Grant Final Report

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Detecting Med Errors in Rural Hospitals Using Technology

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Abstract

Purpose: In 2004, the Patient Safety Center at the University of Mississippi Medical Center was awarded an AHRQ grant to set up a rural hospital medication error reporting network.

Scope: Eight rural hospitals including five in the Mississippi Delta and three in east central Mississippi were recruited to participate in the project. Six of the eight were critical access care hospitals (with fewer than 25 beds). The largest hospital had 69 licensed beds; the smallest had eight beds.

Methods: The network became fully functional on January 1, 2006. From this date forward, we began collecting medication error reports from all eight rural hospitals.

Results: Data on the number of medication errors reported from the eight rural hospitals between January 1, 2006, and August 31, 2008, are provided in the attached tables. .

Key Words: None provided.

Final Report

Purpose

(1) UMMC, Mississippi's Information and Quality Healthcare (IQH) and eight small rural hospitals throughout Mississippi will implement a program using health information technology (HIT) to improve patient safety and quality of healthcare. The research will study the impact that HIT, Quality Iniatives (QI) awareness and training will have on the number of medication errors reported by these rural facilities. The goal is to increase the number of medication errors reported.

All healthcare professionals at each hospital will be ask to participate in the Hospital Survey on Patient Safety Culture in the study. The questionnaire will be used to assess the current atttitudes of healthcare professionals in the eight rural hospitals included in the grant. The questionnaire was developed by the Agency for Healthcare Reseach and Quality (AHRQ). It is the survey currently endorsed by AHRQ, the sponsoring agency of the grant. It is anticapted that the surveys will be done annually for the three years of the grant. The survey will be voluntary.

(2) Privacy and confidentiality of hospital and patient data collected by the study will be protected using both electronic and restricted access measures. Patient anonymity is protected, on the occurence report itself, by using the medical record number to indentify individual patients. All published data will be in aggregate form with patient indentifiers eliminated from the data. It will be impossible to identify individual patients from the aggregate data set. All data abstraction will be conducted on site. Actual patient records will remain in the medical records office at the hospital site. If, on occasion, a co-investigator is invited by the partner institution to view a patient record, this person will have completed the IRB ethics course from Miami University as have all grant personnel. The patient record will never become part of the data.

(3) There was minimal risk to patients.

(4) Electronic reporting of medical errors can reduce future errors in four important ways: 1) Increasing awareness by defining the epidemiology and root cause of an institution's errors and Adverse Drug Reactions (ADEs) 2) Reducing the time lag between report and review 3) Tracking trends in a timely manner and 4) Creating data supported feedback for providers and staff on reporting and QI.

(5) No patients were recruited for this study.

Scope

Medical errors and adverse events (ADEs) are a significant problem within our nation's health care system. In July 2002, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) cited the reduction of errors and ADEs as a priority. Although estimates are wide ranging, medical errors has been reported to be the third leading cause of death in the US, closely trailing heart disease and cancer. Annually, an estimated 7,000 inpatients die nationally, as a result of medical error, and up to 106,000 deaths occur across the country due to adverse effects of medications. Enormous financial costs have been attributed to medical errors with estimates ranging from $130-180 billion per year. Classen and Bates have suggested that the cost per ADE ranges between $2,300 and $4,685. Intangible costs are also high—resulting in patient and provider distrust, dissatisfaction and alienation.

Technology for detecting and defining medical errors has advanced over the years from dropping a handwritten card describing the suspected event into a box to sophisticated, web-based reporting. This technology allows data to be collected from any computer terminal. Practitioners, pharmacists, nurses, and other staff members can enter data that in turn can be stored in a centralized repository. The aggregate data (or individual event) can then be analyzed for trend and severity. Reports can be generated as needed allowing an institution to identify changes necessary to address critical errors and improve patient safety.

The goals of our project were as following:

(1) To introduce voluntary, anonymous, electronic medical error and ADE reporting in eight (8) small, rural hospitals (less than 100 beds) in Mississippi;

(2) To identify barriers to implementation of HIT including educational, cultural, technological, and intangible issues, such as reticence and resistance;

(3) To ascertain the epidemiology and root cause of medical errors and ADEs in small, rural hospitals;

(4) To formulate educational and (continuous quality improvement) CQI strategies that are specific to small, rural hospitals in partnership with participating hospitals;

(5) To develop, demonstrate, and evaluate strategies in partnership with the participating institutions for reducing errors and, ultimately, improving patient safety throughout Mississippi, and by extension, in other rural areas, based on the data we have gathered; and

(6) To disseminate the results of our research and the QI strategies we develop in partnership with our participating institutions throughout the health care industry.

In order to have achieved our stated goals, we have identified six specified aims:

(1) Developed an unprecedented partnership between a network of small, rural hospitals, the University of Mississippi Medical Center (UMMC) and the Institute for Quality Health

(IQH) which has collectively created a "community of learners" whose goal is to improve Mississippi's health care;

(2) Implemented HIT in small, rural hospitals without such capacity by exporting UMMC's voluntary, web-based reporting mechanism to sites;

(3) Fostered a confidential, non-punitive environment for voluntarily reporting medical errors and ADEs;

(4) Defined the epidemiology and identified the root causes of medical errors and ADEs in rural areas;

(5) Developed strategies to improve patient safety by utilizing our partnership for collective development, implementation and testing of an electronic reporting mechanism, QI initiatives, and educational programs for both rural health care providers and the consumers of rural health care services;

(6) Disseminated the results of our research, increasing the awareness of rural health care providers and consumers of their role in improving patient safety, and implemented systematic changes to effect positive outcomes.

Methods

In 2004, the Patient Safety Center at the University of Mississippi Medical Center was awarded an AHRQ grant to set up a rural hospital medication error reporting network. Eight rural hospitals including five in the Mississippi Delta and three in east central Mississippi were recruited to participate in the project. Six of the eight were critical access care hospitals (with fewer than 25 beds). The largest hospital had 69 licensed beds; the smallest had eight beds.

