

***Grant Final Report***

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**Improving Health Care through Health Information  
Technology in Morgan County, Indiana**

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# Abstract

**Purpose:** Evaluate a local health information technology initiative to improve quality of care delivered in Morgan County, IN, through longitudinal electronic patient information across multiple physician practices and Morgan Hospital and Medical Center (MHMC).

**Scope:** MHMC provides primary and secondary health care for residents of Morgan County. Historically, 98% of patients who receive inpatient care from MHMC are Morgan County residents; yet 76% of the hospital care received by county residents occurs outside of the Morgan County, resulting in a fragmented patient record.

**Methods:** Study design used a triangulated approach to evaluate impact of the health information technology initiative. Both qualitative and quantitative measures were obtained. Pre- and post-implementation measures were analyzed using repeated measures analysis of variance techniques.

**Results:** Significant gains in efficiency since MHMC's implementation of EMR and clinical messaging services, including the following:

- 43% increase in average number of results and reports received per day (62 versus 89).
- Decrease in time to track missing results from 90 to 7.6 minutes per day.
- Decrease in time to copy results for other providers from 69.6 to 5.6 minutes.
- No apparent time savings in filing information in paper-based charts.

**Key Words:** health information exchange, electronic medical record.

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# Final Report

## Purpose

The purpose of the study is to evaluate a local health information technology (HIT) initiative to improve the quality of care delivered in Morgan County, IN, through the use of longitudinal electronic patient information across multiple physician practices and Morgan Hospital and Medical Center (MHMC). To achieve this goal, MHMC partnered with the Indiana Health Information Exchange Inc (IHIE) to electronically share clinical information with other hospitals and physicians/health providers in the County, region, and State through a common, secure infrastructure. This infrastructure supports a clinical messaging system (DOCS4DOCS) that provides MHMC hospital and physician practices with clinical data essential to treatment decisions and quality patient outcomes. IHIE is a nonprofit corporation for sharing clinical information among healthcare providers and other health care entities that are part of a unique collaboration of central Indiana hospitals, providers, researchers from Indiana University and Regenstrief Institute, public health organizations, such as Health and Hospital Corporation of Marion County and the Indiana State Department of Health, and economic development groups including BioCrossroads of the Central Indiana Corporate Partnership.

## Scope

MHMC serves the 70,290 residents of Morgan County by providing comprehensive primary and secondary health care through its 113 bed hospital, cancer center, and 15 employed physicians supporting 10 hospital-owned physician practices, among others. Almost all patients (98%) who receive inpatient care from MHMC are Morgan County residents, but 76% of the hospital care received by Morgan County residents took place outside of the county. Tertiary, quaternary and some secondary care services not available at MHMC are provided outside of the county, primarily in Indianapolis or other locations in Marion County. This leads to fragmentation in patient records and frequently large time lags in transferring information between Indianapolis-based providers and their Morgan County colleagues. This disruption in availability of patient information is costly to address and can potentially impact patient safety.

To achieve the objective of improving the quality of care by increasing health information access and data exchange, MHMC replaced/upgraded its hospital information system with the Meditech system over three years including the following phases:

- Phase One – Replace legacy information systems, including patient management, financial, laboratory, radiology, and pharmacy applications.
- Phase Two – Implement advanced clinical applications, including operating room, emergency department, nursing documentation and computerized physician order entry.

- Phase Three – Close the information loop with executive reporting and budgeting, quality and risk management, patient education, and Internet Access for patients and physicians.

The new Meditech information system provides the infrastructure and data necessary to support the clinical messaging services provided by IHIE/Regenstrief, thus expanding its ability to deliver data to community physicians who refer patients to MHMC and to receive information regarding their patients who are treated by other providers who are part of IHIE. IHIE/Regenstrief supports the community-wide clinical messaging system that allows Morgan County providers to access, via secure electronic data exchange, clinical data including radiology, EKG, and other transcribed reports as well as laboratory results, for their patients, regardless of which member hospital or laboratory they visit.

## Methods

### Evaluation Study Design

The study design used a triangulated approach to evaluate the impact of the health information technology initiative. Both qualitative and quantitative measures were obtained. Pre- and post-implementation measures were analyzed using repeated measures analysis of variance techniques.

