Do remote community telepharmacies have higher medication error rates than traditional community pharmacies? Evidence from the North Dakota Telepharmacy Project

Daniel L. Friesner, David M. Scott, Ann M. Rathke, Charles D. Peterson, and Howard C. Anderson

Abstract

Objective: To evaluate the differences in medication dispensing errors between remote telepharmacy sites (pharmacist not physically present) and standard community pharmacy sites (pharmacist physically present and no telepharmacy technology; comparison group).

Design: Pilot, cross-sectional, comparison study.

Setting: North Dakota from January 2005 to September 2008.

Participants: Pharmacy staff at 14 remote telepharmacy sites and 8 comparison community pharmacies.

Intervention: The Pharmacy Quality Commitment (PQC) reporting system was incorporated into the North Dakota Telepharmacy Project. A session was conducted to train pharmacists and technicians on use of the PQC system. A quality-related event (QRE) was defined as either a near miss (i.e., mistake caught before reaching patient; pharmacy discovery), or an error (i.e., mistake discovered after patient received medication; patient discovery).

Main outcome measure: QREs for prescriptions.

Results: During a 45-month period, the remote telepharmacy group reported 47,078 prescriptions and 631 QREs compared with 123,346 prescriptions and 1,002 QREs in the standard pharmacy group. Results for near misses (pharmacy discovery) and errors (patient discovery) for the remote and comparison sites were 553 and 887 and 78 and 125, respectively. Percentage of "where the mistake was caught" (i.e., pharmacist check) for the remote and comparison sites were 58% and 69%, respectively.

Conclusion: This study reported a lower overall rate (1.0%) and a slight difference in medication dispensing error rates between remote telepharmacy sites (1.3%) and comparison sites (0.8%). Both rates are comparable with nationally reported levels (1.7% error rate for 50 pharmacies).

Keywords: Community pharmacy, telepharmacy, errors, quality control, medication safety, patient safety.

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Rural community pharmacies in the United States face a number of major economic and public policy challenges. One important challenge is that many of these pharmacies operate on lower prescription volumes and operating margins than their urban counterparts. As third-party payers attempt to move patients to mail service pharmacies and as rural patients "bypass" local community pharmacies for those in more distant, urban areas, these volumes and margins have declined even further.[1–4] Over time, this has led to pharmacy closures, reduced patient access to pharmacy services, and a negative effect on the economic vitality of rural communities. Community pharmacies that manage to survive in rural areas often find it difficult to attract and retain high-quality pharmacy staff.[5–8] A second major concern is quality assurance. Although community pharmacists in general have become increasingly aware of and have actively worked to minimize the occurence of medication errors,[9] rural community pharmacies are disproportionally concerned with such errors. Rural pharmacies rely almost exclusively on repeat purchases, and medication errors (especially those reaching the patient) affect patient satisfaction and continued patronage severely.[10,11] Difficulties attracting and retaining qualified staff also may force existing staff into unconventional roles or reduce pharmacist oversight of staff in traditional roles[7–8,12–14]; this may further increase the potential for medication errors. Understanding medication errors in rural community pharmacies is important for pharmacy and society overall.

At a Glance

Synopsis: This study reported a lower overall rate (1.0%) and a slight difference in medication dispensing error rates between remote telepharmacy sites (1.3%) and comparison pharmacies (0.8%), with both rates being comparable with nationally reported levels. The study was conducted in North Dakota among pharmacy staff at 14 remote telepharmacy sites and 8 comparison community pharmacies. During a 45-month period, the remote telepharmacy group reported 47,078 prescriptions and 631 quality-related events (QREs) compared with 123,346 prescriptions and 1,002 QREs in the standard pharmacy group. Results for near misses (pharmacy discovery) and errors (patient discovery) for the remote and comparison sites were 553 and 887 and 78 and 125, respectively.

Analysis: *The current findings suggest that remote telepharmacies do not adversely affect public health, patient safety, and the quality of care relative to traditional community pharmacy services. Because of the differences in empirical methodologies and the definition of what constitutes an error, determining whether the error rates found in this study were truly comparable with those found nationally in traditional community settings is not possible and would require further investigation. Policy makers may want to look more closely at telepharmacy procedures and the practical implementation of those procedures to determine whether refinements can be made to reduce QREs even further. Evaluation of medication QREs across different socioeconomic strata within a patient population may help enhance understanding of medication errors, especially if the QREs relate to (1) differences in this broader definition of medication use outcomes and (2) whether errors are found and reported by patients.*

Two studies using the direct observation method found a wide range (1.7–22%) of prescription dispensing error rates.[15,16] Medication dispensing errors received national attention in 2003 when a study conducted by Flynn et al.[15] compared dispensing accuracy rates in 50 pharmacies (26 community chain, 15 community independent, and 9 health-system pharmacies) in six cities throughout the United States. Pharmacies were directly observed by a pharmacist for 1 day, with a goal to inspect 100 prescriptions (new and refill) for dispensing errors, which were defined as any deviation from the prescriber's order. The overall dispensing accuracy rate was 98.3% (range 87.2–100%), and the rates did not differ significantly by pharmacy type or city. In another study, Flynn et al.[16] evaluated the dispensing accuracy and counseling provided in 100 community chain pharmacies. Trained shoppers submitted a new prescription order for one of five study medications to each randomly selected pharmacy. All encounters were recorded on video by ABC News *20/20* staff using hidden cameras. Of 100 dispensed prescriptions, 22 deviated from the prescriber's order (22% error rate). Of these, 3% were judged to be potentially harmful.[17]