In year one, an analysis focusing on technology capacity, physical space, personnel, and current medical error reporting practices was conducted. After collecting data, we developed an educational and implementation strategy. We created customized educational courses that included CE and CME credits focusing on the importance of reporting medication errors and using our web-based medical error reporting system. Of the 210 direct care providers, 198 attended our educational seminars and received CE or CME credit.

In year two, an interoperable frame relay network using fractional T1 lines and computer hardware and software was installed in each of the eight rural hospitals. In order to reduce downtime and maintenance expense, ClearCube technology, consisting of eight blades and a blade server, was installed at UMMC's patient safety center. I-ports were installed at each of the eight rural hospitals, typically at the nurses' stations; I-ports provide the portal for the users to access the blades at the patient safety center. Where internet access was available, icons were placed on user desktops, allowing these computers to connect to the internet server at UMMC using the HTTPS protocol. Ultimately, we chose to use HTTPS rather than VPN because the implementation of HTTPS was more efficient and less expensive. All T1 lines are connected to UMMC's DS3 lines which are terminated at the hospital's outside router.

Results

The network became fully functional on January 1, 2006. At this time, we began collecting medication error reports from all eight rural hospitals. Data on the number of medication errors reported from the eight rural hospitals and, for comparison purposes, UMMC, between January 1, 2006, and August 31, 2008, are provided in the attached tables.

A total of 805 error reports were made during this time period. The top three types of errors reported were administering (419/805), documenting (120/805) and transcribing (111/805). Regarding severity, 172/805 (21.3%) were intercepted with the balance having reached the patient (633/805). Fortunately, only 9 of these (1.4%) were reported as having caused harm.

Sixty-seven percent (540/805) of the errors were "discovered" by the nursing staff; pharmacists accounted for 234/805 discovered errors (29%). Not too unexpectedly since they discovered the majority of events, nurses were deemed accountable for 734/805 (91%) of errors.

Table 1. Number of beds and occupancy rates for rural facilities

Facility	Number of Beds (provided by facility)	AHD Beds	Possible Hospital Days	AHD* Hosp. Days	Rate
Neshoba County General Hospital	64 (82 licensed)	38	365 x 38 = 13,870	7,635	7,635/13,870 = 55%
North Sunflower County Hospital	25 (Census usually 75% to 85%)	25	365 x 25 = 9,125	5,639	5,639/9,125 = 62%
South Sunflower County Hospital	49 licensed IP beds – all open	49	365 x 49 = 17,885	7,280	7,280/17,885 = 41%
Tallahatchie General Hospital	10 Acute – 64 LT	9	365 x 9 = 3,285	1,470	1,470/3,285 = 45%
Sharkey-Issaquena Community Hospital	29 (19 Acute, 4 are LT) – 10 Senior Care	19	365 x 19 = 6,935	1,340	1,340/6,935 = 19%
Humphreys County Memorial Hospital	25	25	365 x 25 = 9,125	4,485	4,485/9,125 = 49%
Laird Hospital	25	25	365 x 25 = 9,125	5,304	5,304/9,125 = 58%
Leake Memorial Hospital	25 (Census usually 10-12 / 30% - 50%)	25	365 x 25 = 9,125	4,040	4,040/9,125 = 45%

*American Hospital Directory website http://www.ahd.com/freesearch.php3

Table 2. 805 total errors reported

Where in the Process	Totals
Administering	419
Dispensing	48
Documenting	120
Monitoring	3
Preparing	76
Prescribing	28
Transcribing	111
Total	805

Table 2b.

Severity	Totals
Intercepted	172
No Harm	624
Harm	9
Total	805

Table 2c.

Who Made Error	Totals
Physician	8
Pharmacist	21
Non-Physician Provider	6
Nurse	734
Other	36
Total	805

Table 2d.

Who Discovered Error	Totals
Physician	16
Pharmacist	234
Non-Physician Provider	3
Nurse	540
Other	12
Total	805

Table 3. Process that reported medication errors occurred by facility

	Admin-istering	Dis-pensing	Docu-menting	Mon-itoring	Pre-paring	Pre-scribing	Tran-scribing	Totals
Humphreys County Memorial Hospital	1	2	17	0	0	2	0	22
Laird Hospital	60	3	19	0	1	11	21	115
Neshoba County General Hospital	126	13	30	1	56	11	57	294
Tallahatchie General Hospital	5	3	3	0	1	0	0	12
South Sunflower County Hospital	30	2	10	1	17	2	17	79
Sharkey-Issaquena Community Hospital	18	16	2	1	1	0	3	41
North Sunflower County Hospital	165	2	23	0	0	1	12	203
Leake Memorial Hospital	14	7	16	0	0	1	1	39
Totals	419	48	120	3	76	28	111	805

Table 4. Severity levels for reported medication errors by facility

	Intercepted	No Harm	Harm	Totals
Humphreys County Memorial Hospital	16	6	0	22
Laird Hospital	21	94	0	115
Neshoba County General Hospital	37	256	1	294
Tallahatchie General Hospital	2	7	3	12
South Sunflower County Hospital	41	35	3	79
Sharkey-Issaquena Community Hospital	21	19	1	41
North Sunflower County Hospital	22	181	0	203
Leake Memorial Hospital	12	26	1	39
Totals	172	624	9	805

Table 5. Count of staff who made the reported medication error by facility

	Physician	Pharmacist	Non-Physician Provider	Nurse	Other	Totals
Humphreys County Memorial Hospital	0	0	0	22	0	22
Laird Hospital	3	2	3	102	5	115
Neshoba County General Hospital	4	13	1	264	12	294
Tallahatchie General Hospital	1	0	0	11	0	12
South Sunflower County Hospital	0	0	2	73	4	79
Sharkey-Issaquena Community Hospital	0	2	0	24	15	41
North Sunflower County Hospital	0	4	0	199	0	203
Leake Memorial Hospital	0	0	0	39	0	39
Totals	8	21	6	734	36	805

