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Phase III

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14. ABSTRACT The MIDHT project continues to implement and research health information technologies (HIT) within the Conemaugh Health System, located in Southwestern Pennsylvania. Core technologies under investigation include pharmacy robotics, bar code medication administration (BCMA) and health information exchange via the eHealth Exchange. Statement of work is being delivered as expected. Research activities for Arm 1 have progressed, including an initial analysis on medication errors and completion of statistical testing on nursing workflow and satisfaction. Conemaugh is participating in the 14 th Virtual Lifetime Electronic Record (VLER) pilot nationwide via data exchange with the Altoona VA Medical Center (Arm 2). Patient correlations, system users and document exchanges all have increased throughout the year. Conemaugh expects to move lab result (C32) functionality into production in October 2014.					
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Introduction

The Military Interoperable Digital Hospital Testbed (MIDHT) is a seven-year program of research to develop a real-world testbed environment in Southwestern PA (SW PA). The purpose of MIDHT is to research and evaluate health information technology (HIT) designed to enhance patient safety and reduce medication errors within an acute care setting. Furthermore, MIDHT will test and evaluate health information exchange (HIE) that makes information readily available to consumers and providers, which will allow for the secure transfer of information between disparate providers in the public and private sector. MIDHT will also define requirements and solutions to optimize healthcare resources for rural communities and identify lessons learned and best practices that benefit the global Military Health System (MHS) environment, stakeholders in SW PA and the general public as a whole. The Department of Defense (DoD) and Conemaugh Health System (CHS) have common requirements for HIE, connecting disparate systems and providers and enabling secure provider-provider and provider-consumer communications. Minimal evidence is available on what business, clinical and technical solutions can be used to overcome the lack of clinical specialists, IT infrastructure, staff resources and geographical barriers associated with the delivery of health care in rural communities. MIDHT has explored the use of HIT and HIE services by: 1) examining the impact of medication dispensing/administration technology within a rural healthcare system and 2) exploring HIE via the Nationwide Health Information Network (NwHIN).

Administrative and logistical matters:

1. CGI Federal, Inc. has been supporting Conemaugh's eHealth Exchange environment on an as needed basis since the executed agreement was signed on October 7, 2013.
2. Conemaugh formally submitted a final 12-month no-cost extension to Ms. Elena Bane on June 19, 2014 via email. A formal contract modification was executed on July 24, 2014.
3. The Conemaugh Health System and associated entities officially become a for-profit Duke LifePoint hospital on September 2, 2014
http://www.conemaugh.org/template_pressrelease.aspx?id=12918. Conemaugh is working with the contracting office to formally reflect this organizational change.

Body

Arm 1: The Impact of Medication Dispensing/Administration Technology within a Rural Healthcare System

Subtask 1.1 Implement pharmacy robotic technology and bar-coded enabled medication administration (BCMA) in an acute hospital system setting.

Pharmacy Robotics / Bar Code Medication Administration (BCMA)

The McKesson Pharmacy System v10.1 Upgrade was successfully completed on October 22, 2013 along with other clinical. The combination of these upgrades provided additional BCMA functionality for nurses, specifically in the area of IV administration. Benefits of the upgrade release were inclusive of the BCAM system at Miners Medical Center (below) as well.

CMMC pharmacy and nursing finalized their medication exchange cart pilots and identified a workflow process for hospital-wide deployment. The process identified the pharmacy as maintaining the envelopes and then transferring all medications into exchange bins before delivery to nursing each day. This approach optimized the robot usage by allowing the filling process to remain unattended. The Medication Exchange cart system (transfer carts and exchange bins), originally ordered in January 2014, was not deployed into clinical areas until August - September 2014 due to supplier (Rubbermaid) backorder and pricing issues. Configuration and bids were more costly than estimated due to larger transfer carts.

Miners Medical Center BCMA – The pre-requisite McKesson ER12 upgrade was successfully implemented on October 22, 2013. Design work was started in early November. User training occurred in late January/early February, with Full LIVE use beginning on February 25, 2014. Adoption rate for the first full month (March 2014) exceeded 96% and has remained strong since then.

A BCMA presentation board was available during the 2014 CMMC Patient Safety Fair held on August 20, 2014, see Figure 1. The fair had presentations and displays from various hospital departments. John Hargreaves spoke with patients, staff and administration about BCMA technology and its important role in reducing medication errors.



Figure 1. 2014 CMMC Patient Safety Fair.

Subtask 1.2 Research and analyze the resulting technological impact on medication errors, pharmacist productivity, nurse satisfaction/workflow and patient satisfaction.

During this reporting period, BCMA was assessed as it relates to patient satisfaction (through Press Ganey™ surveys) and the professional opinions of the technology by physicians and pharmacists/pharmacy technicians at CMMC and Miners Medical Center. Opinions of the technology vary widely in the literature in terms efficiency, safety and work-arounds.

1.2.1 Press Ganey™ surveys – CMMC (*Patient satisfaction*)

Patient comments related to medication administration during the PRE (November 2010 - January 2012) and POST (November 2011 – January 2013) time periods were retrieved from Press Ganey™ for CMMC and manually reviewed by members of the research team (see Table 1). The analysis included 4,000 Press Ganey™ surveys. It is important to note that many pain medications (controlled substances) are dispensed from Pyxis machines, not through Pharmacy automation. Medication-related comments and associated groupings were reviewed by the BCMA Clinical Team Leader and the Patient Representative from Patient Relations at Conemaugh. Neither had recommendations or comments; accepting the data as presented.

Comment Type	PRE Count	POST Count
Delay	13	25
Medication administration issue	8	8
Did not receive medication	8	9
Adverse reaction/allergy	8	10
Medication order/rec issues	5	8
Lack of info about med provided to pt	3	NA
Other	2	1
Positive med comments	2	NA
Positive BCMA opinion	NA	1
IT issue	NA	1
TOTAL surveys	1,989	2,066

Table 1. Press Ganey Comments -PRE & POST.

A statistical analysis comparing the percentage of comment type over time period was performed for the following comment types, see Table 2. A p-value < .05 implies that the change in percentage is statistically significant. Caution must be applied given that the percentages being tested are extremely small relative to the sample size (total surveys) and the expected 1-tailed p-value is significant yet not the 2-tailed.

Comment Type	p-value	
	1-tail	2-tail
Delay	0.0330	0.0659
Adverse reaction/allergy	0.3475	0.6951
Medication order/ rec issues	0.2221	0.4443

Table 2. p-values for Press Ganey Patient Comments – PRE & POST

1.2.2 CMMC Physician BCMA/eMAR Survey Statistical Analysis

Forty-two clinicians, physicians, residents, hospitalists, or physician assistants (PA's) completed the Physician Survey. This survey was executed only during the POST period. Of those, 59% were physicians, 27% residents, 2% hospitalists, and 12% PA's. The respondents indicated a diversity of years of experience, with 44% indicating five or less, 22% twenty or more, and the remaining 34% from 6-20 years. The majority of those surveyed responded favorably:

- 90% indicated that they accessed the eMAR module through CarePortal
- 67% either agreed/strongly agreed that the eMAR module has improved decision-making and efficiency

- 43% believed that adverse drug events were reduced due to BCMA
- 24% believed that BCMA improved physician communication with pharmacy and nursing (60% were unsure)
- 48% would recommend BCMA and the accompanying CarePortal eMAR module

Additional statistical analyses, chi-square crosstabs by previous BCMA experience and years of service and non-parametric correlation, were attempted. These analyses were not tenable due to violations of required underlying assumptions.

A copy of the survey is included in Appendix 2.

1.2.3 CMMC Pharmacy Automation/Robotics Dispensing Survey Statistical Analysis

Thirty-eight pharmacists and pharmacy technicians completed the Pharmacy Survey. Additional statistical analyses, chi-square crosstabs by “Would you recommend the system (pharmacy robotics) to other hospitals?” and years of service, were attempted and found to be not tenable due to violations of one of the underlying statistical assumptions, namely, the maximum percentage of cells with an expected frequency less than five. A non-parametric correlation analyses was also attempted. It too was inconclusive because of violation of the monotonic assumption.

A copy of the survey is included in the Appendix 3.

1.2.4 BCMA Nurses’ survey at Miners Medical Center

The same validated BCMA survey by Hurley et al.¹ (survey attached via email) was distributed to nursing staff at Miners Medical Center on May 27, 2014 (3 months post- live deployment). The POST survey was closed on June 13, 2014.

Miners Medical Center is a 30-bed community hospital serving rural northern Cambria County and surrounding areas, located approximately 45 minutes from Johnstown. A total of 16 nurses gave responses to the survey PRE (2012) and 30 staff nurses and administrators responded to the survey POST BCMA implementation (3 months). All respondents to the POST survey questions worked on the unit before Admin-RX was deployed. Responses below are reported descriptively because questions were not applicable in the PRE survey. The majority of those surveyed responded favorably:

- 75% agreed it is easier to perform all the checking steps needed during the medication administration process;
- more than 90% of respondents agreed this is a safer system for patients;
- Approximately 80% of respondents believed it is easier to access information with the new system, which implies a positive impact on staff efficiency and patient safety.
- Approximately 80% of respondents believed it takes more time to administer medications with the new system.

- Over 50% of staff believed BCMA has made the medication administration process more efficient for them.

The last results are somewhat contradicted by the previous question if improved efficiency results in spending more time with the patient. The impact of pharmacy automation was minimal at this location as an in-house pharmacy is present. Again, there is disagreement amongst staff regarding the availability of medications. Most respondents probably interpreted this question to be about ease of finding medications, not availability of product.

As the Figure 2 displays, satisfaction is spread nearly uniformly across all answer choices. These results are similar to the other two hospitals, Conemaugh Memorial Medical Center and Meyersdale Medical Center.

