Evaluating the impact of telepharmacy

PHILIP J. SCHNEIDER

Purpose. The impact of remote pharmacist review of medication orders in three small community hospitals in California was evaluated.

Methods. A longitudinal study was conducted in three community hospitals without 24-hour pharmacy services before and after the implementation of telepharmacy services. Override reports from automated dispensing cabinets were reviewed. Charts were reviewed for errors and potential adverse drug events. Pharmacist interventions during times when the pharmacy was closed were evaluated. Cost estimates were based on a proprietary intervention tracking program. Surveys were administered to staff nurses and pharmacists to assess concerns about medication-use safety and job satisfaction.

Results. The number of times that nurses obtained and administered medications without pharmacist review declined by 35.3% after implementation of the telepharmacy service. There was a significant reduction in the percentage of high-risk medications obtained without a pharmacist review. Three potential adverse drug events were discovered before implementing remote order review versus none in the postimplementation period. The number of pharmacist interventions increased from 15 to 98 per week after implementing remote order review by pharmacists. Estimated cost savings resulting from preventing, identifying, and resolving medication-related problems were $261,109 per hospital in total cost saved or avoided. Nurses' survey scores reflected increased comfort with the medication-use system, patient safety, and job satisfaction.

Conclusion. Remote review of medication orders by pharmacists when the hospital pharmacy was closed decreased the number of potential adverse drug events reported and improved job satisfaction among nurses.

Am J Health-Syst Pharm. 2013; 70:2130-5

Medication errors are common and can result in injury to patients if not intercepted and corrected.[1] These errors are pervasive throughout the medication-use process, with most errors that result in patient harm occurring in the prescribing stage.[2] In 1997, a one-year study of prescribing errors in a hospital revealed an overall prevalence of errors of 3.99 per 1000 medication orders.[3] This finding prompted a standard of practice that medication orders should be reviewed by a pharmacist before doses are made available for administration to the patient.[4]

Not all hospitals have pharmacists to review all medication orders. There may be some areas of the hospital to which pharmacists are not assigned (e.g., emergency room, procedure areas, operating rooms, labor and delivery, the entire hospital if the pharmacy is not open 24 hours per day). The percentage of hospitals in which pharmacists do not review medication orders round-the-clock has been decreasing over the years, with only 37% of U.S. hospitals not reviewing orders after-hours in 2011.[5]

Remote review of medication orders is now possible as new technologies such as automated dispensing cabinets and electronic health information systems have emerged. Remote review can be performed at an affiliated hospital with a 24-hour pharmacy service, by a national or regional telepharmacy company, or by an employee pharmacist on call or at a remote location. A 2011 national survey of pharmacy practice in hospitals found that 11.7% of hospitals used an affiliated hospital, 11.1% used a national or regional company, and 1.9% used an off-site employee to review medication orders.[5]

This study was designed to evaluate the impact of telepharmacy services on patient safety, cost, and nurse and pharmacist job satisfaction in three small community hospitals that did not have 24-hour pharmacy services.

PHILIP J. SCHNEIDER, M.S., Professor and Associate Dean, Colleges of Pharmacy and Public Health, University of Arizona, Phoenix.

Address correspondence to Mr. Schneider at the College of Pharmacy, University of Arizona, 650 East Van Buren Street, Phoenix, AZ 85004 (schneider@pharmacy.arizona.edu).

The assistance of Terry Urbine, Ph.D., is acknowledged.

Funding provided by the California Health Care Foundation.

The author has declared no potential conflicts of interest.

DOI 10.2146/ajhp130138

Background

Three community hospitals in California that did not have 24-hour pharmacy services and were planning to implement telepharmacy services (PipelineRx, San Francisco, CA) were identified. Before implementation of the telepharmacy service, medications were obtained either from automated dispensing cabinets or by the night nurse supervisor who entered the pharmacy to obtain the medication. Orders for medications obtained by the night nurse supervisor were reviewed by a pharmacist the next morning to detect potential errors after the fact. In each of these three hospitals, nurses could call the on-call pharmacist at home with questions about medications. The telepharmacy service provided a review of the medication orders before the dose was obtained from an automated dispensing cabinet, so that medication-related problems could be resolved before the dose was obtained and administered to the patient. A pharmacist was also available to answer drug information questions for nurses when the pharmacy was closed.

