – July, 2013.
   b. Consultant: Johns Hopkins Applied Physics Laboratory, Study of the effect of automation on dispensing errors in selected military pharmacies, April, 2011 – March, 2013.
   c. Decreasing Vulnerability to Medication Errors: A Measurement Study, University of Colorado Health Sciences Center (UCHSC) School of Nursing, Denver, Colorado, Consultant - observation method to detect errors, July, 2001 to present. Funded by the Agency for HealthCare Quality Research.
   d. Comparison of dedicated medication nurses to traditional nurse medication procedures, Cedars-Sinai Medical Center, Los Angeles, California and The Ohio State University, Columbus, Ohio. Funded by the National Patient Safety Foundation.
   e. Assessment of Pharmacy Compounding Errors and Nurse Administration Errors in Three Clinics, Dana Farber Cancer Institute, Boston, Massachusetts.
   f. Effect of information technology on medication error rates in an emergency room. Proposal to the Agency for HealthCare Quality Research by the University of Utah School of Nursing, not funded. Consultant - observation method to detect errors.
   g. Staff Nurse Work Hours, Errors and Magnet Status, Proposal to the Agency for HealthCare Quality Research by the University of Pennsylvania School of Nursing, not funded. Consultant - observation method to detect errors.
   h. Effect of bar code medication inspection system implementation on medication errors in hospitals, Proposal to the Agency for HealthCare Quality Research by the Health Research and Educational Trust of the American Hospital Association, not funded, 2004. Consultant on use of the observation method to detect medication errors.

4. System Analysis and Re-engineering of a hospital pharmacy department: Emory University Hospitals, Atlanta, Georgia
5. Research on the frequency of pharmacy dispensing errors in 100 pharmacies for American Broadcasting Company (ABC) "PrimeTime Live" program (see Allan et al. 1995 publication).
6. Consultant on pharmacy dispensing error prevention to Raley's Pharmacy, Sacramento, California and Albertson's Pharmacy, Boise, Idaho.
7. Pharmacy design consultant, University of Cincinnati, Ohio (see Lin et al. publication).
8. Assessment of ergonomic design problems in the pharmacy at Eisenhower Army Medical Center, Augusta, Georgia.

9. Consultant on evaluation of an automated medication dispensing cabinet, Veteran's Administration Medical Center, Little Rock, Arkansas.

D. PROFESSIONAL SERVICE

1. Conference Planning Committee Member, Enhancing the Rigor and Utility of Medication Use Research: A Consensus Development Conference. American Association of Colleges of Pharmacy, Pharmacy Practice Research Alliance and United States Pharmacopeia. January 14-15, 2009, Rockville, MD.
2. Reviewer, Quality Improvement course content, PQA, Terri Warholak, 2008.
3. Member, American Association of Colleges of Pharmacy Task Force on Patient Safety, 2007-2008.
4. Stakeholder, Medication Management Meeting on Improving Practice through Methodology, Measurement, and Technology, Robert Wood Johnson Foundation, November, 2007.
5. Member, United States Pharmacopeia Safe Medication Use Expert Committee, 2005-2010.
6. Member, Committee on Identifying and Preventing Medication Errors. Institute of Medicine, National Academies of Sciences. 2005-2006.
7. Reviewer, Interdisciplinary Nursing Quality Research Initiative Grant Proposals, Robert Wood Johnson Foundation, October, 2006.
8. Member of Advisory Group, Care Homes Use of Medicines Study, February, 2005 – June, 2006. The London School of Pharmacy, United Kingdom.
9. Member of the META Network (Medication Error and Technologies Analysis), sponsored by the United Kingdom's Medical Research Council (MRC), the Department of Health, the Economic and Social Research Council (ESRC), the Engineering and Physical Sciences Research Council (EPSRC), and the University of London. January 2004 – September, 2005.
10. President, President-Elect, and Immediate Past-President, New Mexico Society of Health-System Pharmacists, 2003-2005.
11. Reviewer, Quality and Safety in Health Care.
12. Reviewer, Drug Safety.
13. Reviewer, Pharmacotherapy.
14. Reviewer, American Journal of Infection Control.
15. Reviewer, The Joint Commission Journal on Quality and Patient Safety.
16. Reviewer, Journal of Patient Safety.
17. Reviewer, Journal of Telemedicine and Telecare.
18. Reviewer, American Journal of Health-System Pharmacy.
19. Reviewer, Journal of the American Pharmacists Association.
20. Reviewer, Perceptual and Motor Skills.
21. Chair, Dishonorable Conduct Committee, New Mexico Board of Pharmacy, 2002-4.
22. Peer Reviewer. Evidence Report on The Effect of Healthcare Working Conditions on Patient Safety. Oregon Health & Science University Evidence-based Practice Center for the Agency for Healthcare Research and Quality. September, 2002.
23. Spokesperson on Medication Errors. American Society of Health-System Pharmacists

Radio Media Tour. Radio interviews on KCCC-AM 930 Carlsbad, NM November 16, 2000 and KRTZ-FM 98.7 Northwest NM November 21, 2000 and 2001.

24. Member, Adverse Drug Event Committee, New Mexico Board of Pharmacy, 2001.
25. Panelist. Consensus Development Conference on the Safety of Intravenous Drug Delivery Systems. Latiolais Leadership Program, The Ohio State University, Columbus, Ohio. Phoenix, AZ: 1999 Sept. 26-28.
26. Board member. New Mexico Society of Health-System Pharmacists. October 1999-2000.
27. Advisor, Workload and Dispensing Errors. National Association of Boards of Pharmacy Task Force on Work Systems, Chicago, IL. 1998 January 23-24.
28. Reviewer. Automated Decentralized Pharmacy Dispensing Systems. *Health Devices*. 1996 (Dec); 25:436-73.
29. Reviewer. Buchanan EC et al. *Principles of Sterile Product Preparation*. Bethesda, MD: American Society of Health-System Pharmacists. 1995.
30. Member, American Pharmacists Association
31. Member, American Society of Health-System Pharmacists
32. Member, Human Factors and Ergonomics Society
33. Member, American Association of Colleges of Pharmacy
34. Member, Christian Pharmacists Fellowship International
35. Member, New Mexico Pharmacists Association
36. Member, New Mexico Society of Health-System Pharmacists

PRACTICE

1. Community Pharmacist, Kmart Pharmacy, part-time, 2009 to present
2. Hospital Pharmacist, Roswell Regional Hospital, part-time, 2010 – 2013
3. Community Pharmacist, Wal-Mart Pharmacy, part-time, 1989-1995
4. Medicine Clinic Pharmacist, The North Carolina Memorial Hospital, Chapel Hill, North Carolina, June to September, 1986.
5. Ambulatory Pharmacy Supervisor, University Hospitals of Cleveland, Ohio, July, 1985 to June, 1986.
6. Staff Pharmacist, Inpatient Pharmacy, Veterans Administration Medical Center, Gainesville, Florida, April, 1983 to June, 1983.