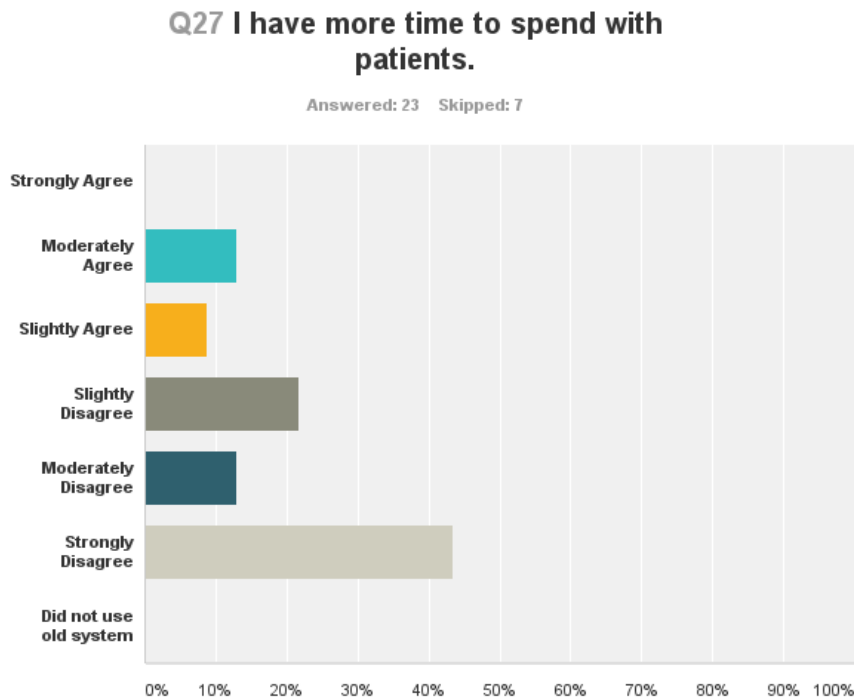


Figure 2. More time to spend with patients.

The same survey was distributed at 6 months post implementation in September 2014 to the nursing staff (Post 2) and 20 surveys were completed by the nursing staff.

Not all surveys were completed in full, therefore the sample size per question varied.

Demographically, no statistically significant difference was found for the mean, median, or distribution of the following variables (see Table 3). Normality was violated for most of the variables over most time periods, but homogeneity of variance held for all but 'Year at CHS'. An ANOVA was used to test the mean (interpreted with some caution due to normality violation), the Median Test for the median, and the Kruskal-Wallis Test was applied to test the distribution.

		Age, years	Years as a Nurse	Years at CHS	Hours worked/wk
Pre	N	13	15	14	15
	<i>Mean</i>	50.08	25.47	13.29	39.20
Post 1	N	28	28	29	28
	<i>Mean</i>	46.11	21.27	8.69	39.50
Post 2	N	16	19	20	20
	<i>Mean</i>	46.13	20.50	7.40	43.80

Table 3. Demographics of survey respondents.

Due to violations of both normality and homogeneity of variance, non-parametric analyses have been applied in conjunction with a non-pairwise ANOVA in order to provide results with the most depth possible. Since an insufficient number of surveys were able to be matched by "SUM" ID, the pairwise (same person completing survey at different time points) analysis was not possible. Unfortunately respondent error with creation of the "SUM" ID and a lack of trust by nurses in order to protect their identity prevented a sufficient sample size to execute a pairwise analysis. The Sidak formula was used to adjust for multiple tests. Overall alpha (family-wise) remained at 0.05.

Three survey questions showed a statistically significant change (pre vs. post) in Table 4: A six-point Likert scale was used for these questions:

- 1 Strongly Agree 3 Slightly Agree 5 Moderately Disagree
- 2 Moderately Agree 4 Slightly Disagree 6 Strongly Disagree
- 0 NA Not Applicable

Survey Question	N	Means	ANOVA, p-values	Kruskal- Wallis Test on the distribution of answers	MEDIANS	Median Test, p-values
The current medication administration system provides me with information to know that a medication order has been checked by a pharmacist before I administer the medication.	Pre = 16 Post 1 = 30 Post 2 = 20	Pre = 4 Post 1 = 2 Post 2 = 2	< .0005 (0,1): .001 (0,2): .002	.004 (0,1): .004 (0,2): .017	Pre = 4 Post 1 = 2 Post 2 = 2	.025 (0,1): .026
The current medication administration system promotes 2-way communication between clinicians (MD, Pharmacist, RN) about medication orders.	Pre = 16 Post 1 = 30 Post 2 = 20	Pre = 4 Post 1 = 3 Post 2 = 3	NS	NS	Pre = 4 Post 1 = 3 Post 2 = 3	.016 (0,1): .028
The turnaround time for receiving medications needed "stat" or for patients newly admitted to the unit is adequate.	Pre = 15 Post 1 = 30 Post 2 = 20	Pre = 5 Post 1 = 3 Post 2 = 3	.002 (0,1): .001 (0,2): .032	.003 (0,1): .002	Pre = 5 Post 1 = 2 Post 2 = 3	.001 (0,1): <.0005 (0,2): .017
The current medication administration system is effective in reducing and preventing medication errors.	Pre = 16 Post 1 = 30 Post 2 = 20	Pre = 4 Post 1 = 2 Post 2 = 2	.001 (0,1): .001 (0,2): .022	.008 (0,1): .006	Pre = 3 Post 1 = 2 Post 2 = 2	NS

NOTES:

A. (0,1) and (0,2) refer to the pairwise comparison between Pre and Post 1 or Post 2

B. Any p-value > .013 and < .05 would likely be statistically significant given additional sample size; however, when the more stringent critical p-value is applied adjusting for multiple tests, statistical significance was not strictly achieved.

Table 4. p-values for stated questions.

All questions show approximately a 33% improvement in the post time periods when compared to the pre, shifting from the 'disagree' to the 'agree' portion of the answer scale.

Graphical comparison of the distribution of answers by time period follows in Figure 3:

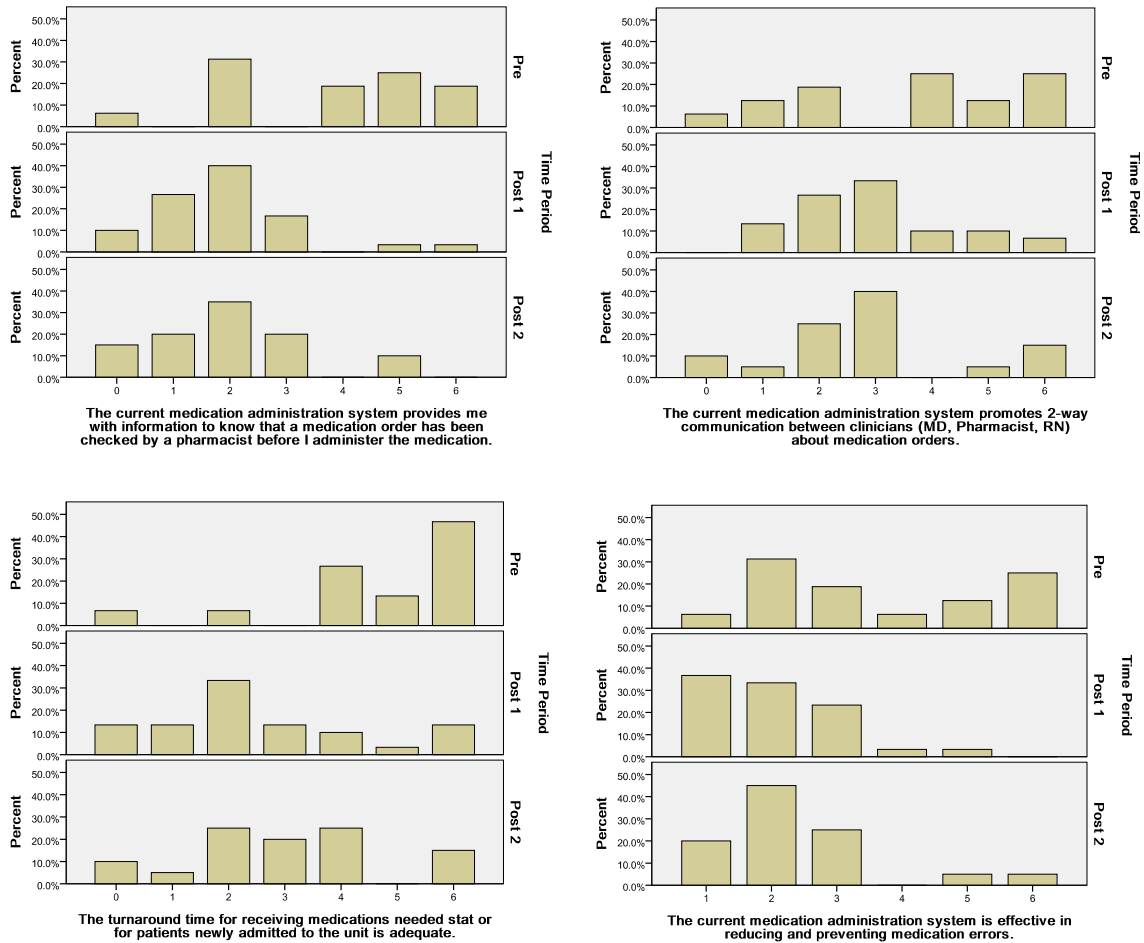


Figure 3. Pre, post 1, and post 2 question comparisons.

Statistical comparisons to Memorial and Meyersdale will be available in the next report.

A copy of the survey is included in the Appendix 4.

1.2.5 Medication Error Analysis

1.2.5.1 Medication Errors Analysis - CMMC

The research team completed an intensive review of all CMMC medication events as reported in the Quantros SRM event/incident reporting system. Researchers reviewed over 1,100 written incident summaries (November 2010 – January 2013) in detail and determined the impact of the MIDHT study using the following variables:

- Medication Error Type: This was predefined within Quantros using standardized phrases. Some of the errors were scrutinized in an attempt to determine the origination of the issue. Also, a small percentage of these standard error types were aggregated by the study team to enable statistical testing on this variable (Table 5 below).
- Phase: The phase was subjectively determined by the study team using common industry standards detailing the medication administration process. Phase identification was consistent with current literature. Table 5(below) displays the statistical percentage breakdown of errors by phase. The MIDHT intervention primarily consisted of technology and process changes that only impacted the Dispense and Administration phases through pharmacy robotics and bar code medication administration at the bedside.

The research team then used both medication error type and phase to subjectively determine MIDHT Applicability (as designated as “Yes” or “No”) for each error. The Error Disposition designation, actual or near miss, was completed by Quantros SRM users. The final dataset contained 630 valid cases.