Table 6. Count of staff who discovered the reported medication error by facility

	Physician	Pharmacist	Non-Physician Provider	Nurse	Other	Totals
Humphreys County Memorial Hospital	2	20	0	0	0	22
Laird Hospital	2	39	0	69	5	115
Neshoba County General Hospital	1	51	240	1	1	294
Tallahatchie General Hospital	1	1	0	10	0	12
South Sunflower County Hospital	9	0	0	62	6	77
Sharkey-Issaquena Community Hospital	0	0	0	41	0	41
North Sunflower County Hospital	0	107	0	96	0	203
Leake Memorial Hospital	1	16	0	22	0	39
Totals	16	234	240	301	12	803

Lessons Learned

To date, we have focused our academic efforts on barriers we encountered while developing our network. Below are some of our thoughts on our experiences implementing an electronic reporting system in a very rural, impoverished part of the United States. We have yet to begin to explore our data acquired during the study period. Well, that is not entirely true. We have done some analyses, but are just now beginning to interpret our findings. Regrettably, this effort has been hampered by the loss of one of our key investigators, Dr. Bill Rudman, who left in September 2008.

The first and most important organizational barrier to the adoption of new technology is cost, including implementation and maintenance costs. Before we were able to recruit hospitals to be

part of our network, we had to assure hospital administrators that there would be no direct costs for implementation and maintenance of this medication error reporting network. Consequently, to overcome this cost barrier in rural settings, our grant paid for the initial implementation and continued maintenance.

After this initial barrier was overcome, we were able to focus on broader, cultural issues related to the adoption of this new technology. We began by creating a learning organization. Learning organizations are based on the open flow of communication, ideas, and worker empowerment. Our education seminars focused on worker empowerment. During the initial phase, we discussed specific requirements with end-users at each hospital in order to customize the procedures and allow users to feel invested in the process. By bringing end-users into the decision-making and design processes, we were able to overcome time, fear, usefulness, and complexity barriers. This empowered workers to own the process of electronically reporting medication errors. Furthermore, in doing so, we were able to bring the process into the workflow, thus reducing time and fear. In fact, during one of our educational seminars, a physician who had worked with the system we developed at UMMC noted that "I spend more time here looking for the paper form than I do filling out the report with this system." By showing end-users the practicality of our system as part of daily workflow routine, we gained end-user trust.

Part of creating a learning organization is providing immediate feedback and monthly reports on reported medication error outcomes. First, we created an automated email notification report; details of the report are then immediately faxed to the specific site. On the fifteenth of each month, each site receives a newsletter and a medication error report that summarizes the reporting behavior and provides a network comparison in order to benchmark progress. The health care workers at the eight rural hospitals are able to observe their efforts in comparison to other hospitals in the network.

Our research identified three barriers to the adoption of new technology that may be specific to rural areas: personnel, physical space, and internet access. Furthermore, we found that the means through which previously recognized barriers may be mitigated are different in rural settings. For example, for rural providers, the previously recognized barrier of cost is closely tied to personnel time—time is money. In other words, we needed to ensure the hospital administrators that our reporting system is easy to learn, easy to use, would save time in reporting the medication error, and that we would provide quality assurance reports, thus lessening time demand and responsibilities for the quality assurance director. Therefore, personnel availability is a barrier that is related to previously identified barriers, but it is also a serious, stand-alone barrier in rural healthcare settings.

An additional barrier for rural hospitals relates to space. For most large urban hospitals, placing a screen and central processing unit (CPU) at a nursing station presents no serious barrier to the adoption of new technology. However, this was an important barrier for all eight hospitals in our network. To overcome this barrier, we used ClearCube technology so that we did not have to find space for a CPU; instead, we only needed space for a screen and I-port. This also eliminated service charges, and it centralized maintenance at UMMC.

The final barrier specific to rural settings that our research identified was the lack of internet access for all direct care providers. Initially, we intended to use the internet as the sole means through which our medication error reporting system could be accessed. However, since not all direct care providers in our rural network had access to the internet, we used T1 lines and the ClearCube technology to provide access to our medication error reporting system. This provided

two ways to access the system, through internet where available and through T1 lines and ClearCube technology installed at all eight hospitals in our rural network.

Our research confirmed that there are barriers to the implementation of technology in healthcare. In addition to the six barriers that prior research has identified, we encountered three additional barriers that may be specific to rural healthcare. However, our research also confirmed that technology, when carefully implemented, can improve medication error reporting processes. In fact, our research indicated that no barrier is insurmountable and that working to mitigate these barriers, particularly in rural settings, can vastly improve medication error reporting. In addition to this realization, our experience also taught us several valuable lessons.

First, we learned that, at least in Mississippi, rural hospitals are enthusiastic about participating in technology projects. Both administrators and staff are more knowledgeable about the benefits and governmental initiatives to create an interoperable information infrastructure than we initially assumed. Before starting this project, we were told by a leading private healthcare agency in our state that we would "be lucky to find eight hospitals to participate and, even if we did find eight, they would not use our system." In fact, thirty-five hospitals volunteered to participate in our study, and, during the first five months, the eight hospitals that we ultimately included in our network reported substantially more medication errors than UMMC during this time.

Second, we learned that setting up the medication error reporting network for our eight rural hospitals required more face-to-face interaction with the end-user than we had anticipated. Initially, we thought that we would only conduct a needs analysis and one educational seminar to secure the adoption of this new technology. In point of fact, during the initial implementation, Patient Safety Center staff made a minimum of three additional visits to each of the eight hospitals in our rural network to cultivate a sense of familiarity with the system, inclusion of end-users, and trust between UMMC and the staff of the eight rural hospitals.

Third, we learned that technology was not solely responsible for the improvement of medication error reporting. Instead, the care with which technology is implemented, including the considerable time to prepare end-users, the inclusion of end-users in the establishment of workflow process, and the attention to site-specific concerns strongly impacts the success or failure of the adoption of new technology.

