Translating Research Into Practice: Voluntary Reporting of Medication Errors in Critical Access Hospitals

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ABSTRACT: ***Context:*** *Low service volume, insufficient information technology, and limited human resources are barriers to learning about and correcting system failures in small rural hospitals.* ***Purpose:*** *This paper describes the implementation of and initial findings from a voluntary medication error reporting program developed by the Nebraska Center for Rural Health Research (NCRHR) to overcome these barriers in 6 Nebraska critical access hospitals (CAHs).* ***Methods:*** *Participating Nebraska CAHs mailed copies of medication error reports to the NCRHR monthly for entry into a database. Quarterly summaries enabled each CAH to compare its reports by severity, type, phase of the medication use process, contributing factors, and causes to those of its peers and MEDMARX℠, a national medication error reporting program. Workshops emphasized learning from the reported errors by identifying system sources of variation in medication use and initiating change to achieve best practices.* ***Findings:*** *Similar to MEDMARX, 99% of medication errors reported by 6 Nebraska CAHs were not harmful, reported errors most often originated in the administration phase, and the most common error type was omission. The CAHs reported significantly smaller proportions of "near miss" errors and errors originating in the prescribing phase than in MEDMARX.* ***Conclusions:*** *By collaborating with CAHs, an academic medical center, and a national reporting program, the NCRHR is translating the Institute of Medicine's recommendation for voluntary error reporting into practices that allow CAHs to learn about and improve their medication use systems. However, limited presence of pharmacists in CAHs is a barrier to implementing double checks and learning from system failures in the medication use system.*

In *To Err Is Human: Building a Safer Health System*, the Institute of Medicine (IOM)[1] reported that up to 98,000 Americans die each year due to medical errors. This fact galvanized the attention of the public as well as health care providers, payers, and policy makers. Less attention has been focused on the IOM's conclusion that, "The problem is not bad people; the problem is that the system needs to be made safer."[1(p49)] A system is composed of human and nonhuman elements that interact to achieve a common aim. The interaction of defects in system structures and processes leads to system failures.[1] Preventing system failures requires measurement of the structures, processes, and outcomes associated with those systems. However, low service volume, insufficient information technology, and limited human resources prevent small rural hospitals from identifying and correcting system failures that lead to errors.[2-4]

Improving patient safety by identifying system failures is the goal of voluntary error reporting programs that emphasize detecting, correcting, and learning from errors before they reach the patient ("near misses"). Voluntary error reporting programs that aggregate reports from multiple organizations allow

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identification of errors due to system failures that may be rare events for individual organizations.[1] Voluntary error reporting is a patient safety practice that is uniquely able to provide resource-deficient small rural hospitals with the opportunity to improve patient safety and quality by learning from errors and near misses.

A successful voluntary medication error reporting program relies upon confidential error reports submitted from a nonpunitive culture to an independent organization. This organization provides timely, expert analysis of the reports using contextual information to identify systems-oriented changes that promote medication safety.[5] According to the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP), a medication error is "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer."[6] Medication errors are believed to be widespread,[7] but the majority of reported errors do not result in patient harm.[8] Adverse drug events include preventable medication errors that result in harm. Adverse drug events are the most common cause of injury among hospitalized patients and increase the cost and length of stay.[9]

This paper describes the implementation of and initial findings from a voluntary medication error reporting program in 6 Nebraska critical access hospitals (CAHs). CAHs are a category of limited-service hospitals created in 1997 as part of the Balanced Budget Act to maintain access to care in rural areas by providing cost-based reimbursement.[10] CAHs are able to designate up to 25 inpatient beds for acute care;[11] as of February 27, 2004, there were 886 CAHs across the nation, 60 of which were located in Nebraska.[12] This project is an example of action research, an emerging framework for social science research that consists of collaboration between researchers and participants and generates hypotheses grounded in real-world experience.[13] The collaborators in this project translated research into action[14] by implementing a voluntary medication error reporting program. Initial findings from this program generated the hypothesis that the nature of voluntary medication errors reported by hospitals was associated with the availability of pharmacy support.