The PRE-BCMA time period was November 2010 – October 2011, while the POST-BCMA time period ran from November 2011 – January 2013. An additional three months were included in the POST-BCMA period because of the phased BCMA deployment schedule at CMMC. All errors that occurred within a unit/department that had not deployed BCMA technology were appropriately removed from the dataset.

The low sample size per error type was an issue and produced many violations of the allowable percentage of cells with a minimum expected frequency less than five. Despite the lack of statistical significance, about 60% of the error types showed a 15% or greater percent change decrease in the POST-BCMA period. Medication error types, drug delay, wrong frequency, wrong label, and wrong patient each had over a 30% reduction in errors and therefore an assumed positive impact on patient safety.

The influence of the MIDHT intervention on medication errors from before BCMA implementation, PRE, versus after implementation, POST, was investigated using the Pearson Chi-squared test. The Fisher’s Exact Test was employed as required. The ordinal variable, Study Time Period, was treated as the independent variable (IV). It had only two levels, PRE and POST,

both which contain 12 months of data for each clinical unit. The statistical analysis plan was comprised of two major steps:

- 1) Each of the following variables were treated as dependent variables and separately tested against Study Time Period. The dependent variables are as follows:

Variable Name	Variable Type	Levels	% Breakdown by Time Period	
			PRE	POST
Error Disposition	nominal	Near Miss	6.4	5.9
		Actual	93.6	94.1
MIDHT Applicability	nominal	Yes	45.4	39.8
		No	54.6	60.2
PHASE	ordinal	ORDER (1 st)	12.9	19.1
		PROFILE (2 nd)	12.6	24.0
		DISPENSE (3rd)†	26.4	16.1
		ADMINISTRATION (4th)†	46.0	37.5
		Other	2.1	3.3
Core Problem (Med. Error) Type	nominal	Please see Table 7 for a detailed listing		

† Primary MIDHT intervention focus

Table 5. Variable Name Description.

- 2) If statistical significance was found for a test variable in step 1, a layered analysis by MIDHT Applicability on that variable(s) over Study Time Period was then executed. This approach allows for a more detailed investigation of change from PRE to POST by using MIDHT Applicability to stratify the variable being tested in step 2.

The stepwise analysis began with testing each of the dependent variables separately can be found in Table 6. The results were:

Crosstab	Chi-squared, χ^2	df	Sample size, N	p-value, asymp. Sig. (2-sided)
Error Disposition * Study Time Period	No statistical significance.			
MIDHT Applicable * Study Time Period	No statistical significance.			
PHASE * Study Time Period	26.386	4	630	< .0005
Core Problem (Error) Type * Study Time Period	25.489	11	630	.008 <i>a</i>

a. 2 cells (8.3%) have expected count < 5. Min. expected count is 1.93.

Table 6. Crosstab inferential results.

Sidak's correction for multiple testing was applied which reduced the testwise alpha criterion to 0.017. This correction was slightly conservative in that no correlation was assumed to exist

among the variables. A correlation analysis of (between) the dependent variables revealed an average correlation of 0.1, which rises slightly to 0.3 if only the statistically significant correlations are averaged. Including the 0.3 correlation into the calculation of Sidak's correction yields a testwise alpha criterion to 0.019 and corresponding critical z-value for 2 sided testing: ≥ 2.3407 (critical z-value for 1 sided testing: ≥ 2.0695). Therefore, only Phase * Study Time Period and Core Problem (Error) Type * Study Time Period crosstabs had a statistically significant result. A progression of the medication errors type can be found below in Table 7.

Core Problem (Med Error) Type – Original	Core Problem (Med Error) Type - Revised
Bar Coding/Scanning Error	Bar Coding/Scanning Error
Charting Error	Charting Error
Drug Delay	Drug Delay
Drug Location Issue	Drug Location Issue
Drug Not Ordered	Drug Omitted
Drug Omitted	Duplicate Therapy
Drug Protocol/Policy Not Followed	Wrong Dose
Duplicate Therapy	Wrong Drug
Incorrectly Stamped Order Sheet	Wrong Frequency
IV Related Issue	Wrong Label
Medication Reconciliation Issue	Wrong Patient
Order Issue	Wrong Quantity
Patient Not Compliant	Wrong Route
Pharmacy Profile Error	
Pyxis Issue	
Wrong Dose	
Wrong Drug	
Wrong Frequency	
Wrong Label	
Wrong Patient	
Wrong Quantity	
Wrong Route	

Table 7. Progression of Medication Error Type Listing

These results indicated that Phase and Study Time Period are not statistically independent over the entire dataset of medication errors; therefore the differences in the distribution by phase by Study Time Period are statistically significant. Standardized residuals of the crosstab revealed that Profile for PRE and POST mainly contributed to the significant chi-square result. Collectively, this implies that the observed increase from PRE to POST is significant. Given the statistically significant result for the crosstab of Phase * Study Time Period, a more detailed analysis was performed on a stratified crosstab of Phase by MIDHT Applicability versus Study Time Period. Statistical significance was found for only MIDHT Applicability = NO for the distribution of Phase between Study Time Period [chi-sq.(4) = 29.959, p-value = < .0005].

The results indicate that the distribution of Core Problem (Error) Type differs over Study Time Period. The standardized residuals imply the following variables in Table 8 contribute to that difference:

	Implication regarding change from PRE to POST
Drug Location Issue	decrease
Wrong Frequency	increase

Note that the implications drawn from the Core Problem (Error) Type * Study Time Period chi-squared analysis are made regarding the distribution of errors by error type by time period.

Table 8. Standardized residual results.

Given the statistically significant result for the crosstab of Core Problem (Error) Type * Study Time Period, a more detailed analysis was performed on a stratified crosstab of Core Problem (Error) Type by MIDHT Applicability versus Study Time Period. Statistical significance was found for only MIDHT Applicability = YES for the distribution of error type by Study Time Period; however, this result is invalid because nearly 40% of the cells have an expected count of < 5. The threshold for validity is < 20%.

Common errors, such as wrong patient, wrong drug, and wrong dose all had a somewhat neutral change from PRE to POST. Either the frequency of each medication error type is so low that no significant change is detected or the error can be attributed to human error and therefore not affected by the MIDHT intervention between time periods. The culture of reporting errors had changed in the POST period, which complicates this analysis. Errors were likely reported out of frustration with the deployed BCMA system and discord between the nursing and pharmacy departments.

The medication administration process is not simply the act of administering medication, but rather complex processes involving multiple steps from numerous disciplines, departments, and users. Errors can appear at one, some or even all stages between the medication order process (prescription) through the actual administration of the medication and/or possible adverse events. Though a specific error may occur prior to a patient receiving the medication, most errors are noted only once the medication is incorrectly administered at the bedside.

Despite the fact that BCMA strives to assure the “five rights” of medication administration – right patient, right route, right drug, right dose, and right time, most studies however have investigated the effect of BCMA on the rate of severity of the errors or the effect of the BCMA on the duration of administering medication.

The distribution of the severity of drug errors was also analyzed over time period. The chi-square analysis produced an invalid statistically significant result because nearly 40% of the cells had an expected count < 5. Harm score was analyzed over time period. Although no

statistical significance was found, this analysis was invalid in that exactly 40% of the cells had an expected count < 5. Importantly, 90.5% PRE and 94.0% POST of the med errors were marked with a Harm Score of NONE.

Initial discussions were rooted in the possibility that reporting frequency of actual vs. near miss may differ (e.g. near miss may be reported less frequently to save time; or near miss errors may be reported more POST BCMA implementation because nurses were disgruntled/dissatisfied with the technology and/or disruptions to their traditional workflow, PRE implementation).

Some studies have reported a nearly 50% reduction in medication errors post BCMA implementation.^{2,3,4} The research team will review these studies in detail and attempt to make a one-to-one comparison between their experiences and ours to generate additional lessons learned.

The medication error rate per 1,000 doses was analyzed. Some inherent error exists in this analysis because the available dosage data was not stratified by clinical unit; therefore, matching of dosage data with medication error data by clinical unit that implemented BCMA was not possible. Presuming that this error is consistent from PRE to POST, this comparison offered additional insight into any change influenced by the MIDHT intervention. A two-group independent T-test revealed no statistical significant difference in the slight increase of the mean of the med error rate PRE (0.08) versus POST (0.09).

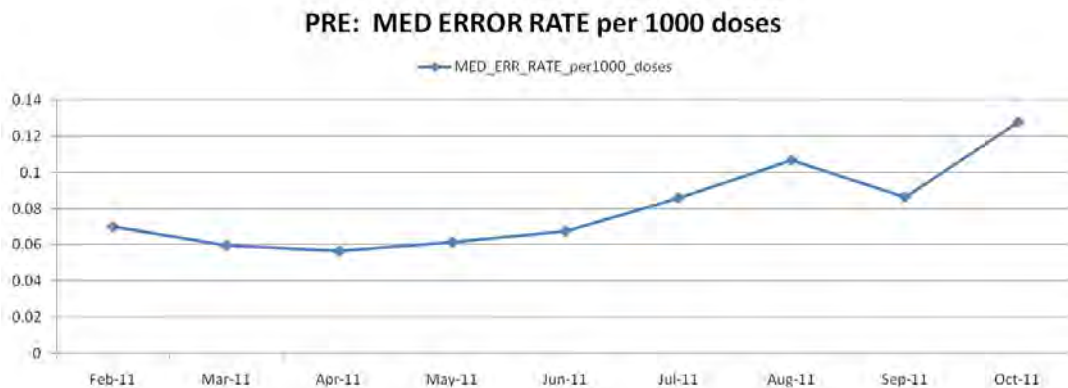


Figure 4. Medication Error Rate per 1,000 doses – PRE

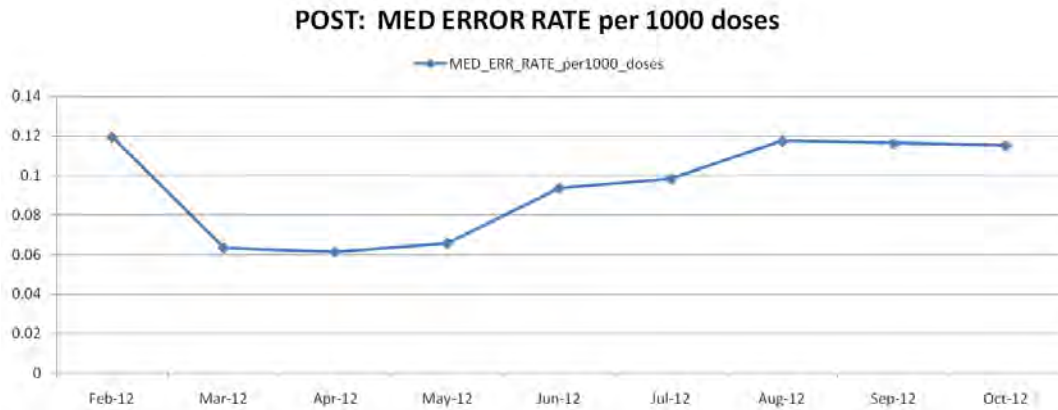


Figure 5. Medication Error Rate per 1,000 does – POST.