Fourth, the distance between urban and rural sites can be mitigated by technology. In our initial planning for this work, we believed that the value of this work would be the transfer of new information and new ideas in one direction—from the large, urban hospital to the small, rural hospitals. However, once we got further into the work, we quickly realized that the learning process was recursive and that the beneficial relationship was reciprocal. We learned more about our own error reporting by listening to what was going on in the rural settings, and vice versa. In fact, as we began this project, UMMC was at a similar stage of needs analysis for the adoption of an intra-institutional EHR. The faculty at the Patient Safety Center is involved in the UMMC patient safety and EHR initiatives. This concurrent process of urban and rural needs analysis made it easy to make connections and see both similarities and differences between the two settings. This subtly transformed the UMMC leadership "mind-set" from an inward focus to an outward focus toward the importance of new technology. By achieving its own goals, UMMC could become a stronger leader in the adoption and implementation of a state-wide, interoperable HIT infrastructure. Ultimately, by creating close, reciprocal community of eight rural hospitals and UMMC, the distance between the two settings seemed less significant and the common goals of all participants were reached.

Finally, our experiences taught us that, although implementation of technology may be different in rural settings, technology can make measurable improvements in patient safety. As in urban areas, the overall impact of the adoption and implementation of new technology in reporting medication errors has the potential to improve patient safety and patient care in rural areas.