A recent study estimated the impact of increased pharmacy technology on medication error rates. More specifically, the study examined whether the use of an automated dispensing machine in two community pharmacies affected medication error rates significantly.[18] During the study period, mean error rates at both pharmacies were between 1.7% and 2.7%. Comparing pretechnology error rates with those after automated dispensing machine adoption, the study found that the technology reduced medication error rates in one pharmacy significantly but did not affect these rates in the other pharmacy significantly. The impact of technology on medication error rates is particularly important to rural community pharmacies for two reasons. First, mail service pharmacies and urban community pharmacies represent the most common alternatives to rural community pharmacies. Using technology to reduce medication errors may provide these pharmacies with a competitive advantage over rural community pharmacies and thereby capture a greater proportion of a rural community pharmacy's already small market base. Second, rural community pharmacies have developed technologies to maintain profitability and retain/restore access to pharmacy services in rural communities. A prime example is the concept of "telepharmacy," where a pharmacist at a traditional community pharmacy (i.e., "central site") uses real-time audiovisual equipment to provide a full set of community pharmacy services at another site (i.e., "remote site"), at a distance.[19] The pharmacist at the central site uses the audiovisual equipment to supervise technicians' work and counsel patients at the remote site. In many rural areas, telepharmacy technology allows a single community pharmacy to expand its scope of service to smaller communities. It also is commonly used to maintain access to pharmacy services in rural communities whose pharmacy is about to close as a result of impending pharmacist/owner retirement.

Taken in tandem, these considerations pose an interesting issue that has not been addressed in the literature. Greater use of technology has the potential to reduce medication errors. However, the literature also suggests that the ability of technology to reduce such errors depends on the nature of the technology and the setting in which it is used. Rural community pharmacies have access to a technology, namely telepharmacy. The question naturally arises as to whether adopting telepharmacy technology leads to higher or lower medication error rates compared with community pharmacies that do not adopt the technology. If error rates are the same as or are lower than community pharmacies that do not adopt the technology, then a case can be made for continued use of the technology in those settings. Higher error rates in these telepharmacies necessitate a reevaluation of the use of the technology in its current form.

Objective

The purpose of this study is to measure medication dispensing error rates in remote telepharmacy sites and compare the error rates with traditional community pharmacies that do not use the technology. We postulated that remote telepharmacy sites were dispensing prescriptions that met current practice standards. Pharmacists at central site telepharmacies monitored the filling process via video computer links and checked the pharmacy technician's work to ensure that the correct prescription was dispensed. Therefore, the investigators hypothesized that telepharmacy sites were dispensing prescriptions at an accuracy rate equal to contemporary community pharmacy sites.

The analysis focuses solely on remote site telepharmacies rather than the corresponding central sites because the latter essentially function as traditional community pharmacies with a pharmacist present at the site. Concomitantly, remote sites do not have a pharmacist on site and their existence (and any medication errors generated by a remote site) is fundamentally tied to the technology. As such, an analysis of medication error rates at remote sites vis-à-vis traditional community pharmacies provides a clearer characterization of the value of the technology. Analyzing error rates at central telepharmacy sites is not the focus of the current work.

Methods

North Dakota is a highly rural state with an estimated population of 646,844 people in 2009.[20] The population density is less than 9.3 individuals per square mile, which is considerably less than the national average (79.6).[21] Approximately 68% (36 of 53) of its counties are designated as "frontier counties" (six people or fewer per square mile).[21] This sparse population creates substantial challenges in accessing and delivering health care services, including pharmacy services, to remote locations. Similar to many rural areas in the United States, rural communities in North Dakota have lost health care providers (e.g., physicians, nurses, pharmacists) because of their small populations. A 2004 Institute of Medicine study[22] reported medical access problems in rural areas because of hospital and pharmacy closures, greater distance to travel for physicians' services, and limited, if any, choice of providers. In 2000, the North Dakota Board of Pharmacy (NDBOP) determined that more than 26 rural community pharmacies in the state had recently closed. During the previous decade, the national pharmacist shortage meant that newly graduated pharmacists were typically being hired out of state where pharmacy chains were offering relatively larger salaries, leaving few pharmacists to take the place of those who were retiring in small rural communities.[7] In some cases, the pharmacist was the only full-time health care provider in the community, and the loss of the pharmacist meant the loss of local access to health care.