Please note the timeframe plotted in Figure 4 and Figure 5 were adjusted to accommodate the phased implementation so that all clinical units are equally represented by time.

Medication errors can vary depending on the differing levels of care per clinical area. Differences between nursing units must be considered because of nurse-to-patient ratio, as well as hospital census differentials. An analysis of the distribution of medication errors by clinical unit was invalid due to the large number of clinical units involved, which produced expected cell count issues. A recent literature review study reported average baseline error frequency rates from 5.8-25.3% (1.6-27.8% if error times were excluded).⁵ Wrong time errors are generally considered to be less severe. Typical reports after BCMA implementation include a 30-50% reduction in medication errors, but only when time errors are excluded.

Work-arounds performed by nursing staff must be acknowledged as a contributing factor on the medication error rates. Table 9 demonstrates manual override statistics from CMMC for July through September 2013. Though these reporting statistics were not available during the study time period, inferences to the impact on medication errors by clinical unit can still be made.

McK Adoption HARx Analytics Medication Administration					
Schedule Override Count	% with Schedule Override	Drug Warning Override Count	% with Drug Warning Override	Quantity Override Count	% with Quantity Override
83	2.96	79	2.86	39	0.62

Table 9. CMMC manual overrides by type (3-month average).

A correlation analysis between the override data above and medication errors by clinical unit was not tenable due to violations arising from sample size after stratification.

Medication error data was retrieved from Quantros for July – September 2013 and summarized for use. This analysis was continued so as to focus on clinical units cited in the literature, and to determine if high override percentages influenced medication error rates.

Considerations for future research are to see if medication errors could be segregated based on origination of the error by dispense location (i.e. if drug dispensed from the robot vs. the MedCarousel vs. manual picks results in any differences in the number, type etc. of medication errors). The current risk management system (Quantros SRM) does not have the functionality to include the phase in which the error occurred resulting in a limitation because the determination of phase was subjective and highly resource intensive.

No past studies have investigated user compliance in the BCMA system (i.e. work- arounds with the BCMA system). As indicated in Table 9, work-arounds totaled over 6% of medications given for the representative sample. Data may need to be re- evaluated over time since as system familiarity evolves, so could work-arounds. Longer- term follow-up studies (> 2 years) are needed both for the aforementioned reason and also for examination of the degree and time post implementation. Policies and procedures need to be in place and enforced to ensure BCMA systems are used as intended.

1.2.5.2 Medication Errors Analysis - MYMC

The medication error data for Meyersdale Medical Center (MYMC), a small critical access hospital located in southern Somerset county, was analyzed by comparing pre versus post on the counts of error type, phase, harm and severity score. Due to the low sample size at this hospital, many of the chi-square crosstabs violated the allowable percentage of cells with a minimum expected frequency less than five. One crosstab, phase by time period did not violate the requirement, but nonetheless, did not show a statistically significant chi-square result. Despite the lack of statistical significance, forty-five percent of the identified error types showed about a 10% or greater percent change decrease in the POST period. Both duplicate therapy and wrong dose had a clinically significant reduction and therefore positive impact on patient safety.

The mean, median, and distribution of count of med errors, doses, and medication error rate were tested using a Studentized-t, Median, and Mann-Whitney U tests respectively. Normality and homogeneity of variance held. No statistical significance was revealed. Medication error rates during 2011-12 are shown below in Figure 6:

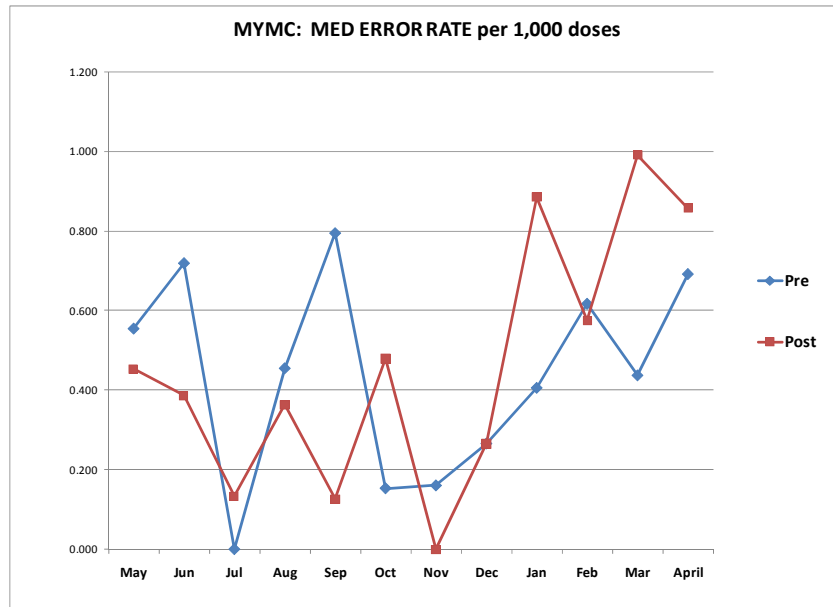


Figure 6. MYMC Med Error Rate per 1,000 doses.

1.2.5.3 Medication Errors Analysis – Miners

The medication error data for Miners Medical Center will be analyzed by comparing pre versus post on the counts of error type, phase, harm and severity score. PRE Data collection was documented from March 2013 – February 2014. Post data collection is anticipated to continue until February 2015. The medication error analysis will be similar to that completed at both CMMC and MYMC.

1.2.5.4 Non-returnable Expired Medications – MMC & MYMC

The quantity and cost of expired medications were compared by time period for MMC & MYMC. An independent t-test revealed no statistically significant difference between time periods for the mean cost or quantity of expired medications. Please refer to Table 10. The distribution of both cost and quantity by time period was also compared using the Mann-Whitney U test; the distributions were found not to be statistically significantly different. The vendor promised reduction in expired medications was not our experience.

Group Statistics

Time period		N	Mean	Std. Deviation	Std. Error Mean
Quantity	Pre	19	466.26	205.542	47.155
	Post	12	514.25	91.844	26.513
Cost, USD	Pre	19	\$18,726.00	\$12,294.76	\$2,820.61
	Post	12	\$19,936.50	\$10,391.10	\$2,999.65

Table 10. Non-returnable Expired Medications.

Non-returnable expired medications were not evaluated at Miners Medical Center since this facility maintained its operational pharmacy, not having medications dispensed from the robotic system.

1.2.6 Workflow Analysis – Time & Motion

The time and motion post data collection occurred July 2014, at Miners Medical Center. This data was compared to the observation in the PRE period (2012) with the following results.