Methods

To identify potential adverse drug events, records of overrides from automated dispensing cabinets (times when the nurse obtained a dose for administration to an inpatient before the medication order was reviewed by a pharmacist) for two weeks before and after the implementation of telepharmacy services were reviewed, and cases in which a high-risk medication was obtained were identified. High-risk medications were defined based on the Institute for Safe Medication Practices list of high-alert medications[6] as well as those with the potential to cause an adverse drug event based on considerations such as allergies and antidotes that might reflect an adverse drug event (appendix). Medical records for each of these cases were reviewed to determine if an error or adverse drug event had occurred. The following was reviewed: prescribed therapy, dose documented as administered, indication, and medication-related problems. The following medication-related problems were tabulated: drug allergy, overdose, underdose, route of administration, drug interaction, and no indication.

Pharmacist interventions were recorded for one week before implementation of telepharmacy services by asking pharmacists about telephone calls at home and retrospective interventions in the morning after an evening shift. Interventions after implementation of telepharmacy services were derived from records provided by the telepharmacy vendor. Interventions were categorized as follows: allergy addressed, dose issue addressed, drug route addressed, clarification of order, drug information provided, and drug interaction identified.

Estimates of cost avoidance were made using a proprietary intervention tracking system (Quantifi, Pharmacy OneSource, Bellevue, WA). Cost estimates associated with pharmacist interventions in this system are based on previously published studies of the cost of adverse drug events.[7-10]

Nurse and pharmacist attitudes regarding medication-use safety and job satisfaction were determined using a survey administered before and after the implementation of telepharmacy services. Separate survey instruments were developed for nurses and pharmacists. A 10-point Likert scale was used, with low scores indicating low satisfaction and high scores indicating high satisfaction with the system.

Statistical tests used included the z test (when there were sufficient numbers of observations), binomial distribution (when sample sizes were small), and the t test (when sample sizes were not equal). The a priori level of significance was 0.05.

Results

A total of 3888 medications were retrieved by nurses and administered to patients without a pharmacist review of the medication order during the two weeks before (preimplementation) and after (postimplementation) the implementation of telepharmacy services. Of these, 2361 occurred in the preimplementation period versus 1527 in the postimplementation period (difference of 35.3%) (Table 1). Of these 3888 events, 351 high-risk medications were obtained without pharmacist review (228 preimplementation [9.6%] versus 123 postimplementation [8.0%]) ($p < 0.05$, z test). While the availability of remote order entry could have theoretically eliminated overrides entirely, nurses still obtained some medications without order review by the pharmacist after telepharmacy was implemented.

Based on a review of the medical records of all overrides for high-risk medications, 37 medication errors were detected before implementation and 5 errors were detected after implementation of telepharmacy services ($p = 0.0004$, z test). A closer review of the medical records revealed that three potential adverse drug events were discovered in the preimplementation period. Two of these events were related to drugs prescribed for patients with a stated allergy to the drug prescribed. The third case involved a patient with hypokalemia for whom i.v. furosemide was prescribed. In none of these three cases were patients seriously harmed. No potential adverse drug events were detected after implementing the telepharmacy service. The reduction of potential adverse drug events was not statistically significant based on the binomial distribution.

A total of 15 interventions were made by pharmacists during a one-week interval before the telepharmacy service was implemented, either during the evening while oncall or retroactively in the morning when the pharmacy opened. No such interventions were made by employees of the hospitals after implementation of the service, but 386 interventions were made by the telepharmacy pharmacists during a four-week interval after the service was implemented. Adjusting to compare one-week intervals, there was an increase from 15 interventions per week preimplementation of telepharmacy services to 98 per week postimplementation. This suggests that drug-related problems go unsolved if a pharmacist is not readily available to identify and resolve them. Costs avoided by pharmacist's preventing, identifying, and resolving medication-related problems were an estimated $15,064 weekly or $783,328 annually for the three hospitals evaluated. If each hospital was considered equivalent, this represents an average of $261,109 per year in total costs avoided (Table 2).

A total of 154 surveys related to concerns about the medication-use process, patient safety, and job satisfaction were completed by nurses and pharmacists before and after implementing the telepharmacy service (Tables 3 and 4). Survey results were available from two of the three hospitals studied. In the survey responses, higher scores reflect less concern about medication errors and patient safety and increased job satisfaction. Average scores for the nurses increased from 6.6 before implementation of telepharmacy services to 7.3 postimplementation ($p < 0.05$, Welch's t test). Average scores for pharmacists decreased from 7.8 preimplementation to 5.4 postimplementation ($p < 0.05$, Welch's t test).