### Data Sources and Collection Methods

Tools used to evaluate the impact on efficiency include direct workflow observation, information processing time analysis, and provider/staff satisfaction with clinical information processes:

**Key informant interviews.** At baseline, face-to-face interviews were conducted with participating MHMC physicians, nurses, and staff member(s) identified as having primary responsibility for clinical information processing within the practice as well as selected hospital staff members who generate and transmit clinical information to physician offices. Informants were asked to describe the activities and processes used for clinical information processing within the practice and their level of satisfaction with current information processes. Interviews were conducted by an external evaluator, Dr. Anna McDaniel, and recorded verbatim by a trained research assistant. The purpose of the interviews was to obtain a robust description of the baseline clinical information management processes within MHMC and key factors in satisfaction with information access. The data were analyzed for themes and patterns; results were used to develop a brief survey to assess satisfaction with accessibility of clinical information and efficiency of clinical information processing within the practice setting.

**Satisfaction surveys.** All MHMC physicians, nurses, and office staff members at affiliated practice sites were invited to participate in an anonymous survey regarding their perceptions of

and satisfaction with accessibility of clinical information at baseline, post-implementation of the Electronic Medical Record (EMR) system, and after implementation of DOCS4DOCS clinical messaging service. The survey instrument was developed from the qualitative data derived from the baseline interviews. The instrument was designed to be minimally burdensome to encourage full participation. The satisfaction instrument consisted of 8 items. An additional 8 items were added after implementation of the clinical messaging system to measure satisfaction with the DOCS4DOCS software and health information exchange processes. Surveys were distributed to all MHMC physicians, nurses, and office staff members along with a letter from the evaluator explaining the purpose and use of the survey. Respondents were asked to indicate their role (physician, nurse, or office staff) but no other identifying information was recorded. All surveys were returned to the external evaluator in a sealed, self-addressed stamped envelope via US mail.

**Workflow observations.** At baseline, Dr. McDaniel and the trained research assistant observed workflow within participating physician office settings on randomly chosen days and time intervals. Data were recorded using a structured checklist of activities related to processing, communicating, delivering, and storing clinical data. The purpose of the observation was to identify and validate items to measure information processing activities and efficiencies with in practice sites.

**Site surveys.** Each physician practice was asked to complete a 16 item information management survey instrument to estimate the amount of staff time devoted to typical clinical information management activities, derived from the workflow observation results.

## Safety and Quality

There is strong evidence to suggest that accessible, well-organized information improves patient safety.<sup>1</sup> To assess the impact of HIT on process improvements that will lead to enhanced accessibility and management of clinical information, we obtained baseline data on the timeliness of access to information necessary for clinical decision making using a retrospective methodology. To measure the amount of time for clinical information to become accessible and useful to the provider, 30 patient records were randomly selected from each practice (8 sites at baseline). For each record, the evaluator recorded the date and time the latest laboratory or radiology report was received in the office. Then a review of the patient's chart was completed to record the date and time of the physician order for the test. No patient identifiers or personal health information were recorded.

## Measures

Quantitative measures of satisfaction with clinical information processes and perceived efficiency were obtained using a Likert-type response survey instrument. The satisfaction instrument consisted of 8 items, on a 4 point scale. Negatively worded items were reverse score and a summary score was obtained, with higher scores indicating a greater level of satisfaction. Cronbach alpha reliability coefficient for this instrument was 0.76. To measure satisfaction with

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the clinical messaging system (DOCS4DOCS) an additional item satisfaction survey was developed. To reduce potential bias from missing responses, a mean score across the 8 items was calculated. Cronbach alpha reliability for this scale was 0.85.

## Limitations

Because the existing information system had limited capability to capture baseline quality and safety data, no direct comparisons pre- and post-implementation could be made. Therefore, the evaluation plans relied primarily on self-report from providers within the ambulatory practice settings at MHMC. A second limitation was the relatively short time frame for assessing the impact of the DOCS4DOCS clinical messaging system. Because of delays in the implementation schedule, post-implementation surveys were distributed between four and eight weeks following “go live” of the system. Thus long-term gains (and potential unintended consequences) of the system cannot be assessed.

## Results

Descriptive findings for the three data collection time points are presented in the following sections. These results are followed by a summary of comparisons across time points, including significance testing.