Methods

In September 2001, the Nebraska Center for Rural Health Research (NCRHR) began a dialogue with 4 CAHs in southeast Nebraska regarding patient safety and quality issues. Through telephone conference calls, nurses involved in quality assurance, administrators of the 4 CAHs, and the NCRHR explored several patient safety topics. These topics included an acknowledgment that levels of pharmacy support vary in CAHs[15] with nonpharmacist personnel frequently obtaining drugs, that many small rural hospitals are unsure of the meaning of a "culture of safety,"[1] and that they lack the resources to analyze error reports.[3] Reflecting the participatory nature of action research, these discussions led to the decision to develop a voluntary medication error reporting program. The NCRHR agreed to direct the program and supply data entry, analytical, and educational resources.

After approval by the Institutional Review Board of the University of Nebraska Medical Center (UNMC), the NCRHR implemented the reporting program by developing a standardized reporting form, creating a database, developing educational materials, and mapping the process of medication use at each CAH during a site visit. NCC MERP categorizes medication errors according to the severity of harm to the patient using an alphabetical index (Table 1).[16] This index was combined with checklists of contributing factors, causes, additional interventions, and actions to avoid future errors, all of which provide contextual information needed for error analysis and follow-up.[1,8,17]

Education was provided by the Outcomes and Performance Improvement (OPI) department of The Nebraska Medical Center using telephone conference calls to discuss the development of a culture of safety, the process of disclosure of errors to patients and families, and the legal discoverability of errors. The development of a culture of safety was related to understanding the nature of errors in health care and the design of safety systems in health care organizations as outlined by the IOM.[1] OPI personnel used the American Society for Healthcare Risk Management (ASHRM)[18] as a resource regarding the disclosure of errors. ASHRM emphasizes that facts regarding an error should be disclosed by all relevant health care providers to the patient or the individual who has the legal power to make medical decisions for the patient. Disclosure of an error that reaches the patient is required under the principle of informed consent that requires disclosure of all outcomes that differ significantly from what is expected.

Relevant Nebraska statutes[19-21] were reviewed as the basis for the legal nondiscoverability of error reporting for quality improvement purposes. A statement was placed on the reporting form indicating that the information was requested for quality improvement purposes, that it was not part of the medical record, and that it would not be legally discoverable. Each participating hospital also signed a contract designating UNMC as an external peer review committee to insure that all communications regarding error reports were privileged.[22]

Table 1. Comparison of Critical Access Hospital and MEDMARX (2002) Medication Error Reports by Severity, Phase, and Type

	Critical Access Hospital n = 800 (%)	MEDMARX n = 192,477 (%)	*P* Value*
Severity categories			
A Circumstances have the capacity to cause error.	12.4	15.6	.011
B An error occurred, but the error did not reach the patient.	16.3	35.2	<.001†
C An error occurred that reached the patient but did not cause harm.	65.5	41.2	<.001†
D An error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm.	4.8	6.3	.067
E An error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention.	0.9	1.4	.244
F An error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization.	0.3	0.3	1.0
G An error occurred that may have contributed to or resulted in permanent patient harm.	0.0	0.02	1.0
H An error occurred that required intervention necessary to sustain life.	0.0	0.02	1.0
I An error occurred that may have contributed to or resulted in patient death.	0.0	0.01	1.0

	Critical Access Hospital n = 701 (%)	MEDMARX n = 162,337 (%)	*P* Value*
Phase of medication use process (for Categories B to I)			
Prescribing	5.1	21.3	<.001†
Documenting	26.3	23.0	.04
Preparation/dispensing	11.4	21.6	<.001†
Administration	56.6	33.0	<.001†
Monitoring	0.6	1.1	.191
Error types (for Categories B to I)			
Omission	31.9	25.6	<.001†
Improper dose/quantity	27.3	25.5	.277
Prescribing	3.6	18.5	<.001†
Unauthorized drug	18.1	11.1	<.001†
Wrong time	10.7	6.9	<.001†
Extra dose	3.0	5.0	.016
Wrong route	1.6	1.6	.989

* *P* values from χ^2 or Fisher exact test for association between categorical variables.
† Statistically significant difference after adjusting for multiple comparisons.