Discussion

The benefits of telepharmacy have been widely described in the medical literature. Boon[10] reported a reduction in the amount of time nurses spent locating medications and entering the pharmacy after-hours after the implementation of telepharmacy services in a critical access hospital. Witkowski[11] described the implementation of a decentralized "cartless" drug distribution system using automated dispensing cabinets and remote order review by pharmacists. One of the improvements noted was a faster

Table 1.
Results of Chart Review Before and After Remote Order Entry

Drug	Screening Criteria	Before Remote Order Entry: Charts Reviewed ($n = 227$)	Before Remote Order Entry: Errors Detected ($n = 37$)	After Remote Order Entry: Charts Reviewed ($n = 123$)	After Remote Order Entry: Errors Detected ($n = 5$)
Ampicillin	Allergy	12	0	19	0
Augmentin	Allergy	0	0	1	0
Carvedilol	Prescribed therapy	0	1	0	0
Cefazolin	Allergy	41	7	22	0
Cefepime	Allergy	0	0	1	1
Cefoxitin	Allergy[a]	2	2	5	1
Ceftriaxone	Allergy	9	1	4	0
50% Dextrose injection	Alerting order	3	0	0	0
Digoxin	Dose	4	1	5	0
Furosemide	Potassium[a]	38	4	20	2
Gentamicin	Dose	1	1	7	0
Heparin	Dose	8	2	1	0
Hydralazine	Look-alike	8	4	7	1
Hydrocortisone	Alerting order	0	0	0	0
Meropenem	Allergy	0	0	5	1
Methylprednisolone	Alerting order	16	2	0	0
Penicillin	Allergy	3	3	7	0
Phytonadione	Alerting order	27	2	0	0
Piperacillin–tazobactam	Allergy[a]	21	3	1	0
Potassium chloride	Dose/rate	1	0	0	0
Sodium polystyrene sulfonate	Alerting order	1	0	0	0
Spironolactone	Potassium	9	0	0	0
Tobramycin	Dose	1	0	0	0
Vancomycin	Dose	19	3	7	0
Warfarin	Dose/interaction	2	0	0	0

[a]One error was detected in the preimplementation group.

turnaround time, with most doses available for administration within two to three minutes after the pharmacist verifies an order.

Pickette et al.[12] described the implementation of a standard pharmacy clinical practice model that included remote order entry through a telepharmacy program operated by an urban tertiary care center. Interventions associated with cost avoidance were documented using a Web-based, clinical documentation tool. They demonstrated a reduction in drug expense of $12.89 per case-mix-adjusted patient-day over time, representing an annual cost avoidance of $984,321 at a 623-bed tertiary care community teaching hospital and $611,595 at a 200-bed community hospital.

Table 2.
Comparison of Costs Avoided Before and After Remote Order Entry

Intervention	Before Remote Order Entry		After Remote Order Entry			
	No. Interventions per Week	Cost Avoided per Week, $	Actual No. Interventions per Month	Cost Avoided per Month, $	Estimated No. Interventions per Week	Cost Avoided per Week, $
Allergy	2	306	43	6,578	10.75	1,644
Clarification	9	1,377	53	8,109	13.25	2,027
Consultation	0	0	74	11,322	18.50	2,830
Dose	1	153	57	18,778	14.25	4,695
Drug	2	306	7	765	1.75	191
Duplication	0	0	21	3,213	5.25	803
Duration	0	0	2	306	0.50	76
Formulary	0	0	24	3,672	6.00	918
Formulation	0	0	1	153	0.25	38
Frequency	1	153	33	5,059	8.25	1,265
Interaction	0	0	2	306	0.50	76
Laboratory test	0	0	8	1,224	2.00	306
Preferred drug	0	0	57	8,721	14.25	2,180
Route	0	0	10	1,230	2.50	308
Total	15	2,295	392	69,436	98.00	17,359

Table 3.
Survey Results for Nurses Before and After Implementation of Telepharmacy Services[a]