### Baseline

Key informant interviews were conducted with physicians and staff who have responsibility for managing clinical data in practice sites. Twenty-two staff members (i.e., nurses, office assistants, laboratory personnel, radiology, and billing) and ten physicians participated in the interviews. Content analysis of the data was conducted and themes were extracted from transcripts of the interviews.

Results of the interviews with physicians (n = 10) can be summarized as follows:

- There was wide variability in perceptions of efficiency of current (baseline) processes.
- Timeliness and completeness of clinical information seen as problem by all participants.
- Physicians reported that clinical information frequently was not available at point of decision making, and this was a concern for patient safety.
- Participants noted that lack of timely clinical information undermines patient-physician trust.
- Providers were concerned that there was no systematic method to track results for follow-up (e.g., screening test results). Each practice had to develop an internal process to avoid “something slipping through the cracks.”

- The current system made it difficult to track results ordered by/for another provider (e.g., emergency room physician, consultant).
- Physicians noted long delays for some results (i.e., those requiring special handling at reference lab).
- In general, providers voiced concern that important results may be overlooked.

Results of the interviews with ancillary staff were similar and can be summarized as follows:

- Respondents reported wide variability in processes for handling clinical information across different practice sites.
- The current information system (at baseline) was seen as inadequate to support needs of support staff.
- Respondents described many manual processes for obtaining clinical information (e.g., ordering, scheduling) and these were seen as highly inefficient.
- The current system for reporting results (e.g., fax machine followed by hard copy) resulted in numerous duplicate reports that required a great deal of extra time to sort and file.
- Staff reported information required from patients was redundant (e.g., asked the same question multiple times), causing potential patient dissatisfaction, inefficiency, and even errors (no way to resolve discrepancies).
- Retrieving missing information was time consuming for support staff.
- Participants noted multiple information systems (e.g., laboratory, scheduling, radiology) that lack integration across MHMC, resulting in manual data entry, multiple telephone calls, and increased manpower to generate and report clinical information.
- Some respondents reported that not everyone within a practice site had access to current (baseline) information systems, causing inefficiencies to track down and interrupt individuals to facilitate information processing.
- Problems with obtaining clinical information were greater with outside entities (e.g., reference laboratories, specialists, consultants).
- Support staff were concerned with patient satisfaction as missing information required multiple calls to/from patients; Respondents noted that inefficiencies in clinical information processing “makes it look like we don’t know what we are doing.”

Overall, results of the qualitative data analysis revealed that most participants (physicians and support staff) viewed the baseline clinical information management processes as inefficient. Specific problems addressed were lack of timely access to clinical information and duplication of results. Both groups of respondents noted that lack of clinical information undermines patient satisfaction with care.

Satisfaction surveys were distributed to all staff members at baseline. The eight item, investigator developed instrument was based on qualitative data gathered during interviews. A four-level Likert response format was used, with high scores indicating greater satisfaction with clinical information management processes. The possible range of scores was from 8 (lowest satisfaction) to 32 (highest satisfaction). Scores ranged from a low of 7 (due to missing data) to 23. The mean score of 13.5 was low across the final sample of 26. Mean physician satisfaction (12.6) was lower than other respondents (mean score of 14.0) but there were no statistically significant differences noted. Individual items with the lowest satisfaction (1.42 on a 1.0 to 4.0 scale) were for “need to call the hospital/laboratory to track patients’ test results” and “managing clinical information (like sorting and filing lab or x-ray reports)”. The item with the highest satisfaction level (2.45) was with “retrieving results in the computer” although some respondents noted this was not available in all practice sites.

Site surveys were completed by 8 practice sites at baseline (100% of MHMC sites at baseline). Practice sites reported receiving between 12 and 110 clinical results (i.e., lab, x-ray, consultation reports) per day, with a mean of 62. Clinical information was reported as “missing” as frequently as 5 to 50% of the time. On average, the practice sites reported that staff members spend 90 minutes per day tracking missing results; 107 minutes eliminating duplicate results; 69.6 minutes to copy results for other providers, and 14.7 hours filing clinical information in paper-based medical records.