Data collection began in February 2002 with the 4 original CAHs. Providers at each hospital forwarded completed error reports to their quality improvement coordinator, who mailed copies to the NCRHR on a monthly basis. By February 2004, 10 Nebraska CAHs were participating, including 3 of the original 4. One of these 4 dropped out after the first year, when an initial fee of $1,500 and annual fees of $1,000 were instituted. As quality improvement activities, these fees are allowable costs for Medicare cost reporting. These fees covered data entry, reporting, and the cost to participate in the MEDMARX^{SM} national medication error reporting program,[8] but they did not cover professional time. At the NCRHR, information from each error report was entered into an Access database (Microsoft Inc., Redmond, Wash.) and analyzed using Excel (Microsoft Inc., Redmond, Wash.) and SAS software (SAS Institute Inc., Cary, N.C.). To maintain anonymity, each CAH was assigned a letter code in a blinded manner. A quarterly summary allowed each CAH to compare its medication error reports by severity, type, phase of the medication use process, contributing factors, and causes to those of its peers and the MEDMARX program. The χ^2 test or Fisher exact test

were used to examine associations between the CAHs and MEDMARX. Associations were considered significant at the $P<.05$ level, and the Bonferroni method was used to adjust for multiple comparisons.[23]

The United States Pharmacopeia (USP) operates MEDMARX, an Internet-based anonymous reporting program that subscribing hospitals and health systems participate in as part of their ongoing quality improvement initiatives. The MEDMARX reporting program uses the NCC MERP index of error severity[16] and integrates the characteristics identified by Leape.[5] In 2002, 482 facilities released 192,477 error reports to MEDMARX.[8] Approximately one third (150) of these facilities were general community hospitals that were not federally owned. Of these non-federally owned hospitals, 9 (6%) had less than 25 beds. In 2003, a collaborative arrangement between USP and the NCRHR was formed to integrate Nebraska CAHs into the reporting program and to study associations between hospital characteristics and reported medication errors.

In the fall of 2003, 2 workshops were held for project participants to determine best practices in medication use in small rural hospitals. These workshops were facilitated by The Nebraska Medical Center Outcomes and Performance Improvement (OPI) department and used the G.E. Work-Out™ to bring together key stakeholders in the medication use process from each CAH. G.E. Work-Out is a team-based decision-making process that empowers stakeholders to improve processes.[24] CAH stakeholders included nurses, pharmacists, and pharmacy technicians, who used process maps to identify current strengths and weaknesses in their individual processes and higher level best practices for the group. Weaknesses identified in medication use in the 4 CAHs included:

- Using stock supply instead of unit doses.
- Not having a pharmacist to dispense drugs.
- Transcribing orders multiple times.
- Not using the medication administration record (MAR) at the bedside to check the correct drug, dose, time, route, and patient.
- Retrieving medications from the pharmacy after-hours.
- Non-pharmacists mixing intravenous medications.
- Opening unit doses before entering the patient's room.
- Signing off medications on the MAR prior to administering them.

To conclude the G.E. Work-Out, the CAHs identified long-term (5 to 10 years) and short-term (1 year) best practices for medication use given their resource limitations. Long-term best practices included computerized provider order entry and bar coding of drugs. Short-term best practices that are supported in the literature[25-27] included:

- Having at least 2 people check all written orders as transcribed to the MAR.
- Transcribing ordered medications only to the MAR.
- Taking an intact unit dose and the MAR into the patient's room.
- Specifically training nurses in dispensing (obtaining on-site pharmacy support 24 hours per day was acknowledged as unrealistic given the low volume of patients).
- Expanding use of automated dispensing machines.

Findings

Initial Findings: Comparison of CAHs to MEDMARX. From February 2002 through December 2003, the NCRHR received 800 medication error reports from 6 CAHs. These reports were compared to the 192,477 errors reported to MEDMARX by 482 facilities in the year 2002[8] (Table 1). Ninety-eight percent of actual errors (Categories B to I) reported to MEDMARX, and 99% reported by the CAHs did not result in harm. Errors originating in the administration phase represented the greatest proportion of reports from both databases, with 57% of CAH error reports and 33% of MEDMARX reports originating during administration.