Figure 1. 805 total errors reported

Figure 1a. Count of where in process the reported medication error occurred

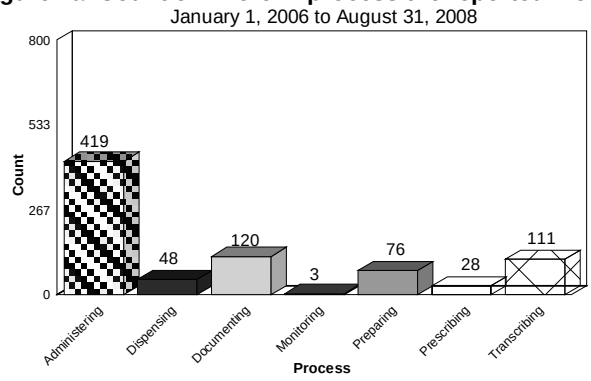


Figure 1b. Count of severity levels for reported medication errors

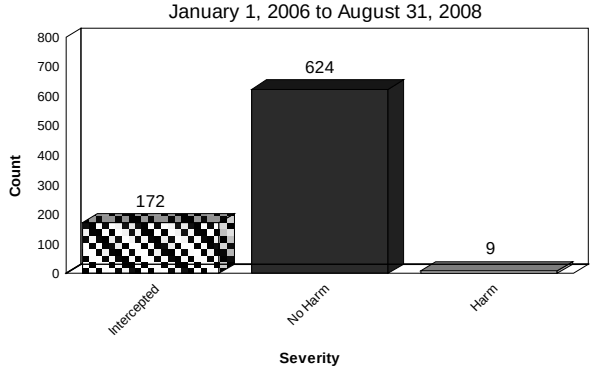


Figure 1c. Count of staff who made the reported medication error

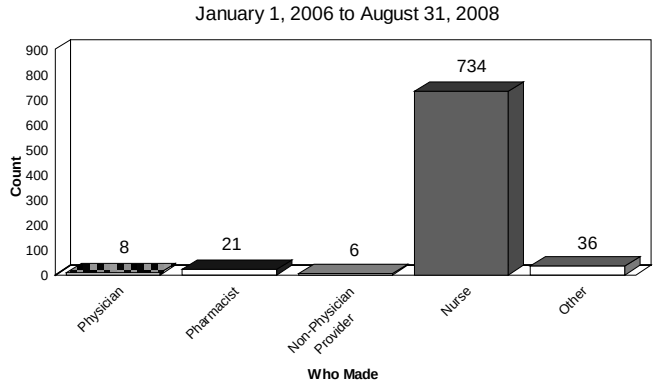


Figure 1d. Count of staff who discovered the reported medication error

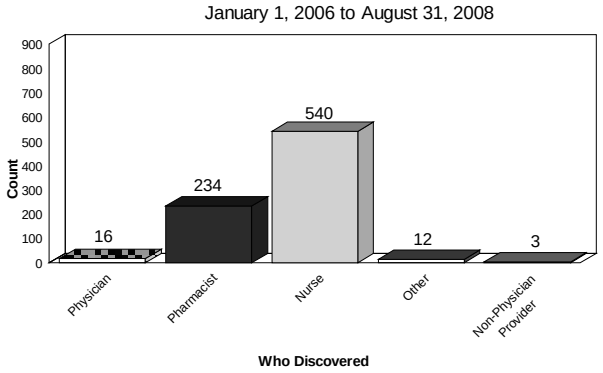


Figure 2. Humphreys County Memorial Hospital: 22 total errors report

Figure 2a. Count of where in process the reported medication error occurred

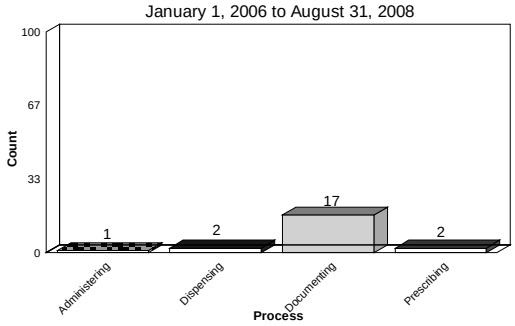


Figure 2b. Count of severity levels for reported medication errors

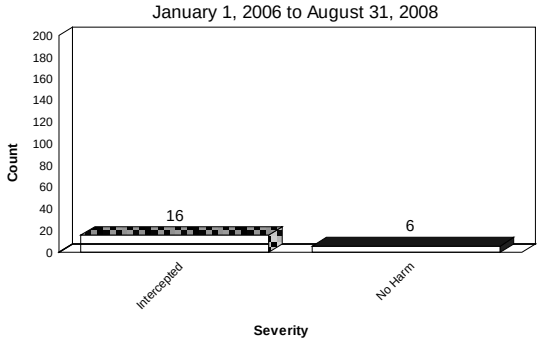


Figure 2c. Count of staff who made the reported medication error

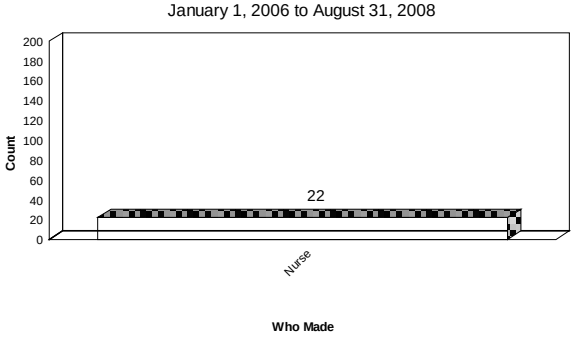


Figure 2d. Count of staff who discovered the reported medication error

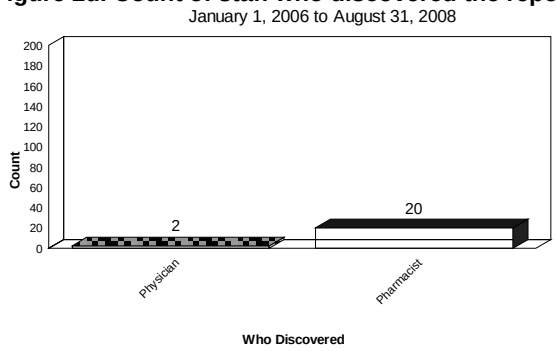


Figure 3. Laird Hospital: 115 total errors reported

Figure 3a. Count of where in process the reported medication error occurred

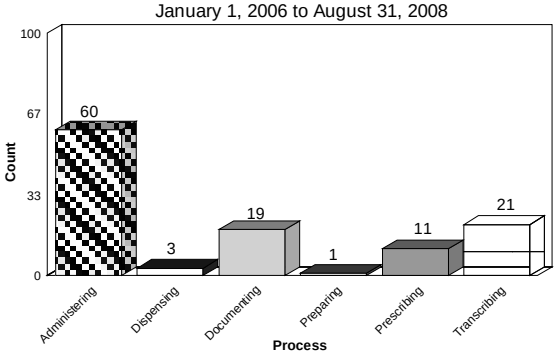


Figure 3b. Count of severity levels for reported medication errors

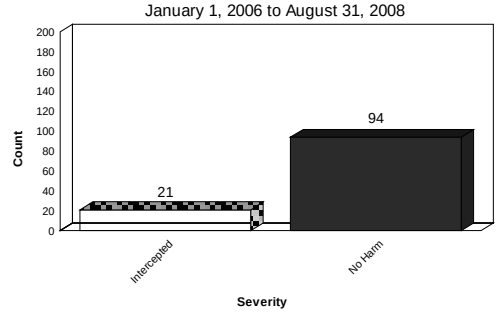


Figure 3c. Count of staff who made the reported medication error

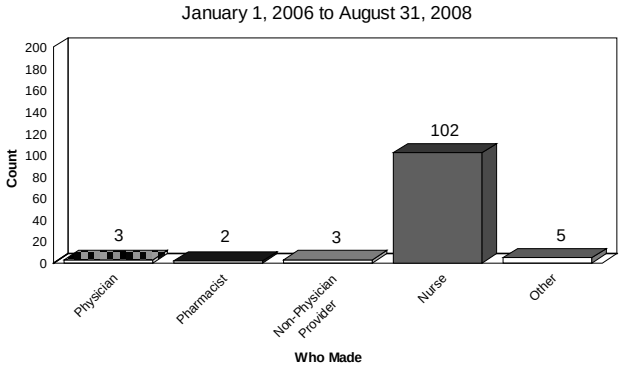


Figure 3d. Count of staff who discovered the reported medication error

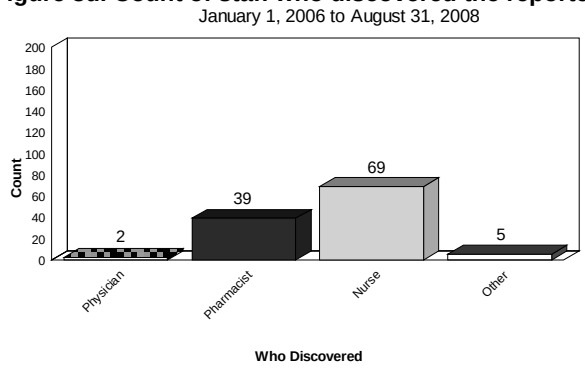


Figure 4. Neshoba County General Hospital: 294 total errors reported

Figure 4a. Count of where in process the reported medication error occurred