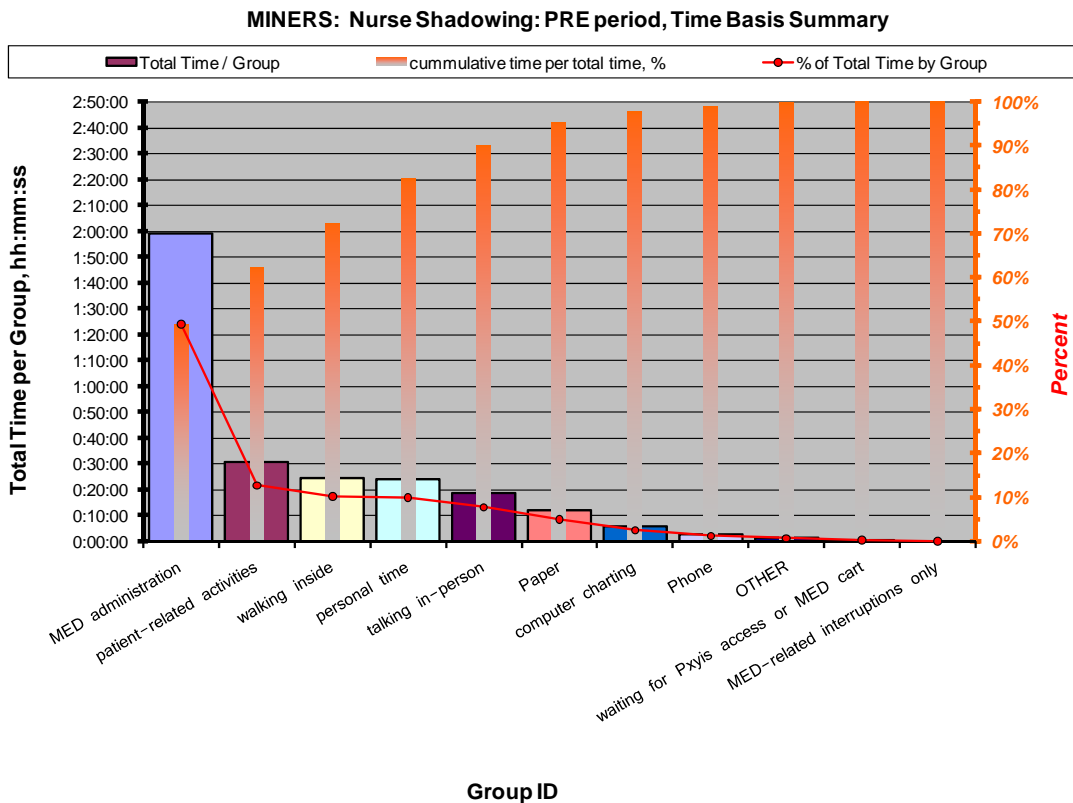


Figure 7. Miners Time & Motion Results – PRE, N = 185

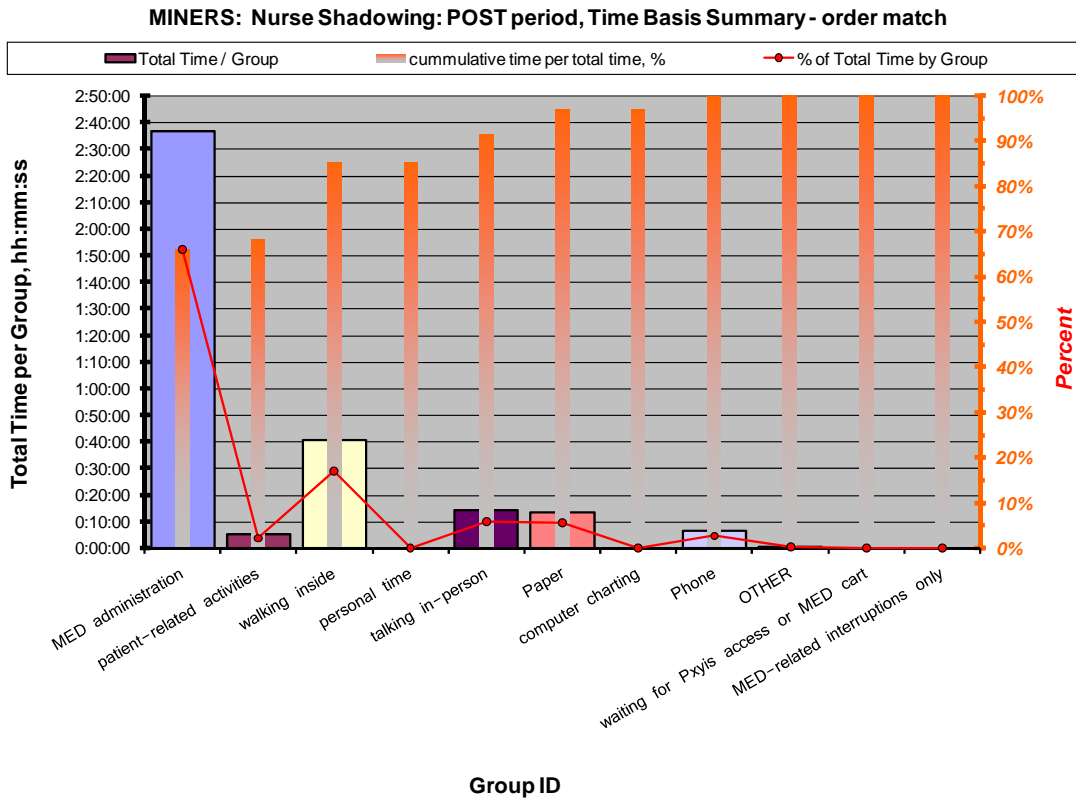


Figure 8. Miners Time & Motion Results – POST, N = 209

So as to be directly comparable, the data for each time period was normalized. ANOVA was applied to each category over time period. Only the Med administration (N,pre = 72; N,post = 128) yielded statistical significance, p-value = .024. Homogeneity of variance held but normality was violated, therefore Mann-Whitney U was applied which yielded a p-value = .004. Even with appropriate application of correction for multiple tests, the reduction in time per med administration event from Pre to Post is likely statistically significant. Of note, statistical comparison for some categories was not calculable due to very small (even zero) sample size, but nonetheless likely represent a meaningful change. Testing by individual activity was hampered by normality violations and both small and severely disparate sample sizes. Even for the few activities for which the Mann-Whitney test was feasible, no statistical significance was found.

Arm 2: Health Information Exchange (HIE) via the Nationwide Health Information Network (NwHIN)

Subtask 2.1 Deploy a limited production, NHIN standards-based HIE focusing on the bi-directional exchange of electronic medical records between CHS and the Military Health System. CHS information to include data domains residing in acute care and ambulatory settings.

2.1.1 Conemaugh Activities

John Hargreaves, Project Manager, discussed the VLER program with various healthcare groups within CMMC and the VA, creating system accounts to allow for usage. Meetings included those with:

- Four CMMC hospitalist providers; - the hospitalist group only provides care to patients while in the hospital; working in conjunction with the patient's primary care provider. (November 21, 2013)
- Members of the Conemaugh and VA teams with providers/staff from the Johnstown VA community based outpatient clinic (CBOC). The hour-long meeting focused on various topics, including the eHealth Exchange, clinical data available, system usage and qualitative surveys (December 10, 2013)
- Dr. Warner's practice [Conemaugh Physician Group (CPG)] in Ebensburg, PA (February 17, 2014)
- Dr. Helman's practice (CPG) in Jennerstown, PA (March 13, 2014)
- Social workers and case managers at CMMC (April 11, 2014)
- Dr. Koh's CPG practice in Ebensburg, PA (August 7, 2014)
- Two CPG clinics in Somerset County; Meyersdale and Salisbury, PA (September 16, 2014)
- Training scheduled with CPG Oncology for October 2, 2014

Figure 9 summarizes the number of veterans contacted about the VLER program and resulting opt-ins performed by Conemaugh. Before distribution, the patient file was reviewed for deceased patients and address changes. A total of 509 Veterans returned authorizations and were opt-ed into the Conemaugh system during the year. The exciting milestone of 1,000 correlations was achieved on June 9, 2014. A monthly summary of correlations can be found in Figure 10.

The return rate of authorizations is directly correlated to the joint mass mailings spearheaded by Conemaugh. Specific patient information cannot be exchanged through the eHealth Exchange until permission is granted from the Veteran.

The difference in the number of veterans that responded and are correlated is not due to patient discovery failures but rather issues with VLER authorizations (e.g. not signed/dated, not completed) and the time delay for both organizations to “Opt-In” patients into their system. All Veterans on the initial shared patient list have been sent information regarding the VLER program. Discussions have been ongoing with the Department of Veterans Affairs (VA) regarding future mailings. A new patient list has been generated (approximately 300) consisting of patients that have been referred from the VA to Conemaugh in the past two years. It was decided that the Altoona VAMC would manage this manage mailing moving forward. Medical record requests for Conemaugh data not available via the eHealth Exchange have been simplified internally and have resulted in more efficient processing with the Altoona VAMC.

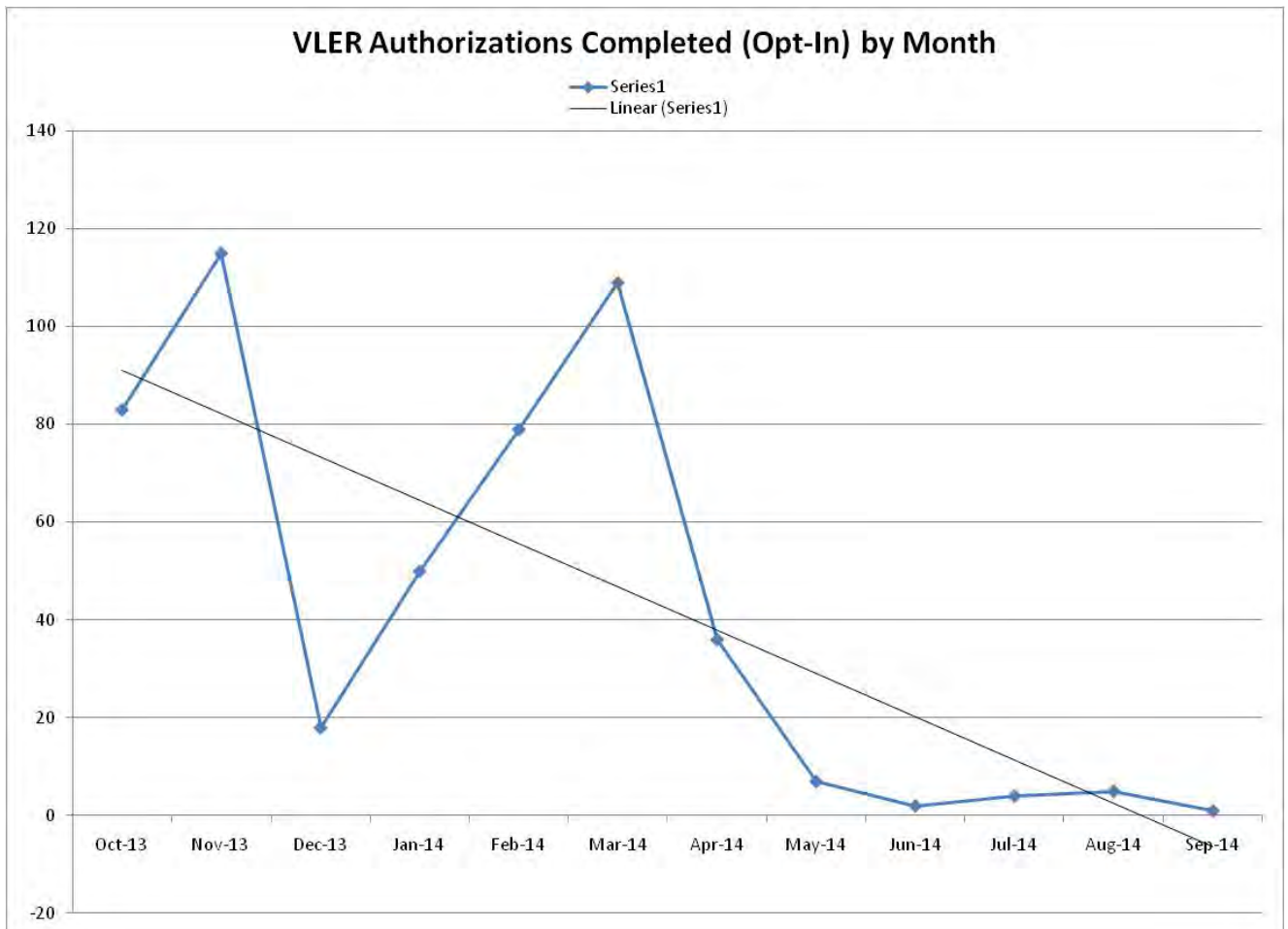


Figure 9. Summary of VLER Authorizations.