All actual errors (Categories B to I) were classified according to 13 different error types. Definitions of the 7 most frequent error types in CAH and MEDMARX reports are as follows: O*mission* is failing to give an ordered dose (excludes patient refusal); *improper dose/quantity* is any dose or strength that differs from what was ordered; *prescribing* is any error involving incorrectly prescribed or authorized medications; *unauthorized drug* is a medication not authorized by a legitimate provider; *wrong time* is a scheduled dose given outside of a facility's acceptable interval; *extra dose* is a duplicate dose administered at a different time; and *wrong route* is administration by other than the intended route.[28] These 7 error types accounted for nearly 95% of errors reported to both databases.

Despite the above similarities, there were significant differences between the CAHs and MEDMARX in the severities, phases, and types of errors reported. The CAHs reported a significantly smaller proportion of Category B near-miss errors and a significantly greater proportion of Category C errors than did facilities reporting to MEDMARX. Consequently, a greater proportion of CAH reports (71%) concerned errors that reached the patient (Categories C to I) as compared to MEDMARX (49%). The CAHs reported significantly smaller proportions of errors that originated in the prescribing and preparation/dispensing phases and a significantly greater proportion that originated in the administration phase as compared to MEDMARX.

There were no statistically significant differences between the CAHs and MEDMARX in the proportions of reported errors originating in the documenting and monitoring phases.

There were statistically significant differences between the CAHs and MEDMARX in the reported proportions of 2 error types that are associated with pharmacy support. Specifically, of Categories B to I errors reported to MEDMARX, 19% were prescribing errors and 11% were unauthorized drug errors; of Categories B to I errors reported by the CAHs, 4% were prescribing errors and 18% were unauthorized drug errors. Proportions of reported errors classified as administering an improper dose/quantity, administering an extra dose, or administering by the wrong route were not significantly different between the 2 databases, whereas omission errors and wrong time errors were more common in the CAH reports than in MEDMARX.

Hypothesis Generation: Comparisons by Pharmacist Availability. We hypothesized that the differences in proportions of Category B error reports; the differences in proportions of reports originating in the prescribing, preparation/dispensing, and administration phases; and the differences in proportions of error types between the MEDMARX and CAH databases were associated with availability of pharmacy support. Specifically, 81% of reports were received from 4 CAHs that had on-site pharmacy support available from 20 to 60 hours per week. The remaining 19% of CAH reports were from 2 facilities that contracted with consultant pharmacists to provide services limited to a few hours per week. In contrast, 75 of the 150 non-federal general community hospitals reporting to MEDMARX had pharmacists available 24 hours per day, 7 days per week (MEDMARX 24/7 hospitals).

As part of the collaborative arrangement with MEDMARX, the CAH error reports by pharmacy support were compared to the MEDMARX 24/7 hospitals (Table 2). Pharmacists and pharmacy technicians played a fundamental role in medication error reporting in the MEDMARX 24/7 hospitals by submitting 26% of all reports. In contrast, in the CAHs with on-site pharmacists, pharmacy personnel submitted 11% of reports, whereas in the CAHs with consultant-level pharmacy support, pharmacists did not contribute any reports. Greater availability of pharmacists was associated with reporting greater proportions of Category A or B errors by pharmacy and nursing personnel.

The likelihood of reporting errors and potential errors before they reached the patient was associated with pharmacy support. The proportion of Category A and B reports was 13% in CAHs with consultant pharmacists, 32% in CAHs with on-site pharmacists, and 57% in the MEDMARX 24/7 hospitals. The phase of the medication use process in which reported errors originated was also associated with pharmacy support. Proportions of errors originating in the prescribing and preparation/dispensing phases were largest in the MEDMARX 24/7 hospitals and smallest in the CAHs with consultant pharmacists. Proportions of reported errors originating in the administration phase were greatest in the CAHs with consultant pharmacists, which is consistent with the fact that nurses submitted 97% of error reports from these hospitals. There were no statistically significant differences in the proportions of reported errors by levels of pharmacy support in the monitoring phase.