Survey Item	Hospital 1		Hospital 2		Average of Both Hospitals	
	Before	After	Before	After	Before	After
I can obtain medications for my patient in a timely manner.	5.0	7.6	6.1	5.3	5.5	6.4
I am concerned about administering a dose of medication to my patient before a pharmacist review of the medication order.	5.9	8.0	5.3	5.9	5.6	7.0
I would like to have a pharmacist answer drug information questions.	7.0	8.7	8.9	9.3	8.8	9.0
The current medication-use system is safe.	6.1	7.9	6.7	6.6	6.4	7.2
I spend too much time with medication-related activities in my practice.	5.3	6.5	6.7	4.0	6.0	5.2
Overall, I am satisfied with pharmacy services at this hospital.	5.3	8.0	5.3	6.9	5.3	7.4
I am satisfied with my job.	8.0	8.7	8.6	9.4	8.3	9.0
Average	6.1	7.9	8.8	6.8	6.6	7.3

[a]Nurses were asked to rate their agreement with each statement using a 10-point scale, where 1 = low satisfaction and 10 = high satisfaction. These statements relate to times when the pharmacy is closed.

Garrelts et al.[13] evaluated the impact of telepharmacy in a multihospital health system and found that order processing was reduced from 26.8 to 14 minutes, stat order processing was shortened from 11.6 to 8.8 minutes, and the number of clinical interventions made increased by 42%. Further, a net estimated annualized savings of $1,132,144 was realized, and nurses' job satisfaction improved.

In his work on managing the risk of organizational accidents, Reasons[14] identified the factors by which hazardous conditions result in incidents in which harm occurs. Within systems of work, there are weaknesses that create the potential for harmful events when there are hazardous conditions. These weaknesses are termed latent conditions and active failures.[14] Studies of medication errors and adverse drug events have clearly revealed that medication use is a hazardous system and that harm occurs too often.[2,7] One of the methods for reducing the chance of accidents that result in harm is to create defenses: checks in the system to identify and correct latent conditions and active failures before mistakes become harmful events.

Having pharmacists review medication orders to identify potential harm before medications are administered to patients is a proven defense that is an evidence-based component to any medication-use system. Historically, this has required a pharmacy to operate 24 hours per day, 7 days per week and 365 days per year. This is only the case in approximately one third of U.S. hospitals.[5] Expenses and the availability of pharmacists have limited the growth of round-the-clock pharmacy services, particularly in smaller hospitals. Technologies such as automated dispensing cabinets and the availability of electronic health records have opened the door to services that resolve this problem.

This study was designed to determine the impact of implementing telepharmacy services that provide pharmacist review of medication orders before a dose is administered to a patient. Patients are at risk when a dose of a high-risk medication is prepared and administered before the order is checked by a pharmacist. By reducing the frequency of this unsafe practice, medication errors and adverse drug events are less likely. A reduction in adverse drug events results in avoiding the costs associated with the treatment of them and increases in length of stay. These costs have been estimated to be between $2013 and $5857 per event.[8,9,15] Concerns about patient safety can erode job satisfaction for nurses and pharmacists, affecting retention and recruitment. The results of this study demonstrated improvements in patient safety, costs avoided, and job satisfaction for nurses after implementation of telepharmacy services when the pharmacy was closed.

This study had several limitations. Despite reviewing a considerable number of medication records, no adverse drug events were detected. In two cases of patients receiving drugs

Table 4.
Survey Results for Pharmacists Before and After Implementation of Telepharmacy Services[a]

Survey Item	Hospital 1 Before	Hospital 1 After	Hospital 2 Before	Hospital 2 After	Average of Both Hospitals Before	Average of Both Hospitals After
I am concerned about delays in the start of treatment after a drug order.	7.7	3.5	8.5	6.0	8.1	4.8
I worry about medications being administered to patients before a pharmacist review of the order.	9.4	3.0	9.5	7.3	9.4	5.2
I do not like reviewing medication orders after one or more doses have already been administered to patients.	7.2	5.0	6.8	5.7	7.0	5.0
I worry about patient safety when the pharmacy is closed.	8.3	4.0	9.1	6.0	8.7	5.0
I do not like to get called at home about medication-related problems when the pharmacy is closed.	6.4	5.5	8.2	2.3	8.2	3.9
Overall, I am satisfied with pharmacy services at this hospital.	6.6	6.5	5.6	5.0	6.1	5.8
I am satisfied with my job.	7.7	8.5	7.5	6.3	7.6	7.4
Average	7.6	5.1	7.9	5.5	7.8	5.4

[a]Pharmacists were asked to rate their agreement with each statement using a 10-point scale, where 1 = low satisfaction and 10 = high satisfaction. These statements relate to times when the pharmacy is closed.

to which they had an allergy history documented, the patients had either no allergic reaction or a minor rash. In both cases, alternative therapy was prescribed after the first dose was administered. Allergy histories are not always accurate, but an order for a medication to which a patient has an allergy documented in the medical record should be evaluated, and, except for very special circumstances, alternative therapy should be suggested. Fortunately, despite the common frequency of medication errors, very few of these errors actually result in an adverse drug event.[16] Studies of medication safety over shorter periods of time are therefore not likely to detect actual injury resulting from an error.