**Chart audit.** Timeliness of clinical information results was estimated by a chart audit. Thirty medical records were pulled at random for each of eight practice sites. Data were captured on the date and time that clinical tests (lab or x-ray) were ordered and when results were available to the provider. A total of 222 records with clinical results were reviewed. Cases were excluded if the clinical information was obtained prior to 2005 (current year of the chart audit) or if the results indicated greater than 1000 hours (note: these cases were assumed to be the result of missing or lost information requiring a repeat test). The final sample was based on 182 cases. The mean time to receive clinical information was 73 hours (S.D. = 113). As might be anticipated, the results were highly skewed. Median time for a practice to receive clinical information was slightly more than one day (28 hours).

## **Wave 1 (Post-implementation of Electronic Medical Record)**

Satisfaction surveys were repeated after organization-wide implementation of an electronic medical record (EMR). Satisfaction surveys were distributed four months after access to the EMR was achieved.

A total of 37 staff members completed the satisfaction survey, 16 of whom were physicians. Total satisfaction scores ranged from 10 to 30, with a mean satisfaction score of 18.3 (SD = 4.2). This represents a statistically significant increase in mean satisfaction with clinical information management over baseline [13.5 versus 18.3,  $t = -4.5$ ,  $p < .001$ ]. As was documented at baseline,

physician satisfaction was slightly lower than non-physician (17.7 versus 18.8), although this difference was not statistically significant.

Lowest satisfaction was reported for the amount of time it takes staff to manage clinical information (mean of 1.64 on scale of 1-4). Respondents reported the highest level of satisfaction for timeliness of receiving test results (mean of 2.76). Compared to baseline measures, significant increases in mean satisfaction were seen for: the need to call to track test results ( $p < .001$ ); the amount of time staff take to look up test results ( $p < .001$ ); satisfaction with current system for handling clinical information; and timeliness of test result being reported ( $p < .001$ ).

## **Wave 2 (Post-implementation of Clinical Messaging Services)**

Satisfaction surveys were repeated at the end of the project period, which came one month after implementation of the DOCS4DOCS clinical messaging service was deployed.

A total of 32 participants responded to the survey, including 6 physicians. Mean satisfaction score for Wave 2 was 19.3, the highest for any data collection time period. The lowest rated item was for duplication of printed reports (1.81 on a 4.0 scale). The highest level of satisfaction was for timeliness of reports (3.19).

For this wave of data collection, additional survey questions related to the DOCS4DOCS software were added to the survey. To avoid biased estimates due to missing data (i.e., non-response to some survey items), a mean score was calculated rather than a summated rating. Across all items, the satisfaction with the clinical messaging system was 2.94, on a 4-point scale. The highest rated individual item was for the ability to “search the DOCS4DOCS web application and reprint misplaced reports” (3.20). The lowest satisfaction was with the training received prior to implementation of the software (2.81). Although this item received the lowest rating, it should be noted that the item mean of 2.81 is still above the mid-point value (2.5 on a 1-4 scale) for satisfaction.

Site surveys were completed by 7 practice sites at the last time point (70% of 10 MHMC sites at conclusion of the study). Practice sites reported receiving between 5 and 230 clinical results (i.e., lab, x-ray, consultation reports) per day, with a mean of 89. Clinical information was reported as “missing” on average 7% of the time (range from 5% to 18%). Practice sites reported that staff members spend 7.6 minutes per day tracking missing results; 5.6 minutes to copy results for other providers and 15.7 hours filing clinical information in paper-based medical records.

## **Comparisons Across Time Points**

Satisfaction with Clinical Data Management was measured at three time points (i.e., baseline, post-implementation of the Electronic Medical Record (EMR) system, and after implementation of DOCS4DOCS clinical messaging service). Comparisons across time were analyzed by one-way analysis of variance and post-hoc tests (Tukey’s Honestly Significant Differences). Table 1 summarizes the descriptive statistics for the satisfaction survey.

**Table 1. Satisfaction with clinical data management**

WAVE	Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
Baseline	TOTSAT	26	7.00	23.00	13.5385	4.02225
Baseline	Valid N (listwise)	26				
Post— EMR	TOTSAT	36	10.00	30.00	18.3056	4.19911
Post— EMR	Valid N (listwise)	36				
Post— D4D	TOTSAT	32	13.00	23.50	19.3438	3.00923
Post— D4D	Valid N (listwise)	32				

There was a significant increase in satisfaction with clinical information management from baseline to study end. Table 1 shows that mean satisfaction increased over time. Post hoc tests revealed that the increased satisfaction from Wave 1 (Post-EMR implementation) and Wave 2 (Post-clinical messaging) was not statistically significant.