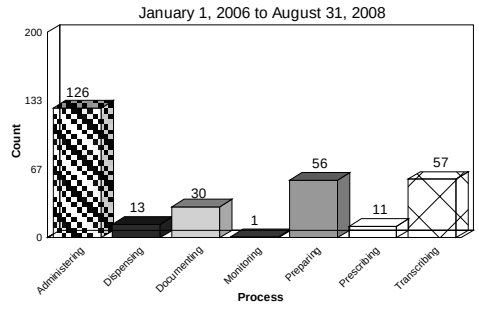


Figure 4b. Count of severity levels for reported medication errors

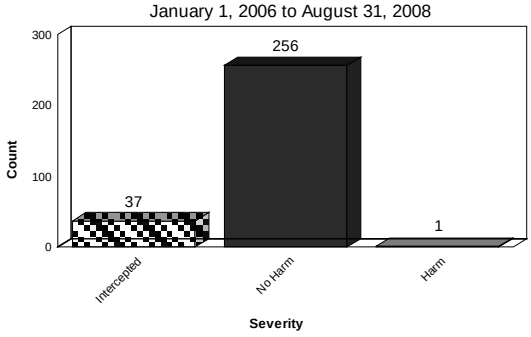


Figure 4c. Count of staff who made the reported medication error

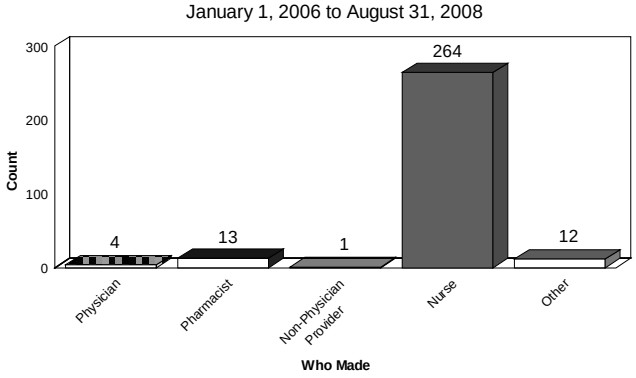


Figure 4d. Count of staff who discovered the reported medication error

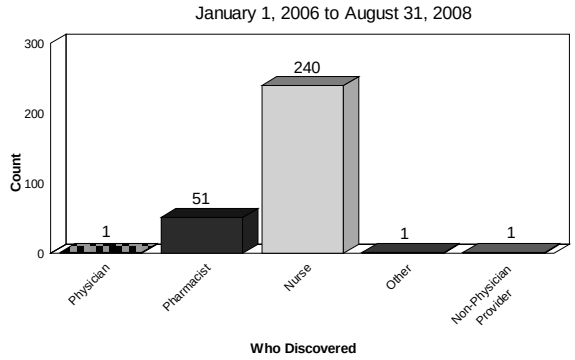


Figure 5. Tallahatchie General Hospital: 12 total errors reported

Figure 5a. Count of where in process the reported medication error occurred

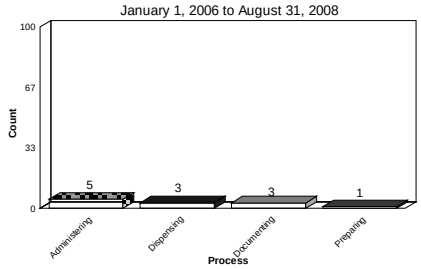


Figure 5b. Count of severity levels for reported medication errors

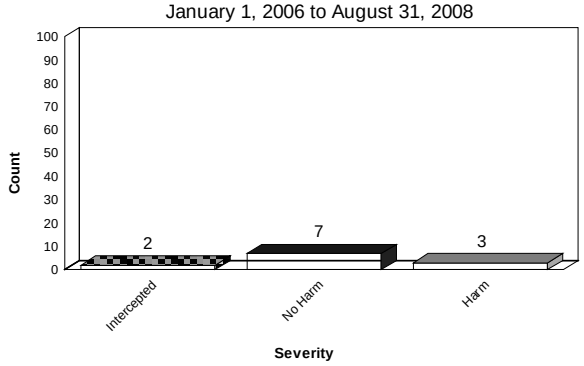


Figure 5c. Count of staff who made the reported medication error

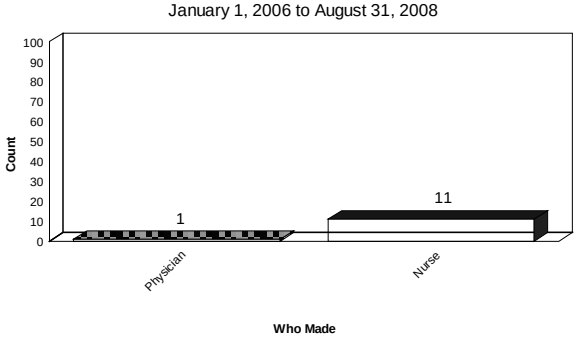


Figure 5d. Count of staff who discovered the reported medication error

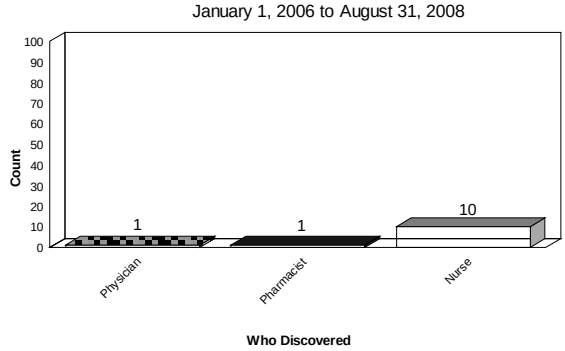


Figure 6. South Sunflower County Hospital: 79 Total errors reported

Figure 6a. Count of where in process the reported medication error occurred

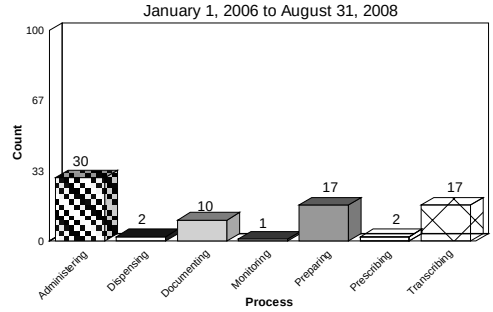


Figure 6b. Count of severity levels for reported medication errors

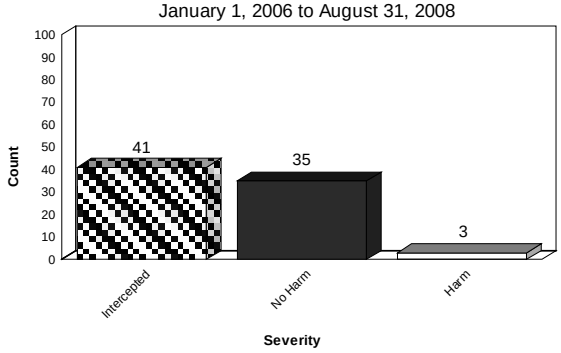


Figure 6c. Count of staff who made the reported medication error

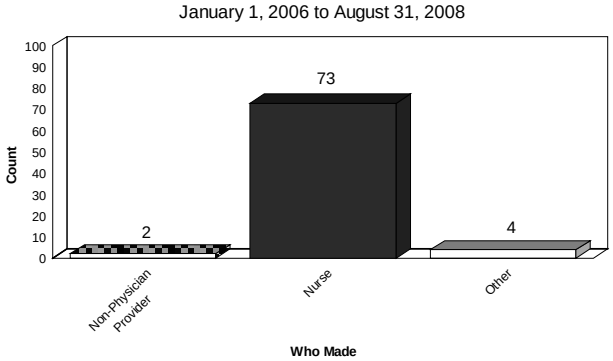


Figure 6d. Count of staff who discovered the reported medication error

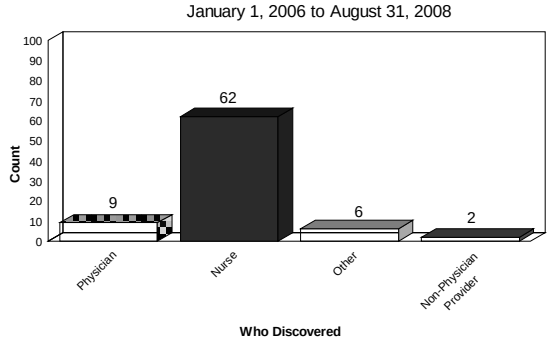


Figure 7. Sharkey-Issaquena Community Hospital: 41 total errors reported

Figure 7a. Count of where in process the reported medication error occurred

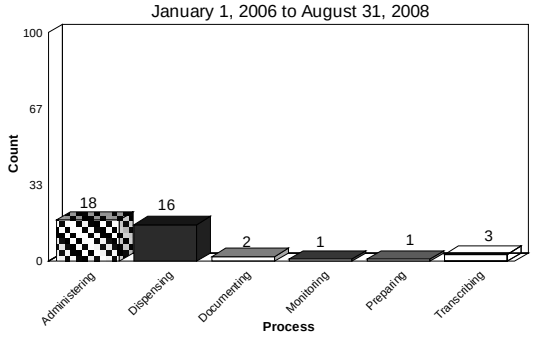