The proportions of the types of error reports by pharmacy support were significantly different for 4 of the 5 error types analyzed. Overall proportions of improper dose/quantity and unauthorized drug error reports were smallest from the MEDMARX 24/7 hospitals, and these hospitals were most likely to report these error types before they reached the patient (Category B). For example, 12% of all reports from the MEDMARX 24/7 hospitals were unauthorized drug errors, and 43% of these were reported as Category B, whereas 20% of all reports from the CAHs with consultant pharmacists were unauthorized drug errors, but just 7% of those were reported as Category B. Furthermore, 3% of unauthorized drug error reports from the MEDMARX 24/7 hospitals, 1% from the CAHs with on-site pharmacists, and 7% from the CAHs with consultant pharmacists resulted in harm to the patient.

Reported proportions of prescribing errors were associated with increasing availability of pharmacy support. Nearly 21% of MEDMARX 24/7 hospital error reports were prescribing errors, and 88% of this error type were reported as Category B. In contrast, 4% of reports from CAHs with on-site pharmacists were prescribing errors, and 48% of these were reported as Category B; 1% (2/147) of reports from CAHs with consultant pharmacists were prescribing errors, and neither was reported as Category B. The proportions of reported wrong-time errors ranged from 8% in the MEDMARX 24/7 hospitals to 11% in the CAHs with on-site pharmacists. However, proportions of wrong-time errors did not vary by severity across the categories of pharmacy availability. Specifically, a wrong-time error was just as likely to be reported as a Category B in the CAHs as in the MEDMARX 24/7 hospitals.

Discussion

Ninety-nine percent of reported medication errors from 6 Nebraska CAHs and 98% reported to a national

Table 2. Comparison of Critical Access Hospital and MEDMARX (2002) Medication Error Reports by Pharmacist Availability

	Critical Access Hospital Consultant Pharmacist n = 152 (%)	Critical Access Hospital On-site Pharmacist n = 648 (%)	MEDMARX Pharmacist Available 24/7 n = 66,170 (%)	*P* Value*
Pharmacist/other pharmacy personnel reported error	0.0	10.7	26.4	<.001†,‡
Severity category				
A to B¶ (% of all pharmacist/pharmacy reports)	0.0	55.1	84.8	<.001‡,§
C to D‖ (% of all pharmacist/pharmacy reports)	0.0	42.0	14.7	<.001‡,§
E to I** (% of all pharmacist/pharmacy reports)	0.0	2.9	0.5	.046‡
Nursing personnel reported error	97.4	81.8	41.6	<.001†
Severity category				
A to B¶ (% of all nursing personnel reports)	12.8	30.4	34.8	<.001§
C to D‖ (% of all nursing personnel reports)	85.1	68.9	62.5	<.001§
E to I** (% of all nursing personnel reports)	2.0	0.8	2.7	.018
Severity category				
A to B¶	13.2	32.3	56.7	<.001§
C to D‖	84.9	66.8	41.6	<.001§
E to I**	2.0	0.9	1.7	.304

	Critical Access Hospital Consultant Pharmacist n = 147 (%)	Critical Access Hospital On-site Pharmacist n = 553 (%)	MEDMARX Pharmacist Available 24/7 n = 50,605 (%)	*P* Value*
Phase of medication use process (for Categories B to I)				
Prescribing	2.7	5.6	23.2	<.001§
Documenting	16.3	28.8	25.8	.009§
Preparation/dispensing	2.0	13.9	16.1	<.001§
Administration	78.9	51.0	33.7	<.001§
Monitoring	0.0	0.7	1.3	.201
Error types (for Categories B to I)				
Omission (% of all error reports)	33.3	31.5	30.6	.706
B¶ (% of omission error reports)	4.1	6.3	29.8	<.001§
C to D‖ (% of omission error reports)	93.9	92.5	68.1	<.001§
E to I** (% of omission error reports)	2.0	1.2	2.0	.697
Improper dose/quantity (% of all error reports)	25.2	27.9	20.4	<.001†
B¶ (% of improper dose/quantity error reports)	18.9	33.8	45.9	<.001§
C to D‖ (% of improper dose/quantity error reports)	81.1	64.3	51.1	<.001§
E to I** (% of improper dose/quantity error reports)	0.0	2.0	3.0	.68
Unauthorized drug (% of all error reports)	20.4	17.5	11.6	<.001†
B¶ (% of unauthorized drug error reports)	6.7	21.7	43.1	<.001§
C to D‖ (% of unauthorized drug error reports)	86.7	77.3	54.3	<.001§
E to I** (% of unauthorized drug error reports)	6.7	1.0	2.6	.197
Prescribing error (% of all error reports)	1.4	4.2	20.6	<.001†
B¶ (% of prescribing error reports)	0.0	47.8	88.0	<.001§
C to D‖ (% of prescribing error reports)	100.0	52.2	11.0	<.001§
E to I** (% of prescribing error reports)	0.0	0.0	1.0	1.0