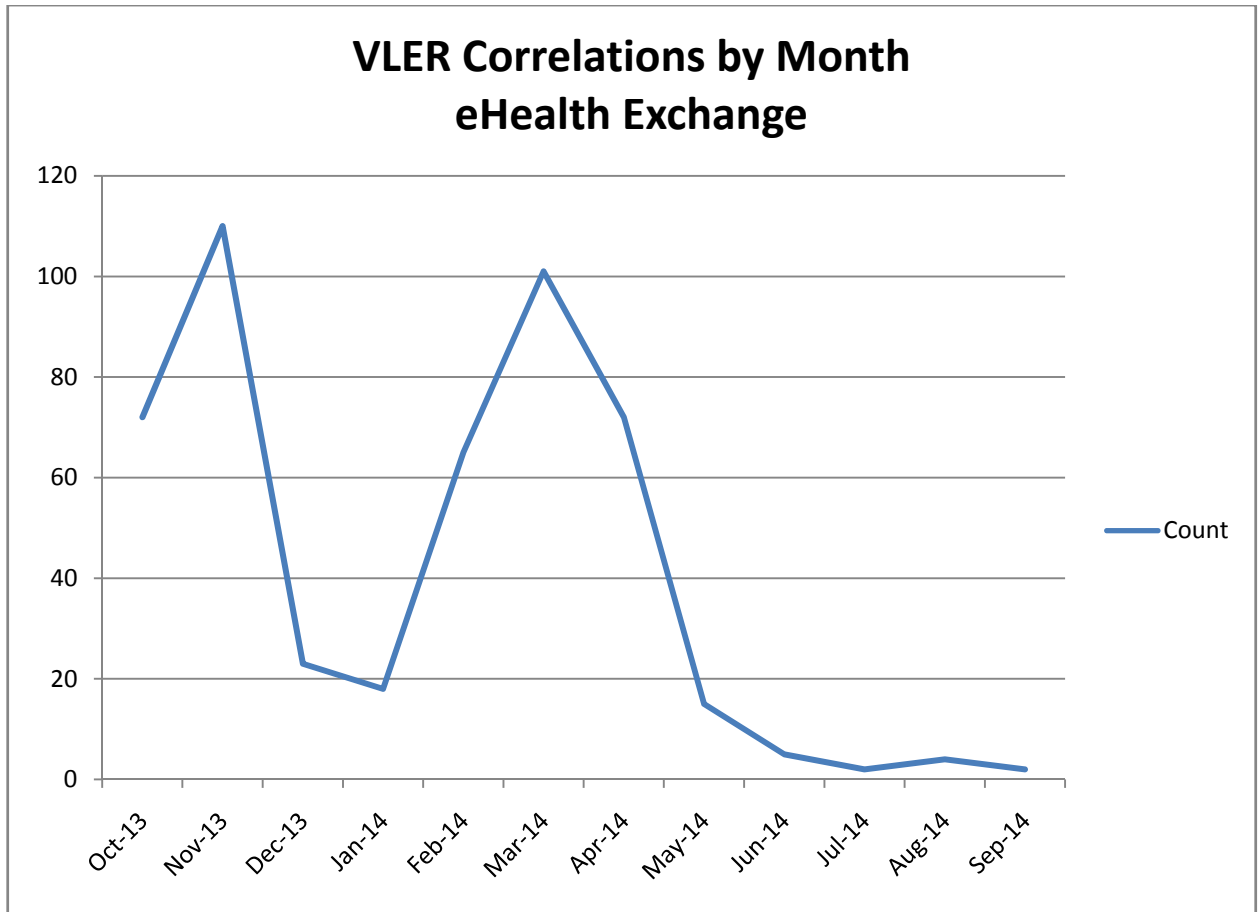


Figure 10. Patient Correlations by Month.

Significant progress has been made incorporating lab results from the Sunquest lab system into the CONNECT environment. Conemaugh first began work with Sunquest on the HL7 interface for laboratory results during February 2014. The first successful lab query response was completed on March 13, 2014. A handful of issues including integration into the CONNECT environment and C32 document were resolved during the summer before we completed testing with the VA on August 18, 2014. We then proceeded to test the live Sunquest interface with live data. This exercise brought additional issues to the surface that required resolution. We also decided to restrict microbiology and blood bank results. Data includes the most recent six months of laboratory results from all three hospitals and is eloquently combined with the existing Allscripts outpatient data. John Hargreaves worked with the CMMC lab to provided documentation to meet the College of American Pathology (CAP) interface requirements. Current plans include moving the lab result functionality into production in early October. Figure 11 is a screenshot of the test data and a review of the eHealth Exchange architecture can be found in Appendix 5.

Summarization of Episode Note Page 3 of 5

DATE/TIME	RESULT TYPE	RESULT VALUE	REFERENCE RANGE	INTERPRETATION	RESULT STATUS	SOURCE
14-MAY-2014	GLYCATED HEMOGLOBIN (% GHb)	Unknown2	Unknown2	---	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	GLYCATED HEMOGLOBIN (% A1C)	5.5 %A1C	4.0-6.0	---	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	ESTIMATED AVERAGE GLUCOSE	110 MG/DL	Unknown2	---	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	ANTI-NUCLEAR AB BY EIA	Unknown2	NEG	A	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	ANTI-NUCLEAR AB IFA TITER	Unknown2	Unknown2	---	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	BUN/UREA NITROGEN	102 MG/DL	9-21	H	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	CALCIUM	DEL MG/DL	9.1-10.4	---	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	CREATININE	0.8 MG/DL	0.7-1.3	---	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	GFR, ESTIMATED	104 mL/min	Unknown2	---	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	DIRECT LDL OR LDL	600 MG/DL	<130	H	completed	Conemaugh Valley Memorial Hospital
14-MAY-2014	HEP B SURFACE AB	Unknown2	NEG	A	completed	Conemaugh Valley Memorial Hospital

Figure 11. C32 Lab Results – Chemistry & Hematology

Conemaugh upgraded the outpatient Allscripts EHR over the weekend of March 8, 2014. MIDHT integration and functionality was changed, tested and put back into production very efficiently.

Allscripts Clinical Analytics – a purchase agreement was executed with the vendor on November 1, 2013. After an initial installation postponement due to Allscripts 11.4.1 upgrade delay, the production database was made available to Conemaugh in May. Staff training was conducted over 8 sessions (webinar/workshop). The MIDHT team has been learning the application and running reports on correlated veterans. Clinical data has been extracted according to 2014 American Diabetes Association (ADA) standards. Data has been consolidated for presentation to system users.

The MIDHT team then worked closely with the CPG Director of Primary Care on review and distribution of the data. After review, individual CPG practice files were created for HIPAA reasons and provided on September 3, 2014. All files will be distributed to the practices by the beginning of October. The goal is to increase document queries by Conemaugh users by analyzing existing clinical data in the electronic record and comparing it to national standards in order to identify gaps in care.

Sample Report:

Practice	Provider	Immunizations within a year of this report	Tobacco Use?	Diabetes Medication listed	Aspirin Therapy	BP, Systolic	BP, Diastolic	Days from most recent HbA1c	count of HbA1c values within 180 days	most recent HbA1c	Days from most recent eGFR	count of eGFR values within 365 days	most recent eGFR	Days from most recent LDL	count of LDL values within 365 days	most recent LDL	Days from most recent HDL	count of HDL values within 365 days	most recent HDL	Days from most recent Cholesterol	count of Cholesterol values within 365 days	most recent Cholesterol	Days from most recent TSH	count of TSH values within 365 days	most recent TSH	Days from most recent UACR	count of UACR values within 365 days	most recent UACR
Ebensburg	Koh, Enrique	3	N	N	Y	100	60	125	DUE NOW	8.4	177	9	194	123	6	124	145	6	27	143	6	204	123	6	265	123	6	249
Ebensburg	Koh, Enrique	D	N	Y	N	120	70	no result in EHR	DUE NOW		280	2	134	280	2	139	280	2	32	280	2	183	280	2	208	1064	DUE NOW	14
Ebensburg	Koh, Enrique	D	Y	N	Y	112	60	98	1	6.7	40	12	243	80	4	0	80	4	24	80	4	111	80	4	410	278	1	18

Figure 12. Allscripts Analytics Sample Worksheet.

Initiate MPI Upgrade – MIDHT team successfully upgraded the CONNECT environment on June 18, 2014 after an Initiate MPI upgrade occurred enterprise-wide. This included adding a certificate and updating the endpoint. Testing with VA confirmed patient discovery was working well.

Technical issues surfaced in December 2013, which impacted incoming messages to the CMMC gateway. All issues were proactively identified and worked on in a timely manner. They included connection issues between the CONNECT and CAL servers, a configuration change with Horizon Patient Folder and VA connection issues with the CMMC endpoints.

2.1.2 VLER Exchange Usage

Successful document retrieve transactions for treatment purposes through the eHealth Exchange have increased but vary by month. Data displayed does not include patient discoveries and document queries. Figure 13 is an overall representation and Figure 14 displays document types by direction of receipt. The inclusion of lab results into the Conemaugh C32 will likely increase usage in the coming months.

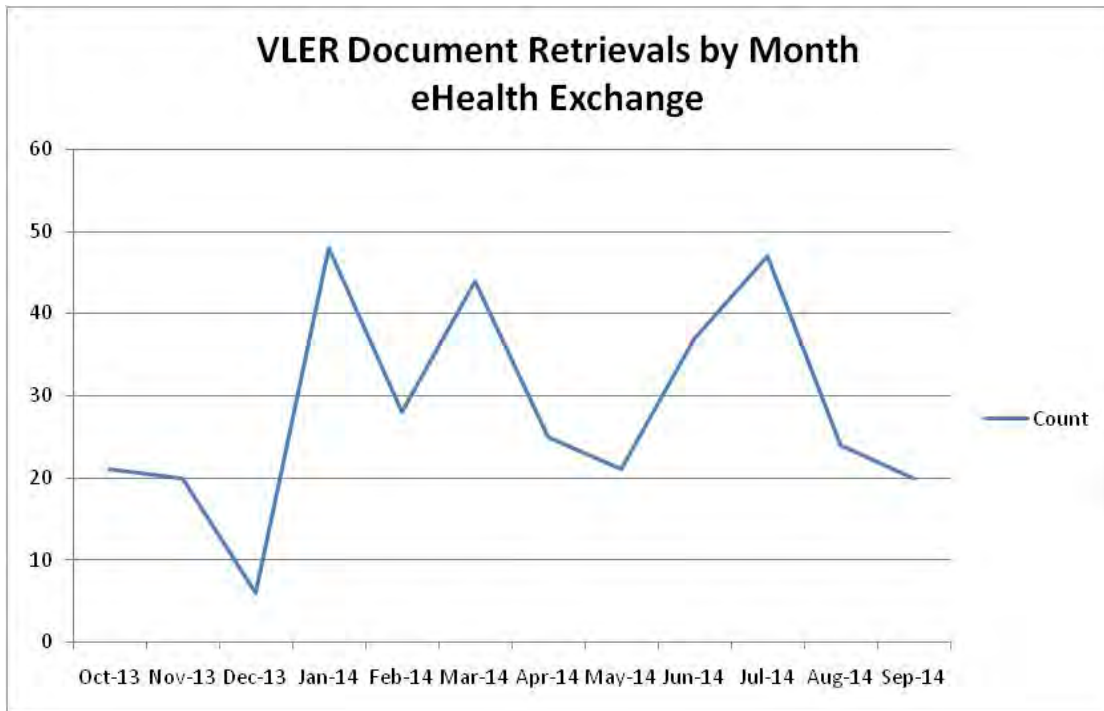


Figure 13. Document Retrieval Summary by Month.