Figure 7b. Count of severity levels for reported medication errors

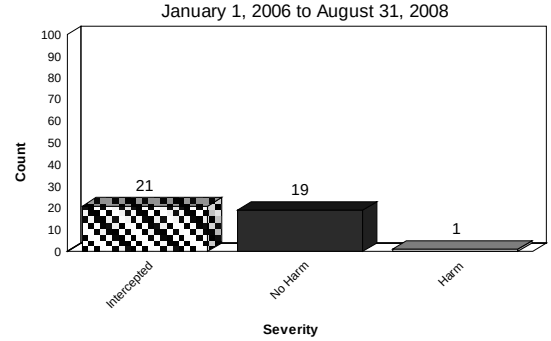


Figure 7c. Count of staff who made the reported medication error

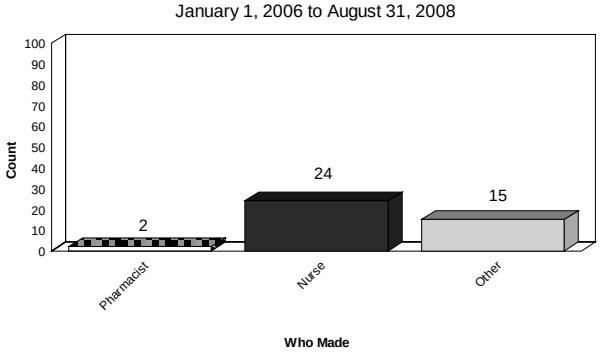


Figure 7d. Count of staff who discovered the reported medication error

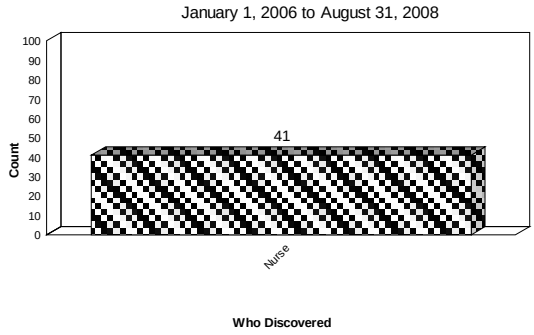


Figure 8. North Sunflower County Hospital: 203 total errors reported

Figure 8a. Count of where in process the reported medication error occurred

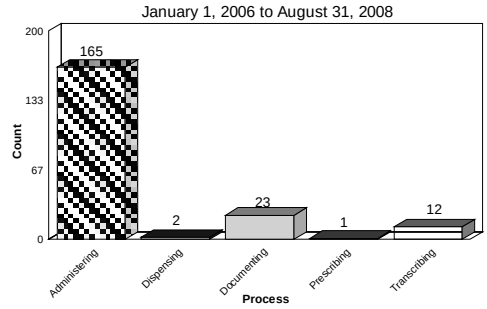


Figure 8b. Count of severity levels for reported medication errors

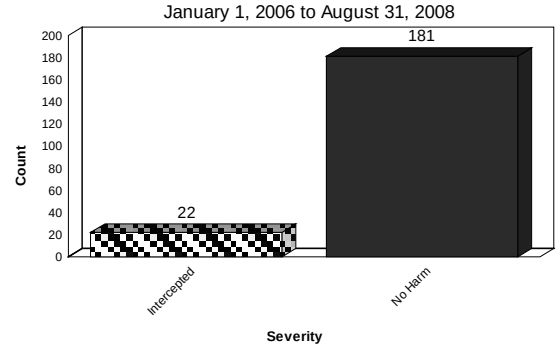


Figure 8c. Count of staff who made the reported medication error

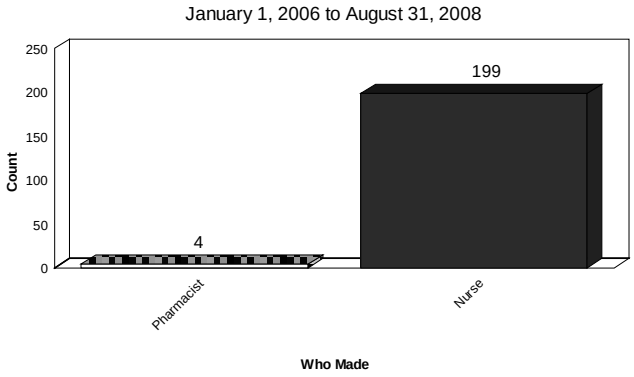


Figure 8d. Count of staff who discovered the reported medication error

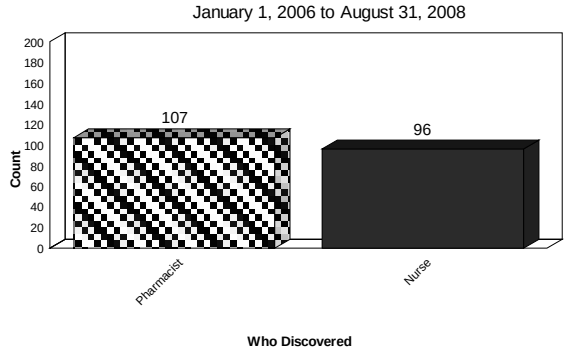


Figure 9a. Leake Memorial Hospital: 39 total errors reported

Figure 9a. Count of where in process the reported medication error occurred

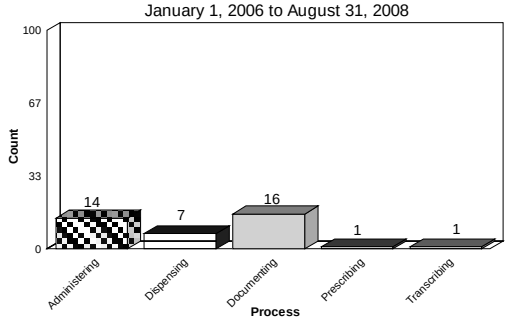


Figure 9b. Count of severity levels for reported medication errors

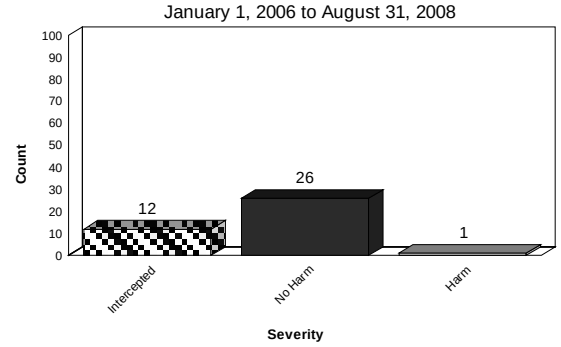


Figure 9c. Count of staff who made the reported medication error

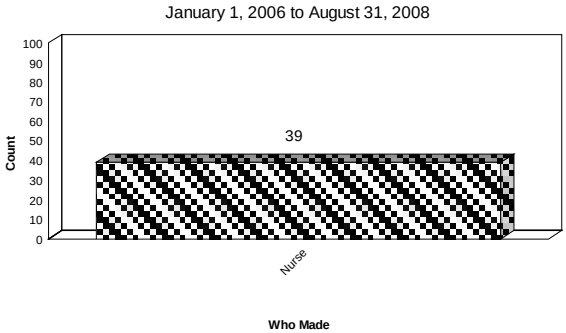
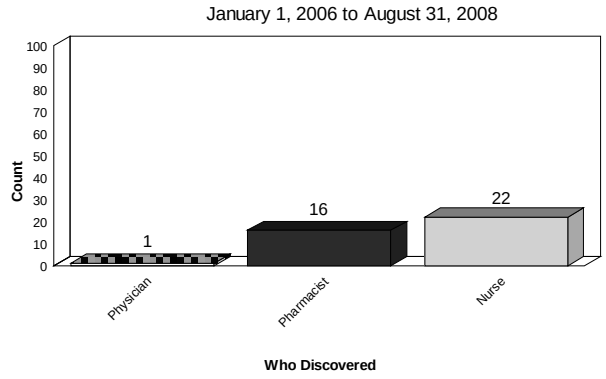


Figure 9d. Count of staff who discovered the reported medication error



List of Publications and Products

1. Rudman, W., Burke-Bebee, S., Hart-Hester, S., Brown, C.A., McIlwain J., Jr., Ekundayo, O., and Eberhardt, J., "Patient Safety and Patient Care among Small Rural Physician Offices: The Impact of Electronic Medical Record Adoption on Medical Error Reduction, Patient Care, and Cost Reduction." *JAMIA*, May, 2008. (Submitted)