Four individual satisfaction items increased significantly over the study time period. These items included:

- Need to call the hospital/laboratory to track patients' test results.
- Amount of time looking for missing test results.
- Overall satisfaction with handling clinical information.
- Timeliness of results reporting.

Only overall satisfaction significantly increased over all three time points.

Comparison of results from Clinical Information Management Site Surveys shows significant gains in efficiency since implementation of the EMR and clinical messaging services. No statistical significance testing could be completed due to the highly skewed findings and small sample size of the physician practice based survey. However, important results include:

- 43% increase in the average number of reports received per day (62 versus 89).
- Decrease in time to track missing results from 90 to 7.6 minutes per day.
- Decrease in time to copy results for other providers from 69.6 to 5.6 minutes.
- No apparent time savings in filing information in paper-based charts.

## Discussion and Implications

Implementation of an electronic medical record system with clinical messaging capabilities has had significant impact on efficiency of information management at MHMC. Perceived satisfaction with clinical data management increased throughout the project period. Important gains in timeliness and completeness of results were reported by both physician and support staff.

The baseline medical record audit revealed that prior to implementation the median time to obtain results in the medical record was slightly more than one day. Since implementation of the EMR and clinical messaging service, results are nearly instantaneous.

Practice sites report important gains in efficiency in clinical information management. Time to track missing results and to share information with other providers has been nearly eliminated, despite increased volume of results. Interestingly, there were no reported gains in time to file clinical information. This might be explained by the perceived need to print or file faxed results in traditional paper records even with the use of the EMR.

Staff reported lower satisfaction with training for the clinical messaging system relative to other components of the DOC4DOCS implementation. Considering the short follow-up time for the survey after implementation, it is possible that the staff members are not yet comfortable with new workflow processes for obtaining data from the clinical messaging system. There is some support for this conclusion in the fact that staff also reported low satisfaction with the number of duplicate results. Processing problems (e.g., duplication of paper records) are the result of reports being sent to multiple providers in one practice or the printing of PACS reports which are also faxed by a third party. Even though staff members were made aware of these two cases, they continue to print all results without filtering for known duplicates.

Other indications of workflow issues were observed as well. Results are readily available in the system but must be saved regularly (and are archived indefinitely) to keep the provider inboxes available for current results. This process requires log in and file saving, which must be incorporated into clinic workflow. Duplicates may also be the result of multiple, unnecessary printing of reports, as management continues to require that all results be placed in a paper chart. With increased use and training, it is likely that the management and staff will incorporate new thinking, processes, and efficiencies into routine workflow.

## Conclusions

MHMC's research results are impressive, however the entire project also yielded many additional improvements in patient safety and quality of care resulting from the implementation of its new hospital information system and leveraging the messages being sent to IHIE/Regenstrief for DOCS4DOCS. MHMC is pleased to report them in its final report to demonstrate that the entire project, while challenging in many ways, yielded many positive changes that continue to support its initiatives to improve patient safety and quality of care.

Bar-coding of medications beginning in the pharmacy to automated drug dispensing machines to the patient using bedside medication verification; the use of electronic medication records; automated drug dispensing capabilities interfaced to the information system; and physician order entry of medication all contribute to better control over medications, and help to ensure that the correct patient is receiving the correct medication and the correct time and in the correct dosage.

Messages developed for sending information to DOCS4DOCS were leveraged to send required data to the Public Health Emergency Surveillance System (PHESS), and demographic information to Indiana Network for Patient Care (INPC). Through its relationship with INPC, MHMC now receives vital patient information in its Emergency Department at the point of registration. Physicians find this data helpful as a reference in determining the course of care.

MHMC intends to continue its information system projects and in the future will implement auto faxing of prescriptions, automated drug dispensing for anesthesia services and medication

reconciliation at the time of admission and at every point of transfer through patient discharge. It will also work continue to work on delivering laboratory results to INPC and moving the paper INPC report to an electronic format in its EMR.

MHMC feels as if it is a world away from where it was three years ago, at the beginning of its grant work. There are a number of projects that remain to be completed, but the motivation levels are high and its recent successes are proof that even a small hospital can achieve big dreams.

## List of Publications and Products

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