Annualized estimates of costs avoided were based on two two-week intervals. There could have been changes in census, case mix, severity, staffing, and other factors that affected the validity of these extrapolations. While longitudinal studies have their limitations, the design and conduct of a more-rigorous, randomized controlled trial would be a challenge and require careful matching of hospitals to ensure comparability that is easier to assume by performing this evaluation in the same hospital. Evaluating the impact of telepharmacy at only one time period soon after implementation of telepharmacy services may not reflect long-term changes.

Cost estimates are difficult to document. Because no actual adverse drug events were detected, an actual cost savings could not be determined. Based on larger population studies, estimates of the costs avoided by correcting medication errors before an event occurs have been derived. The proprietary system used to estimate cost avoidance is an example of such a system.

Conclusion

Remote review of medication orders by pharmacists when the hospital pharmacy was closed decreased the number of potential adverse drug events reported and improved job satisfaction among nurses.

References

1. Leape LL, Brennan TA, Laird N et al. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *N Engl J Med*. 1991; 324:377-82.
2. Leape LL, Bates DW, Cullen DJ et al. Systems analysis of adverse drug events. *JAMA*. 1995; 274:35-43.
3. Lesar TS, Briceland T, Stein DS. Factors related to errors in medication prescribing. *JAMA*. 1997; 277:312-7.
4. Comprehensive accreditation manual for hospitals. Medication management standard MM.05.01.01. Oakbrook Terrace, IL: Joint Commission Resources; 2013.
5. Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: dispensing and administration—2011. *Am J Health-Syst Pharm*. 2012; 69:768-85.
6. Institute for Safe Medication Practices. ISMP's list of high-risk medications. www.ismp.org/tools/highalert medications.pdf (accessed 2013 May 13).
7. Classen DC, Pestotnik SL, Evans S et al. Adverse drug events in hospitalized patients: excess length of stay, extra costs, and attributable mortality. *JAMA*. 1997; 277:301-6.
8. Bates DW, Spell N, Cullen DJ et al. The cost of adverse drug events in hospitalized patients. *JAMA*. 1997; 277:307-11.
9. Jason D, Wuller WR. Evaluating the financial impact of clinical interventions made by student pharmacists during their advanced community pharmacy practice experiences. www.pharmacyonesource.com/images/quantifi/Jason_Pub_09.pdf (accessed 2013 May 13).
10. Boon AD. Telepharmacy at a critical access hospital. *Am J Health-Syst Pharm*. 2007; 64:242-4.
11. Witkowski P. Case study: novel ways automation enhances medication safety. *Am J Health-Syst Pharm*. 2007; 64(suppl 9):S21-3.
12. Pickette SG, Muncey L, Wham D. Implementation of a standard pharmacy clinical practice model in a multihospital system. *Am J Health-Syst Pharm*. 2010; 67:751-6.
13. Garrelts JC, Gagnon M, Eisenberg C et al. Impact of telepharmacy in a multihospital health system. *Am J Health-Syst Pharm*. 2010; 67:1456-62.
14. Reasons J. Managing the risks of organizational accidents. Aldershot, England: Ashgate; 1997:10-1.
15. Schneider PJ, Gift MG, Lee YP et al. Cost of medication-related problems at a university hospital. *Am J Health-Syst Pharm*. 1995; 52:2415-8.
16. Bates DW, Boyle DL, Vander Vliet MB et al. Relationship between medication errors and adverse drug events. *J Gen Intern Med*. 1995; 10:100-205.

Appendix—List of high-risk medications used to identify cases to include in the analysis

Ampicillin
Augmentin
Carvedilol
Cefazolin
Cefepime
Cefoxitin
Ceftriaxone
50% Dextrose injection
Digoxin
Furosemide
Gentamicin
Heparin
Hydralazine
Hydrocortisone
Meropenem
Methylprednisolone
Penicillin
Phytonadione
Piperacillin–tazobactam
Potassium chloride
Sodium polystyrene sulfonate
Spironolactone
Tobramycin
Vancomycin
Warfarin