Table 2. Continued

	Critical Access Hospital Consultant Pharmacist n = 147 (%)	Critical Access Hospital On-site Pharmacist n = 553 (%)	MEDMARX Pharmacist Available 24/7 n = 50,605 (%)	*P* Value*
Wrong time (% of all error reports)	10.2	10.9	7.8	.017†
B¶ (% of wrong-time error reports)	20.0	11.7	18.0	.436
C to D‖ (% of wrong-time error reports)	80.0	88.3	80.6	.318
E to I** (% of wrong-time error reports)	0.0	0.0	1.4	1.0

* *P* values from χ^2 or Fisher exact test for association between categorical variables.
† Statistically significant difference at the $P<.05$ level.
‡ *P* value is for the difference between critical access hospital on-site pharmacist and MEDMARX pharmacist available 24/7.
§ Statistically significant difference after adjusting for multiple comparisons.
¶ Error does not reach the patient.
‖ Error reaches the patient, does not result in harm.
** Error reaches the patient, results in harm.

medication error database did not result in patient harm. However, voluntary error reporting programs are estimated to capture less than 10% of actual errors.[29,30] This underreporting of errors and the high volume of medication use support the IOM's conclusion that medication use is associated with significant risks to hospitalized patients.[1] It is estimated that more than 770,000 people are injured or die each year in the hospital due to adverse drug events.[9] Physicians' and nurses' lack of knowledge about drug interactions and correct dosing has been shown to be the most common cause of these harmful events.[31] The complexity of medication use requires that pharmacists play a central role in an interdisciplinary system of independent double-checks that places more than 1 provider between the drug and the patient.[1,25,32,33]

Designing medication use systems that employ interdisciplinary independent double-checks is difficult in small rural hospitals that do not have the service volume to support a pharmacist or find it difficult to recruit a pharmacist. A recent survey found that 38% of CAHs do not directly employ pharmacists and most likely contract with community pharmacists to act as consultants who provide limited services.[15] The implementation of a voluntary medication error reporting program in 6 Nebraska CAHs and collaboration with USP allowed us to explore the effects of limited pharmacy support on the severity, phase, and type of medication errors reported by CAHs compared to those reported by larger hospitals with continuous pharmacy support. The findings suggest that greater levels of pharmacy support are associated with an increased likelihood of reporting potential and near-miss errors (Categories A and B) by both pharmacy and nursing personnel.

Furthermore, our findings demonstrate that increasing the extent of interdisciplinary double-checks with the presence of pharmacists is associated with reporting larger proportions of medication errors that originate in the prescribing and preparation/dispensing phases. Our finding that prescribing errors, unauthorized drug errors, and improper dose/quantity errors are more likely to be reported before reaching the patient in hospitals with greater pharmacy support is also consistent with the presence of independent double-checks in medication use systems. Due to the small numbers of harmful errors, we did not have the power to detect differences in proportions of reported harmful errors by levels of pharmacy support.