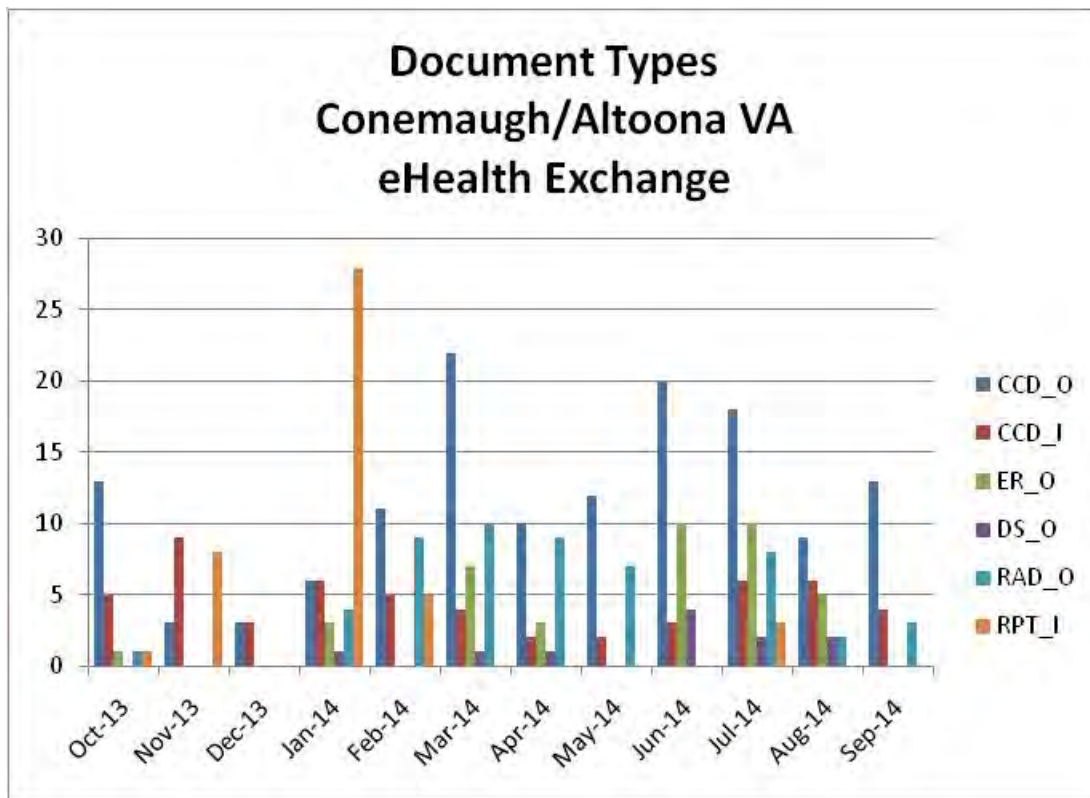


Figure 14. Document Retrieval Document Types by Month.

CCD_I = Continuity of Care Document Inbound
CCD_O = Continuity of Care Document Outbound
RAD-O = Radiology Report Outbound
DS-O = Discharge Summary Outbound
ER_O = Emergency Room Note Outbound
RPT_I = C62 Reports Inbound

2.1.3 HIE Vendor Support – CGI Federal, Inc.

October 2013 Activities

- Account setup
 - Setup Virtual Private Network (VPN) user accounts and verify access to environments and subversion
 - Complete all project administrative setup tasks
- Establish CMMC trouble ticketing instance and work management (JIRA)
- Patient consent issue
 - Patient consent documents were not being saved to the document repository because of a bug in CONNECT, which used an inappropriate method for assigning primary keys. The bug fix was developed, deployed, and verified with CMMC, and then applied to the CONNECT trunk.
- Document Query (DQ) test server failures
 - This was a two part issue; firstly, there were some inconsistencies between the SSL port configurations between the test and go live servers. These differences have been resolved, using the go live configuration as the gold standard. Secondly, the values in the eHealth exchange valuation Universal Description Discovery and Integration (UDDI) were incorrect. John Hargreaves was able to get those updated via the appropriate channels.

November 2013 Activities

- CMIDHT-1 Universal Client Patient Correlation Issue
 - The correlation displayed the Home Community Identification (HCID) of the organization rather than the name. Issue was that the HomeCommunityMapper class was changed as part of a major upgrade in 3.3 to incorrectly pull the name from the key value (the HCID). Changed back to pull from the business entity name.
- CMIDHT-2 Incorrect Style sheet
 - Lab comments for the VA C32 were incorrectly formatted, this XSL file wasn't on production or in the source code but located on the test server. Updated the source code with this correct XSL.
- The consent document issue resurfaced where they are not persisting in the document repository

- Duplicate primary key issue which manifests as Consumer Preferences Profile (CPP) documents were not being correctly saved to the document repository. The issue has been resolved and the configuration change has been checked into the CMMC SVN server.
- Supported CMMC with finding Document Query response message in the log files
- Assisted CMMC with location of certain log files

December 2013 Activities

- The consent document issue resurfaced where dynamic Radiology Study documents were being assembled and added to the repository and not updating the auto increment counter.
 - A configuration got corrupted in some deployment. A fix to resolve the issue with the primary key was deployed, a server restart was required. The issue was resolved and the configuration change has been checked into the CMMC SVN server.
- Inability to find and review activity in the log files
 - Log files were limited to 120,000 Kbs, log file size was increased to roll over daily to provide adequate storage to review activity.
- VA was showing the CMMC gateway as unavailable
 - After investigation, it appeared there was an incorrect endpoint in the UDDI for Conemaugh GW01. The UDDI was showing https://207.255.238.12/Gateway/PatientDiscovery/1_0/NhinService/NhinPatientDiscovery but should be pointing to port 8181. Received contact information for CMMC network personnel and worked cooperatively to open port 8181. Still working with VA through the end of quarter to identify and resolve connection issue(s) from VA to CMMC.

January 2014 Activities

- Preproduction certificate update – The eHealth Exchange validation certificate in the pre-production environment expired in January; worked with John to update that certificate.
 - Unfortunately the standard process for importing the signed eHealth Exchange certificate back into the originating keystore no longer works. The suspicion is that some process or technology on the entrust site has silently changed, it is common knowledge that some Java Development Kit (JDK) implementations create slightly differently formatted PEM and DER encoded which the Oracle JDK has trouble with.
 - Unfortunately it's difficult to confirm this as the culprit without input on the technology used on the Entrust side. After many hours looking at this issue and with folks from MiHIN (facing a similar issue) we were able to create a workaround.
 - The work around involves converting the original keystore to the PKCS12 format and then importing the signed certificate with another tool called OpenSSL, then converting the certificate back to JKS.
 - Supported VA with their test environment – Once the Conemaugh certificate issue was resolved were able to begin testing per VA request against their test environment.
 - Support testing with VA with their new production certificates – VA updated their production eHealth Exchange certificate last week and asked Conemaugh to support them by testing the connection on the Conemaugh GO LIVE environment.

- It appears that VA was not using the latest Conemaugh endpoints from the production UDDI, and once they started using them there were some issues with the ConemaughAdapterCommonDataLayer.
- John was able to resolve those issues and successfully monitor messages in the form of PDs, DQs, and DRs.
- Reviewed the Conemaugh logs for certain messages supporting a patient search issue, it was determined that the record in question was missing the SSN.
- Began reviews of the supplied files and held an internal discussion for the proposed lab interface work with Sunquest.

February 2014 Activities

- Preproduction certificate resolution – There was a request by Healthway to Entrust to modify the algorithm for the eHealth Exchange security certs. Creating an interoperability issue between older eHealth Exchange certificates and the newer ones. There was a significant amount of research performed and working with multiple organizations besides Conemaugh to isolate and resolve the issue.
- Though Healthway stands by their decision that it was a good and necessary certificate upgrade, Healthway representatives have finally agreed with the findings of the support team and are working with Entrust for a better process when making these types of upgrades and transitions in the future.
- As part of responding to the larger impacts of CONNECT implementers in the eHealth Exchange community the support team wrote up and contributed documentation to 1) Detail how to update a new root certificate from the eHealth Exchange and 2) Key troubleshooting steps for chain of trust issues.

March 2014 Activities

- Provided support for lingering issues testing and exchanging messages with the VA. These included various email responses and review of the Conemaugh environments.
- Checked on the certificates – installation, configuration and expiration dates
- Verified Conemaugh endpoints
- Reviewed logs for related activity and issues
- Discussed 2010 versus 2011 specifications and impacts

April 2014 Activities

- Researched and developed a fix for an issue with test UDDI results issue where the maximum number of entries of 100 was hardcoded in the code. Tested and deployed the configurable return value for UDDI results into the Conemaugh environments.
- Worked with Conemaugh staff on subversion issues limiting the accessibility and delays to deployment. Started working on a new process that will allow for more timely and efficient deployments.
- Attended meetings and worked on an approach to on-demand document improvements for Conemaugh. The approach will involve a Document Assembly Manager to incorporate the three separate lab messages into an aggregated single synchronous message and pass it to the Common Access Layer.

- Provided support for questions regarding VA transactions on production and test.