North Dakota Telepharmacy Project

The North Dakota State University (NDSU) College of Pharmacy, Nursing, and Allied Sciences received a federal grant in 2002 from the Office for the Advancement of Telehealth to implement a statewide telepharmacy program (North Dakota Telepharmacy Project) to save rural pharmacies from closing and test the new telepharmacy pilot rules.[19] The NDSU College of Pharmacy, Nursing, and Allied Sciences, in cooperation with NDBOP and the North Dakota Pharmacists Association (NDPhA), were awarded federal funding for fiscal years 2002 through 2008 from the Health Resources and Services Administration (HRSA) Office of Advancement of Telehealth for implementing telepharmacy services in underserved rural communities in North Dakota. In 2003, NDBOP established permanent rules[23] that allowed community pharmacies to open and operate in remote rural areas of the state without a licensed pharmacist being physically present in the pharmacy. It also allowed a pharmacist to supervise a registered pharmacy technician at a remote telepharmacy site in the processing of prescriptions for patients. This is accomplished through the use of real-time telecommunications technology and already-existing NDBOP rules that (among other things) require the completion of an American Society of Health-System Pharmacists training program as a prerequisite for becoming a registered pharmacy technician. The latter ensures that all technicians have the competencies necessary to assume unconventional roles in specific pharmacy settings, including telepharmacy,[8] while the former gives the pharmacist the ability to responsibly oversee (and, if necessary, place restrictions on) the work of technicians as they assume those roles. Under the permanent North Dakota telepharmacy rules, there are essentially no procedural differences in how prescriptions are received (e-prescription, telephone, and manual/written) or processed (including the dispensing of Schedule II drugs) at remote sites compared with central sites or other licensed community pharmacies in North Dakota.[8] The only operational difference is that in a traditional setting, the pharmacist oversees the work of technicians and interacts with patients directly, whereas the telepharmacy model uses audiovisual technology to oversee technicians' work and speak with patients. Currently, 72 pharmacies are involved in the project, including 24 central pharmacy sites and 48 remote telepharmacy sites.[24] Since the project's initiation, numerous other state boards of pharmacy have implemented telepharmacy rules and regulations to facilitate the use of telepharmacy in a variety of medically underserved settings, both rural and urban, and in community and health system practices.[25] These rules and regulations vary by state and may limit or otherwise alter the roles and responsibilities of remote site technicians and central site pharmacists.

Pharmacy Quality Commitment system and training intervention

In 2004, the Web-based Pharmacy Quality Commitment (PQC; www.pqc.net) reporting system was initially incorporated into the North Dakota Telepharmacy Project in 16 community pharmacies (8 remote telepharmacy sites and 8 comparison pharmacies not currently using telepharmacy technology).[26] NDBOP sent a letter of invitation to all licensed community pharmacies, and from the list of respondents, eight pharmacies were drawn to participate in the comparison group. Pharmacies in each group were selected to ensure a reasonably even distribution of geographic sites across the state. To ensure a sufficient number of participants and ensure that participants report errors in a consistent and accurate manner, the anonymity of pharmacies included in the study was ensured in all publicly available reports.

All participating pharmacies were community independent pharmacies. Most of the comparison pharmacies were located in rural areas (2,000–20,000 population). The comparison pharmacist owners were considered by peers within the state to be progessive, providing a full range of high-quality pharmacy services. These owners and their staff pharmacists routinely acted as pharmacy preceptors; were involved in state association activities, often as board members; and provided disease management services. Most participating pharmacies had one to four staff pharmacists and prescription volumes between 75 to 400 per day.

Most of the central site telepharmacies were located in rural communities (1,500–5,000 population), were staffed by one to three pharmacists, and had prescription volumes between 75 and 250 per day (exclusive of remote site activity). Remote site telepharmacies had a staff of one to two pharmacy technicians (overseen through the use of telecommuication equipment by the pharmacist at the central pharmacy), were located in smaller rural communities (usually less than 1,500 residents), and had prescription volumes between 40 and 100 per day.

Kenneth Baker and David Brushwood developed and marketed PQC as a dispensing error reporting system and quality improvement system for pharmacists.[27] The system focused on two general types of quality-related events (QREs). An error was defined as a mistake that gets to the patient. A near miss was considered a success because pharmacy personnel caught the problem before the prescription was delivered to the patient. Baker and Brushwood proposed that pharmacists and pharmacy technicians catch most mistakes before they get to the patient. Hence, near misses occur much more often than errors. The system was designed to allow a meaningful entry by the pharmacist in a short period of time (about 30 seconds). With this system, pharmacists were allowed to gather and use information in a continuous quality improvement (CQI) process to improve the dispensing process and prevent or reduce errors.

A major concern of the investigators was avoiding the mindset of "shame and blame" concerning medication errors. Instead, the focus of the project and the training seminars was to adopt a nonblaming approach and to follow the Institute of Medicine's problem-solving and CQI approach.[9] The comparison group received the training concurrently with the remote telepharmacy sites. A 2-hour training session was conducted to train pharmacists and pharmacy technicians to use the PQC system. The training session included an overview of the Sentinel System and Quality Manager, as well as hands-on use of the PQC system.[27] In phase 1, training sites in Fargo (eastern North Dakota, September 2004) and Dickenson (western North Dakota, September 2004) were used to train participants from eight comparison sites and eight remote sites. If pharmacists were unable to attend, telephone consultation and/or onsite training was provided. A refresher workshop (April 2005) was offered at the NDPhA annual meeting for pharmacists and technicians who either missed the initial training or felt the need for additional information on the PQC program. In 2006, the error reporting system was expanded to include six additional remote telepharmacy sites (phase 2), and participants received training in Bismarck (September 2006) and Fargo (September 2006).

Data collection

Each pharmacy was asked to use the Web-based PQC system to report the following categories:

- New or refill prescriptions
- Type of dispensing error (i.e., incorrect drug, incorrect strength, incorrect directions, refill incorrect, incorrect quantity, other)
- Where in the process the mistake was made (i.e., receiving incomplete or missing patient information; entry process mistakes including selected incorrect drug, selected incorrect patient or profile, selected incorrect strength, entered incorrect directions, incorrect refill information, other; filling process including selected incorrect drug, selected incorrect strength, placed incorrect label on container, incorrect quantity, other; other interventions including pharmacist drug review, counseling and delivery, discovered physician or nurse error, other).
- Where the mistake was caught (i.e., final pharmacist check, partner check, audit, patient discovery, entry, filling, counseling, delivery, other).