Our findings are consistent with a recent study by Crawford et al[34] of the systems factors associated with reporting medication errors. Based on a survey of 156 medical-surgical hospitals in the United States, Crawford et al. determined that increased availability of pharmacist services resulted in more structured and systematic efforts to detect and report medication errors. We believe our findings specifically demonstrate that limited access to pharmacists in small rural hospitals results in 3 consequences for medication safety. First, there are fewer opportunities to learn about the medication use system from potential (Category A) and near-miss (Category B) errors. Second, there are greater opportunities for prescribing errors, unauthorized drug errors, and improper dose/quantity errors to reach the

patient. Third, limited access to pharmacists results in limited ability to independently double-check provider prescribing behavior and may result in greater opportunities for preventable adverse drug events. Further research with greater numbers of small rural hospitals and additional methods for detecting adverse drug events are necessary to determine if the probability of harm to patients is greater when there is limited participation of pharmacists in medication use and medication error reporting.

All decision makers must place the policy relevance of these findings in the context of the provider shortages and low service volume in rural hospitals.[2] It is unrealistic to address our findings by advocating for increased physical presence of pharmacists in small rural hospitals. Telepharmacy interventions are currently maintaining community pharmacy services in 9 counties in North Dakota,[35] extending pharmacy support across 12 counties in Utah,[36] and providing nighttime pharmacy support in a hospital in Washington, D.C.[37] These interventions allow remotely located pharmacists to review patient information and computerized, scanned, or faxed orders and to use video connections to communicate with and view medications obtained by nurses and pharmacy technicians.

Our findings should be of interest to decision makers at all levels. At the national level, the subject of limited pharmacy support in small rural hospitals can be viewed as an example of underservice, limited access, and provider shortages that characterize rural health care. However, this issue can also be considered an opportunity to leverage telepharmacy innovations to achieve equitable access to pharmacists' services for rural populations.[38] Reimbursement strategies to support telepharmacy services must evolve with the technology.

At the state level, relationships between network hospitals and CAHs should be structured to facilitate sharing resources across multiple facilities, as in the Utah Telehealth Network.[37] State legislatures and boards of health and professional practice should take leadership roles to remove legal barriers to voluntary error reporting and to adapt practice acts to allow existing providers to dispense medications under the supervision of a remote pharmacist. At the local level, administrators, governing boards, and providers must understand the importance of organizational culture in patient safety, the need to build relationships with peers in order to share resources, and the importance of participating in voluntary medication error reporting programs to generate meaningful analyses of their medication use systems.

The sensitive nature of voluntary medication error reporting requires that independent organizations receive the reports to maintain the anonymity of the contributing hospitals. Replicating this voluntary medication error reporting program will require CAHs to financially support and share the analytical, educational, and human resources provided by this independent organization. The decision to financially support the shared resources should be based on the knowledge that supporting fees are allowable Medicare costs. This project also revealed that the barriers to quality improvement that exist in CAHs often result in the need for structured education to implement and maintain system changes. Network hospitals, state hospital associations, and academic research centers are examples of independent organizations that can provide the necessary anonymity and shared resources. Replication of this project on a large scale should be based on its ability to increase knowledge and practice of safe medication use in small rural hospitals.

There are limitations to these findings because they are based on proportions of reported errors and not actual error rates. Neither the 6 Nebraska CAHs nor the hospitals that chose to submit their error reports to MEDMARX can be considered representative samples. The authors plan to address these limitations as the reporting program recruits more CAHs. We now have the potential to aggregate data from medication error reports submitted by all CAHs in the state of Nebraska through the use of a MEDMARX multifacility module. This module allows online generation of reports and trends based on specified criteria for individual facilities as well as aggregation of all facilities in a group.

Conclusions

Quality of care is a system function that reflects the capacity and performance of the organization.[2] Aggregating data across similar facilities provides small rural hospitals with the opportunity to measure quality by identifying and correcting system failures that lead to errors. Participating in voluntary error reporting programs will allow rural hospitals to participate in the national patient safety and quality agenda and will provide research opportunities to determine the effects of resource variation on patient safety and quality measurements. The NCRHR is translating research into practice through collaboration between an academic medical center, a national error reporting program, and CAHs to enable these small rural hospitals to learn about medication use systems, medication error reporting, and the effects of pharmacy resource constraints.

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