2. Miller-Davis, P., Brown, C.A., Rudman, W., and Hart-Hester, S., "Blunt End/Sharp End" Perceptions of Patient Safety Culture: A Practical Approach to Developing Performance Improvement Initiatives. *Academic Medicine Special Issue: Quality and Safety Improvement in Health Care*, May, 2008. (Submitted)

3. Rudman, W., Hart-Hester, S., Brown, C.A., and Pierce, W., "Mississippi HIT Initiatives", National Oral Health Conference, April 28-30, Miami, FL

4. Rudman, W., Hart-Hester, S., Brown, C.A., and Pierce, W., Fairley, K., and Hamlin, S., "Factors Affecting the Adoption of EHR: The Use of Bayesian Models in Assessing EHR Adoption", National Rural Health Association 14th Annual Rural Minority and Multicultural Health Conference, December 11-12, 2008, Albuquerque, NM

5. Rudman, W., Hart-Hester, S., Brown, C.A., and McIlwain, J., "HIT/HIE/EMR Trends and Updates", Healthcare Financial Management Association Summer Meetings, August, 2007, Philadelphia, MS

6. Rudman, W., Burke-Bebee, S., Hart-Hester, S., Brown, C.A., McIlwain J., Jr., Ekundayo, O., and Eberhardt, J., "Patient Safety and Patient Care among Small Rural Physician Offices: The Impact of Electronic Medical Record Adoption on Medical Error Reduction, Patient Care, and Cost Reduction." AHRQ Annual Conference, September, 2008, Bethesda, MD

7. Rudman, W., Hart-Hester, S., Brown, C.A., Ford, E., and Eberhardt, J. "Research Reviews and Secondary Analysis", In Watzlaf, V. and Layman, E.eds, *Research In Health Information Management*, April, 2008.379.