Pharmacists generally appointed technicians as quality supervisors for each pharmacy site to ensure that everyone at the site was trained and mistakes were routinely reported. Each

Table 1. Medication dispensing mistakes

	Total: January 2005 to September 2008		Year 1: January 2005 to September 2005		Year 2: October 2005 to September 2006	
Variable	Comparison pharmacies	Remote site telepharmacies	Comparison pharmacies	Remote site telepharmacies	Comparison pharmacies	Remote site telepharmacies
Total prescriptions filled	123,346	47,078	30,809	11,878	31,454	8,887
Total mistakes, or QREs	1,002	631	215	221	268	110
Prescriptions that are QREs (%)[a]	0.81	1.34	0.70	1.86	0.85	1.24
Pharmacy-discovered QREs	877	553	189	208	242	93
QREs that did not reach patient ("near misses") (%)	0.71	1.17	0.61	1.75	0.77	1.05
Patient-discovered QREs	125	78	26	13	26	17
QREs that reached the patient ("errors") (%)	0.10	0.17	0.08	0.11	0.08	0.19

Abbreviation used: ORE, quality-related event.
[a]Percent of prescriptions that are QREs equals error rate that combines "near misses" and "errors."

site was asked to report mistakes on a daily basis, either using the Web-based system or the peer review audit form, in which case mistakes were recorded on the PQC system at least once per week.

Evaluation study design and data analysis

The evaluation's design was consistent with a simple, cross-sectional, pilot study (also known as a preexperimental, static-group comparison design), with a single control group (traditional community pharmacies) and a single test group (remote site telepharmacies).[28] As noted above, 8 pharmacies were included in the control group and 14 remote site telepharmacies in the test group. To ensure pharmacy anonymity and keep the analysis tractable, a decision was made to aggregate the data across all sites in each group. Moreover, because the level of the evaluation analysis was conducted at the level of the group (and not at the level of the QRE), the NDSU Institutional Review Board approved the study.

All QREs were entered into the PQC system,[27] which is Health Insurance Portability and Accountability Act compliant and approved by the National Alliance of State Pharmacy Associations. Each participating pharmacy (central, remote, or comparison site) was given a password-protected account. If central telepharmacy site pharmacists oversaw two or more remote telepharmacy sites, they could only access data for their central site and remote site(s). The project investigators had management access to all sites in the project, and the primary emphasis was to examine trends in the aggregated data for the sites, rather than examine specific data for a specific pharmacy. All data were encrypted before transmitting to ensure integrity and confidentiality of information. No specific patient or provider identifiers were used in reporting.

To ensure consistency in the analysis, the investigators focused on several normalized and nonnormalized variables. First, for each of the two groups, the number of QREs (including near misses [i.e., QREs caught before they got to the patient] and errors [QREs discovered after the patient received the medication]) was determined for each group. Potential drawbacks to using the total number of QREs were as follows: (1) more remote telepharmacies were in the test group (n = 14) than in the control group (n = 8), (2) remote telepharmacies sites were added in two phases, and (3) a typical remote telepharmacy site tended to produce a smaller prescription volume than a traditional community pharmacy. The first of these drawbacks may inflate the number of QREs in the test group (relative to the control group), whereas the latter two may understate this number. To account for these issues, the rates and/or proportions of QREs also were examined. More specifically, the number of total mistakes, pharmacy-discovered mistakes, and patient-discovered mistakes were divided by the total number of prescriptions filled, resulting in the percent of QREs, the percent of QREs not reaching the patient, and the percent of QREs reaching the patient, respectively.

Data were available for the entire 45 months of the project (January 2005 to September 2008), and unless otherwise stated, all empirical analyses covered the entire time frame. However, considering whether the rates of QREs vary by time frame also is of interest. To that end, the comparison and test groups also may be disaggregated by fiscal year (October 1 to September 30). Because the full 2005 fiscal year was unavailable, each dynamic analysis was conducted twice: once for all time frames (years 1–4) and once excluding the first (partial) fiscal year (years 2–4).

The investigators postulated that the remote telepharmacy sites dispensed prescriptions in a manner that met current practice standards. As such, no average differences in the rates and/or proportions of QREs between the control and test groups should occur. Combining this assumption with the experimental design suggested that all null hypotheses operated under the premise that no mean or relative frequency differences existed between the rates of QREs in the control and test groups. Based on this null and the nature of the data, the hypotheses were evaluated using simple hypothesis tests. More specifically, simple (unmatched sample) z tests were used to compare QRE rates across the control and test groups for a given category of QRE. The chi-square test of homogeneity was

Year 3: October 2006 to September 2007		Year 4: October 2007 to September 2008		Years 1–4		Years 2–4	
Comparison pharmacies	Remote site telepharmacies	Comparison pharmacies	Remote site telepharmacies	χ^2	*P*	χ^2	*P*
43,611	9,641	17,472	16,672	10,724.765	<0.001	10,739.838	<0.001
391	136	128	164	236.253	<0.001	120.969	<0.001
0.90	1.41	0.73	0.98				
353	116	93	136	239.353	<0.001	118.115	<0.001
0.81	1.20	0.53	0.82				
38	20	35	28	13.967	0.0030	13.485	0.0012
0.09	0.21	0.20%	0.17				

used to assess differences in number of QREs (equivalently expressed as a proportion [or rate] of QREs in the entire sample) between the control and test groups. Chi-square tests are useful when examining trends in QREs across groups of medication error categories and/or over discrete time periods. For all tests, a significance level was established at 5%. The data were downloaded and analyzed with Microsoft Excel (Microsoft, Redmond, WA) and the SPSS Statistical Package (SPSS, Chicago).

Results

Dispensing error rate

At 45 months, 631 QREs were reported in the remote telepharmacy group (47,078 prescriptions) and 1,002 QREs were reported in the control group (123,346 prescriptions). This study reported a lower overall error rate (1.0%) than the national average and a slight difference in medication dispensing error rates between remote telepharmacy sites (1.3%) and traditional sites (0.8%). Both rates were less than the 1.7% error rate that was reported for 50 community pharmacies.[15] Results for near misses and errors for remote and traditional sites were as follows: pharmacy discovery (631 vs. 887 QREs) and patient discovery (78 vs. 125 QREs), respectively (Table 1). Later categories of patient-discovered mistakes resulted in an error rate of 0.17% for the remote group and 0.10% for the traditional group. Chi-square tests also indicated that a significant association existed between the type of pharmacy and the time frame of the analysis.

Longitudinal analysis of dispensing error rates

Given the large number of statistics and tests in Table 1, our findings are summarized in the figures in a longitudinal fashion. Figure 1 tracks the percentage of QREs for both the traditional community and remote telepharmacy groups. The trend for the remote sites decreased from year 1 to 4. For the traditional pharmacy group, the lowest rate was reported in year 1 and a slight increase was reported in years 2 and 3, followed by a slight decrease in year 4 to a level similar to year 1. The overall rate was slightly lower for the comparison group than the remote group, and this rate from years 1 to 4 ($P < 0.05$) and years 2 to 4 ($P < 0.05$) was statistically significant (Table 1).

Pharmacy-discovered mistakes (i.e., percent of QREs that did not reach the patient; near misses) are shown in Figure 2. The trend showed a declining rate from year 1 through year 4 for the remote telepharmacy group. The comparison group rate increased slightly from year 1 through year 3, then decreased to its lowest level in year 4. The overall rate was slightly lower for the comparison group than for the remote group, and this rate from years 1 to 4 ($P < 0.05$) and years 2 to 4 ($P < 0.05$) was statistically significant.

Patient-discovered errors (the percentage of QREs that did reach the patient or actual errors) are reported in Figure 3. The remote telepharmacy group increased from year 1 to year 3, then decreased during the next year to a low of 0.17%. The comparison group's lowest level occurred in years 1 and 2, then increased during the last two years to 0.20% in year 4. At the end of year 4, the comparison group (0.20%) had a slightly higher error rate than in the remote group (0.17%), although this rate was not statistically significant. The overall rate was slightly lower for the comparison group; however, the remote group showed greater improvement from years 1 to 4, and this rate from years 1 to 4 ($P < 0.05$) and 2 to 4 ($P < 0.05$) was statistically significant.

Type of mistake

Having identified longitudinal trends in aggregate QRE categories, disaggregating the aggregate QRE statistics based on subcategories (and tracked cumulatively during the 45 months of the study), in order to identify more detailed differences in QREs across the two groups, was possible. Tables 2 through 4 contain these analyses. Table 2 compares the types of dispensing mistakes, both on total and as a percentage of total QREs, across the two groups of pharmacies. The types of mistakes made for test and control sites that were statistically significant were incorrect strength (27.6% vs. 12.3%, $P < 0.05$), refill incorrect (4.9% vs. 20.2%, $P < 0.05$); and incorrect quantity (3.2% vs.

Table 2. Type of dispensing error

Type of error	Remote site telepharmacies No. (%)	Comparison pharmacies No. (%)	Total No. (%)	*Z* test Statistic	*Z* test *P*	χ^2 Statistic	χ^2 *P*
Incorrect drug	111 (17.6)	164 (16.4)	275 (16.8)	0.644	0.520	119.052	<0.001
Incorrect strength	174 (27.6)	123 (12.3)	297 (18.2)	7.805	<0.001		
Incorrect directions	119 (18.9)	197 (19.7)	316 (19.4)	–0.399	0.690		
Refill incorrect	31 (4.9)	202 (20.2)	233 (14.3)	–8.578	<0.001		
Incorrect quantity	20 (3.2)	15 (1.5)	35 (2.1)	2.272	0.023		
Other	176 (27.9)	301 (30.0)	477 (29.2)	–0.929	0.353		
Total	631 (100)	1,002 (100)	1,633 (100)				

Table 3. Where the mistake was made

Location of the mistake	Remote site telepharmacies No. (%)	Comparison pharmacies No. (%)	Total No. (%)	*Z* test Statistic	*Z* test *P*	Subgroup χ^2 test Statistic	Subgroup χ^2 test *P*	Overall χ^2 test Statistic	Overall χ^2 test *P*
								195.502	<0.001
Receiving the prescription									
Patient information missing/ incomplete	7 (70.0)	4 (22.2)	11 (39.3)	19.249	<0.001	6.152	0.013		
Other (explain)	3 (30.0)	14 (77.8)	17 (60.7)	–19.249	<0.001				
Subtotal	10 (100)	18 (100)	28 (100)						
Entry process						59.707	<0.001		
Selected incorrect drug	65 (18.3)	113 (14.3)	178 (15.5)	2.197	0.028				
Selected incorrect patient or profile	39 (11.0)	67 (8.5)	106 (9.2)	1.716	0.086				
Selected incorrect strength	66 (18.6)	80 (10.1)	146 (12.7)	5.013	<0.001				
Entered incorrect directions	112 (31.5)	187 (23.6)	299 (26.1)	3.558	<0.001				
Incorrect refill information	37 (10.4)	181 (22.9)	218 (19.0)	–6.234	<0.001				
Other	36 (10.1)	164 (20.7)	200 (17.4)	–5.480	<0.001				
Subtotal	355 (100)	792 (100)	1,147 (100)						
Filling process						26.532	<0.001		
Selected incorrect drug	67 (28.2)	48 (30.8)	115 (29.2)	–1.133	0.257				
Selected incorrect strength	92 (38.7)	26 (16.7)	118 (29.9)	9.446	<0.001				
Place incorrect label on container	9 (3.8)	10 (6.4)	19 (4.8)	–2.414	0.016				
Incorrect quantity	40 (16.8)	50 (32.1)	90 (22.8)	–7.145	<0.001				
Other	30 (12.6)	22 (14.1)	52 (13.2)	–0.871	0.384				
Subtotal	238 (100)	156 (100)	394 (100)						
Other interventions									
Pharmacist drug review, counseling and delivery	9 (32.1)	14 (38.9)	23 (35.9)	–2.766	0.006	0.792	0.673		
Discovered physician or nurse error	14 (50.0)	14 (38.9)	28 (43.8)	4.407	<0.001				
Other	5 (17.9)	8 (22.2)	13 (20.3)	–2.135	0.033				
Subtotal	28 (100)	36 (100)	64 (100)						
Total	631 (100)	1,002 (100)	1,633 (100)						

1.5%, $P < 0.05$). Nonstatistically significant differences between groups were incorrect directions (18.9% vs. 19.7%), incorrect drug (17.6% vs. 16.4%), and other (27.9% vs. 30.0%).

Where the mistake was made

The results reported in Table 3 contain some striking differences across our control and test groups based on the point at which the mistake occurred. Approximately 70.2% of errors

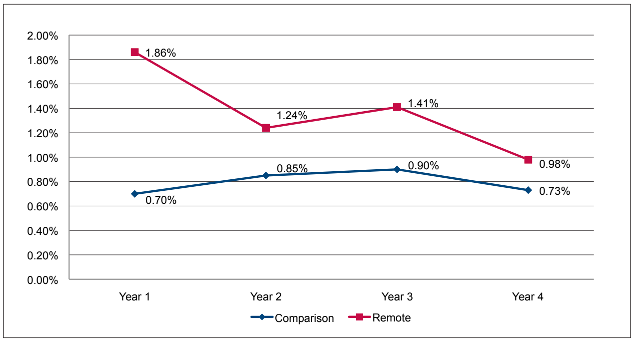

Figure 1. Percent of quality-related events

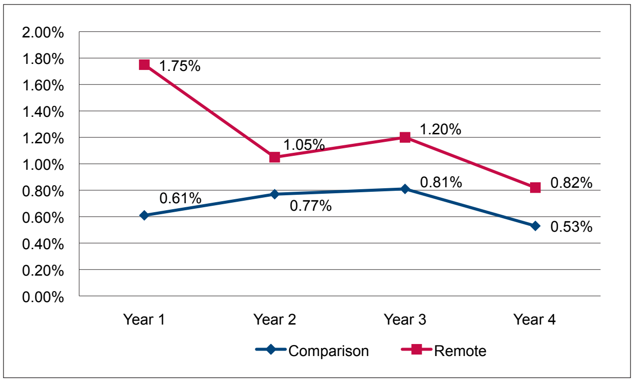

Figure 2. Percent of quality-related events that did not reach the patient

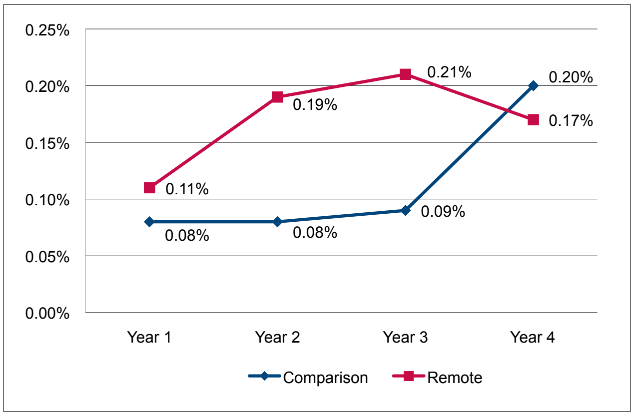

Figure 3. Percent of quality-related events that reached the patient

(1,147 of 1,633 total mistakes) were made in the entry process (56.3% for remote telepharmacy and 79.0% for traditional sites), and 24.1% (394 of 1,633 total mistakes) of mistakes were made in the filling process (37.7% for remote telepharmacy and 15.6% for traditional sites).

The percentages of "where the mistake was made" for remote telepharmacy and traditional pharmacy sites were entered incorrect directions (31.5% vs. 23.6%, $P < 0.05$), entered incorrect drug (18.3% vs. 14.3%, $P < 0.05$), entered incorrect strength (18.6% vs. 10.1%, $P < 0.05$), and entered incorrect refill information (10.4% vs. 22.9%, $P < 0.05$). The mistakes made in the entry process were the most common major category, followed by mistakes in the filling process. The later category included selected and filled the incorrect strength (38.7% vs. 16.7%, $P < 0.05$), selected and filled the incorrect quantity (16.8% vs. 32.1%, $P < 0.05$), and selected and filled the incorrect drug (28.2% vs. 30.8%).

Cumulatively, the results in Table 3 suggest mixed evidence about our null hypotheses. The results suggest that significant differences in QREs (both on total and as a rate) occurred across the control and test groups. However, one group does not universally have higher or lower QREs than the other. Rather, remote telepharmacies appeared to be better at reducing QREs related to incorrect refills and incorrect quantities (among other factors), while traditional community pharmacies had lower QREs for (among other factors) selecting the correct drug and selecting the correct drug strength.

Where the mistake was caught

A breakdown of the point at which QREs were caught is shown in Table 4. Overall, the pharmacist check caught 64.8% of mistakes (691 of 1,002), followed by patient discovery (12.6%) and partner check (6.1%). The percentages of "where the mistake was caught" for remote telepharmacy sites and traditional pharmacy sites were pharmacist check (58.2% vs. 69.0%, $P < 0.05$), partner check (10.1% vs. 3.5%, $P < 0.05$), and filling (6.2% vs. 3.9%, $P < 0.05$). Again, whether remote site telepharmacies have higher or lower QREs that are caught depends on the designation of whether the mistake was caught. Of interest, no significant difference were observed across the two groups regarding the rate of mistakes caught by patients.

Discussion

Our empirical analysis yields several major conclusions. First, and most importantly, the study found a difference in medication dispensing error rates between traditional (nontelepharmacy) sites and remote telepharmacy sites. The findings suggest that the error rates of remote site telepharmacies were slightly higher than comparison pharmacies. Thus, we rejected our null hypothesis of no difference in error rates across the two sets of pharmacies. However, given that both groups of pharmacies had rates that were consistent with those reported nationally,[15] the current study's findings suggest (but in no way prove) that remote telepharmacies do not adversely affect public health, patient safety, and the quality of care relative to traditional community pharmacy services. Because of the differences in empirical methodologies and the definition of what constitutes an error, determining whether the error rates found in this study were truly comparable with those found nationally in traditional community settings is impossible. Further work is necessary to corroborate (or refute) this contention.

Second, an analysis of time trends suggests that during the 45 months of data collection, a general decrease occurred in both the total number of QREs (as a proportion of the total number of prescriptions filled) and the rate of QREs that did

Table 4. Where the mistake was caught

Location of the catch	Remote site telepharmacies No. (%)	Comparison pharmacies No. (%)	Total No. (%)	Z test Statistic	Z test P	χ^2 test Statistic	χ^2 test P
						67.897	<0.001
Final pharmacist check	367 (58.2)	691 (69.0)	1,058 (64.8)	–4.449	<0.001		
Partner check	64 (10.1)	35 (3.5)	99 (6.1)	5.483	<0.001		
Will call audit	2 (0.3)	11 (1.1)	13 (0.8)	–1.729	0.084		
Patient discovery	76 (12.0)	129 (12.9)	205 (12.6)	–0.493	0.622		
Entry	17 (2.7)	15 (1.5)	32 (2.0)	1.699	0.089		
Filling	39 (6.2)	39 (3.9)	78 (4.8)	2.111	0.035		
Counseling	17 (2.7)	22 (2.2)	39 (2.4)	0.642	0.521		
Delivery	22 (3.5)	5 (0.5)	27 (1.7)	4.610	<0.001		
Other	27 (4.3)	55 (5.5)	82 (5.0)	–1.090	0.276		
Total	631 (100)	1,002 (100)	1,633 (100)				

not reach the patient for the remote telepharmacies. A relatively stable trend in these rates can be established for the traditional community pharmacies. This study began during a period of time in which the North Dakota telepharmacy model was being enacted. Hence, error rates would be expected to decline as pharmacists and their technicians became accustomed to the regulations, protocols, and standards of practice inherent in the telepharmacy model. This further suggests (but again does not prove) that in the long run, the North Dakota telepharmacy model appears to be a relatively safe approach to maintaining and restoring access to rural pharmacy services.

Third, the results suggest that the formation and resolution of QREs is different in remote telepharmacies compared with traditional community sites. Although one would not, a priori, expect the telepharmacy technology to cause the specific differences in QREs (and their resolution) that were identified in the data, they do exist and deserve further scrutiny. Policy makers might want to look more closely at telepharmacy procedures and the practical implementation of those procedures to determine whether refinements can be made to reduce these QREs even further.

Fourth, although a substantial number of studies have been performed in institutional settings (e.g., hospitals, nursing homes), studies in community pharmacies are lacking. Flynn and Barker's[15] study is often quoted as the best study of community studies done in the United States, and it used a direct observational technique to observe medication errors in a single 8-hour period at each pharmacy. In other studies where this was done, the Hawthorne effect (i.e., the tendency of some people to work harder and perform better when they are participants in an experiment) can become a potential confounder.[29] Accordingly, when pharmacists are observed for a relatively short period of time, they might demonstrate a greater level of concentration and vigilance and tend to have one of their best patient safety days. Therefore, a lower rate of errors would likely be reported. Our study was done in a natural setting over an extended period of time (45 months), so the Hawthorne effect (which cannot be entirely discounted) would be expected to have a less pronounced effect.

Areas for future research

This report did not include an assessment of medication dispensing errors rates between remote telepharmacy sites and the corresponding central pharmacy sites. This is particularly important because pharmacists at the central sites essentially have two jobs: managing activity and prescription volumes at the central site and managing one or more remote telepharmacy sites. The higher workload placed on central site telepharmacists inevitably begs the question as to whether the added workload has any effect on the number and types of medication errors at the central site (i.e., whether the central site staff are taking on more responsibility than they can handle). This question will be addressed in a future article.

This analysis only evaluates medication errors from a narrow perspective in the medication dispensing process. The presence of a pharmacist in a community could affect the quality of drug therapy in that community. Different types of medication QREs could be identified if the focus on patient medication access is expanded beyond dispensing to overall medication use by patients (i.e., patient outcomes of drug therapy) in a community where the pharmacist is physically present versus by a remote pharmacist via telepharmacy. Evaluation of medication QREs across different socioeconomic strata within a patient population also may add valuable information to our knowledge of medication errors, especially if the QREs relate to (1) differences in this broader definition of medication use outcomes and (2) whether an error is found and reported by the patient.

Although a considerable amount of rhetoric concerning the need for patient safety currently exists, very little research has been done to understand the formation of QREs, particularly in community pharmacies.[30] Perhaps more disconcertingly, very few federal dollars (with the exception of HRSA and the Agency for Healthcare Research and Quality) have been expended to sponsor these studies. Although studies in community settings may be more difficult than in institutional settings, wide-based research should be done to establish accurate error rates and to implement quality improvement in these settings so that overall medication errors are reduced and patients receive the highest possible quality of medication care.

Limitations

One limitation was that pharmacists in the North Dakota study were possibly underreporting. Several authors[31–34] warn about the danger of underreporting when pharmacists are asked to report their error rates. However, even if that underreporting of errors occurred, the rate of underreporting was likely comparable for both groups, in which case the relative comparisons made in this study between the remote telepharmacy and traditional pharmacy groups likely caused any underreporting to cancel out.

Incidence rates for medication error studies depend on the detection method used, including direct observation, chart review, computerized monitoring, and voluntary reporting.[31] Studies have suggested that voluntary reporting such as that used in this study also may result in marked underestimation of rates of medication errors.[31–34] A large study comparing direct observation, chart review, and incident reporting found that direct observation identified the greatest number of errors.[34] A comparison of computer surveillance, chart review, and voluntary reporting found that of the 617 adverse drug events detected, chart review identified 65%, automated surveillance 45%, and voluntary reporting 4%.[33] Voluntary reporting rates were generally low because of factors such as time pressures, fear of punishment, and lack of a perceived benefit.[33] Improvements in internal reporting have been achieved in nonpunitive reporting environments,[35] but these rates tend to underestimate the true incidence. Because our study involved self-reporting, the possibility of underreporting cannot be dismissed. However, the primary focus of our study is the between-group comparison and not actual rate of errors.

A second limitation was that because this project is essentially a pilot study, the remote and comparison pharmacies were not randomly selected. Instead, participation was voluntary, which suggests that the pharmacies, their owners, and/or the pharmacists involved were progressive and possibly practiced pharmacy at a higher-than-normal level. Hence, the rate of dispensing errors may tautologically be lower than that occurring in other community pharmacies in North Dakota.

A third limitation was that two types of personnel (technicians and pharmacists) participated in the dispensing error reporting. Adherence with mistake reporting was vital to the success of this project, and the investigators provided a number of reminders during the course of the study to reinforce the need to report on a routine basis. Although the investigators stressed the importance of routine reporting, to achieve full cooperation from each of the pharmacies in the study, a decision was made to give each pharmacy the discretion to determine which type of personnel (technician or pharmacist) was responsible for entering the medication error data into Web-based system. Therefore, a potential limitation is that nonstandardized reporting may have resulted from variations in personnel entering medication error data.

Last, differences in methodologies and operational definitions may have affected the generalizability of our results. For example, studies that use different definitions of medication errors or that use different techniques to record QREs (e.g., observational techniques versus self-reporting) may obtain different rates than those obtained in the current study. In addition, different definitions of the classes of medication errors (i.e., errors in the entry process versus entering incorrect refill information) may distort the accuracy (if the classes are poorly defined) and precision (overaggregation if classes are correctly defined but in too broad of a fashion) of error rate estimates.

Conclusion

At 45 months, the North Dakota study reported a slight difference in medication dispensing error rates between remote telepharmacy sites and comparison pharmacy sites. The findings suggest that the error rates of remote site telepharmacies (and the error rates of traditional pharmacies) are consistent with those reported nationally. Also, this study measured where dispensing mistakes were made, followed by where these mistakes were caught. Significant differences were found across the two types of pharmacies in each of these categories, suggesting that the formation and resolution of errors in a remote telepharmacy setting may be fundamentally different than those in traditional community pharmacy settings.

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