May 2014 Activities

- The focus this month was adding lab capabilities to the Document Assembly Manager, leveraging the code developed for 3.1 and merging it with minor modifications for 3.3.1.3.
 - Built and deployed Conemaugh lab reporting modifications from MIDHT_PHASE3 repository
 - Tested lab reporting modifications and found missing functionality added in CONNECT 3.3 (because MIDHT_PHASE3 was based on CONNECT 3.1), made necessary updates
 - Merged lab reporting modifications into CONNECT 3.3 and built and deployed
 - Testing/troubleshooting is on-going, continuing to coordinate with Conemaugh resources
- Due to the discovered situation and cleanup related to the second bullet point above with the current repository, the team migrated to Bitbucket for better version control.

June 2014 Activities

- Investigated a Patient Discovery failure on June 4 – Reviewed logs and investigated the process flow from gateway to adapter to initiate. Determined timeout issues between the adapter and initiate. Worked with Conemaugh team to restart Initiate and resolved the communication issue.
- Notified of Patient Discovery Issues in Production on June 9 – Expected patient correlations were not being made. Investigation determined a timeout was happening at the AdapterMpiSecured service waiting on Initiate. The log files were inconclusive on the cause, determined that restarting the CONNECT server would be the best course of action. The server restart corrected the timeout issue.
- Updated the Initiate link in production on June 18 and ensured the new certificate was added along with a restart and verification of proper operations. Verified functioning with Conemaugh that patient search was working from the GUI and Care Portal. Also received validation from the VA with a successful PD test.
- Finalized set up of the Conemaugh JIRA site on June 20 to more accurately track and schedule project work. The timing miscommunication of the certificate upgrade and communication confusion with the lab results effort illustrated the need for process improvement in order to more efficiently and accurately track work through more formal ticketing. Ensured all users have logins, access and proper permissions. Link below: <https://cgiinterop.atlassian.net/browse/CMIDHT/?selectedTab=com.atlassian.jira.jira-projects-plugin:issues-panel>
- Throughout June – continued work on adding lab result reporting capabilities to the Document Assembly Manager, leveraging the code developed for 3.1 merging it with minor modifications for 3.3.1.3. Focused on the following four tickets:
 - CMIDHT-6 Updated CommonDataLayer Adapter for querying lab results
 - CMIDHT-7 Updated Lab Response Builder to pull information from correct message type
 - CMIDHT-8 (Still in progress) Updated information source of CDA header for correct hospital information

- CMIDHT-9 (Still in progress) Modified LabResponseBuilder and retrieve Lab Results for Patient NWHINTWO NWHINZZZTESTPATIENT
- Below are listed some of the higher level tasks required to date for this effort, several of these were not originally expected to be part of the scheduled work and added to the overall scope and effort
 - o Supported securing Conemaugh related services, an issue with client-auth in production; ultimate fix was not small and not non- invasive
 - o Merged code received from Conemaugh into 3.3.1.3 codebase
 - o Fixed build issues due to integrated code in local 3.3.1.3 to proceed
 - o Wrote unit tests to validate the flow of LabModule work.
 - o Added interface to call LabModule in CAL.
 - o Made required code changes in the WSDL provided to the CAL Service
 - o Made required code changes to accommodate the Schema for the same service
 - o Modified the code to get the Response (Response as String) as per modified WSDL and Schema.
 - o Cleanup of previous contractor work to accommodate receiving Response of type ORF_R04 (was ORU_R01)
 - o Performed additional analysis on message variations between ORF_R04 and ORU_R01 to account for and properly read the new message type
 - o Added into properties folder missing jars (slf-4j) into the properties folder (provided by Conemaugh)
 - o Copied an updated xsl provided by Conemaugh to properties file

July 2014 Activities

- Supported Conemaugh testing with the VA (In their SQA test environment)
 - o [CMIDHT-12](#) – Investigated a Patient Discovery (PD) issue reviewed logs and provided the VA with the correct endpoints. Updated UDDI information and ensured that the VA and Conemaugh gateways were using the 2010 spec version while preparing for testing with the 2011.
 - o Participated in testing meetings in support of the VA and Conemaugh testing.
 - o Researched and resolved a patient search issue occurring during the VA testing.
- [CMIDHT-17](#) – Installed and validated new Healtheway certificate, current certificate expires at the end of July.

New Development Work (Lab Results Project):

- Development work continued making updates to the adapter for refinement and to handle variations in the HL7 lab responses. Work also continued on the C32 clinical document builder. Tickets worked on and closed this month provide additional detail regarding work completed this month.

- [CMIDHT-8](#) – Updated the information source of the CDA header for correct hospital information
- [CMIDHT-9](#) – Made modifications to the LabResponseBuilder service and retrieve LabResults service to ensure test patient NWHINTWO was displaying correctly, this was the first patient where a number of the OBR results variations were identified and worked through.
- [CMIDHT-10](#) – Researched HL7 lab results and introduced filtering logic to filter out specific text to provide the correct display of results and remove unwanted information.
- [CMIDHT-11](#) – Corrected values to meet the VA style sheet expectations. Concatenated multiple OBXs with the same ID and mirrored how the VA was handling comments.
- [CMIDHT-13](#) – Researched issues and introduced additional search criteria for “Reference range” and “Units” in the OBX text block. The new logic properly filter and displays the results in the F observation.
- [CMIDHT-14](#) – Researched results and added additional filtering logic to properly support certain orders such as a blood bank order which appears as multiple OBXs.
- [CMIDHT-15](#) - Updated the adapter to change the labresult result type to populate in the display name not the reference value to comply with the VA style sheet.
- [CMIDHT-16](#) – Continued to refine the adapter to comply with the VA style sheet by adding more logic to handle variations in the lab result messages, updated the XSL to pull result type for display from display name.
- Provided additional research and guidance related to HL7 lab messages and the best way to handle the variances and discern what the VA might be expecting based on the labs result messages being supplied.

August 2014 Activities

- Continued support for Conemaugh testing with the VA (In their SQA test environment)
 - [CMIDHT-12](#) – Investigated a Patient Discovery (PD) issue reviewed logs and provided the VA with the correct endpoints. Updated UDDI information and ensured that the VA and Conemaugh gateways were using the 2010 spec version while preparing for testing with the 2011.
 - Keeping CMIDHT-12 open until all open issues are resolved and the use case variances are accounted for with different lab results.
 - This ticket also covers some of the supported being required for the VA CONNECT 4.2.2.2 implementation.

New Development Work (Lab Results Project):

- Development work continued making updates to the adapter for refinement and to handle variations in the HL7 lab responses. Work also continued on the C32 clinical document builder. Tickets worked on and closed this month provide additional detail regarding work completed this month.
- [CMIDHT-18](#) – Inconsistencies and display issues with lab results in VA Vista.
 - Performed research and developed two options, presented these to Conemaugh for review.
 - Received guidance to proceed with the second option detailed in the JIRA ticket.
 - Developed, tested and implemented the solution, was verified with the VA.
- [CMIDHT-19](#) – Install Certificate in Conemaugh Test Server to point CONNECT to initiate in LIVE and perform an end to end test.
 - Installed the Certificate on the Conemaugh Test Server and pointed the initiate.properties to the new endpoint for Live.
 - Supported testing activities while performing an end to end test, ensured the clinical document was created.
 - Identified another use case where requirements are needed on document creation where lab results aren't found (new ticket will be created for this situation).
- [CMIDHT-20](#) – Add OBX information to comment field in C32 instead of individual result.
 - Researched supporting specifications and reviewed current coding to see how this would mesh with current customized adapter logic.
 - Discussed via email with Conemaugh received approval with the following logic contained in the JIRA ticket comments (8/26/2014).
 - Development of this logic will occur in early September.
- [CMIDHT-21](#) – Edit internalconnectioninfo.xml in production.
 - After discussions determined this wasn't required in production only test.
 - Verified that Conemaugh was able to interoperate with the VA post their 4.2.2.2 implementation.

Continue to provide additional research and guidance related to HL7 lab messages and the best way to handle the variances and discern what the VA might be expecting based on the labs result messages being supplied.

September 2014 Activities

- Continued support for Conemaugh testing with the VA (In their Production/ Live data testing)
 - Keeping [CMIDHT-12](#) open until all open issues are resolved and the use case variances are accounted for with different lab results.
- [CMIDHT-22](#) – Adjust CONNECT Timeout Settings
 - Issues with the live Sunquest interface appear to have been resolved, including the 1 year date range.
 - Reviewed log file and considered how to adjust CONNECT timeouts.
 - The timeout has been increased in gateway.properties for webservice proxy timeout and QueryForDocuments.
- [CMIDHT-23](#) – Failed Doc Retrievals
 - The VA supports only 2010 endpoints and the VA endpoints in Conemaugh Production UDDI are overridden by adding only 2010 endpoints in internalConnectionInfo files.
 - The proper endpoints were updated and DR requests to VA works when Conemaugh initiates for a Retrieve.
- [CMIDHT-24](#) – Revise logic for C32 comment field population
 - Changes were made to CAL adapter requiring NTE segments to be updated.
 - Updates were made and now being captured and displayed as comments.
- [CMIDHT-25](#) – Receiving read timeouts when trying to test a CAL (labs) change, was not able to get a C32 document created for a patient
 - Unable to recreate the issue and reported this status back.

Subtask 2.2 Provide technical and documentation assistance on DoD-managed Virtual Lifetime Electronic Record (VLER) efforts.

*****No specific tasking has been identified by TATRC*****

Subtask 2.3 Investigate productizing a Patient Consent module using established standards, such as TP20/XACML.

*****All tasks have been completed*****

Subtask 2.4 Assess and analyze NHIN-related activities, to include data center performance metrics, physician evaluation and usage of the NHIN Portal, and resulting benefits of HIE with federal participants.

2.4.1 Health Information Exchange Research

Data collection continues with documentation of monthly transactions between Conemaugh and VA for treatment purposes as reported earlier in Figure 13 and Figure 14. In addition, the number of sent invitations, returned authorizations and successful patient discovery correlations is maintained by the project manager. Glassfish monitoring statistics are no longer being collected. The VA has not provided authorization to participate in the HIE survey, which is unfortunate.

A total of 63 Veterans completed the survey during this annual report period. Below in Figure 15 and Figure 16 are a few key questions and their results.

Q5 Did your providers talk about the new service during your appointments?

Answered: 59 Skipped: 4

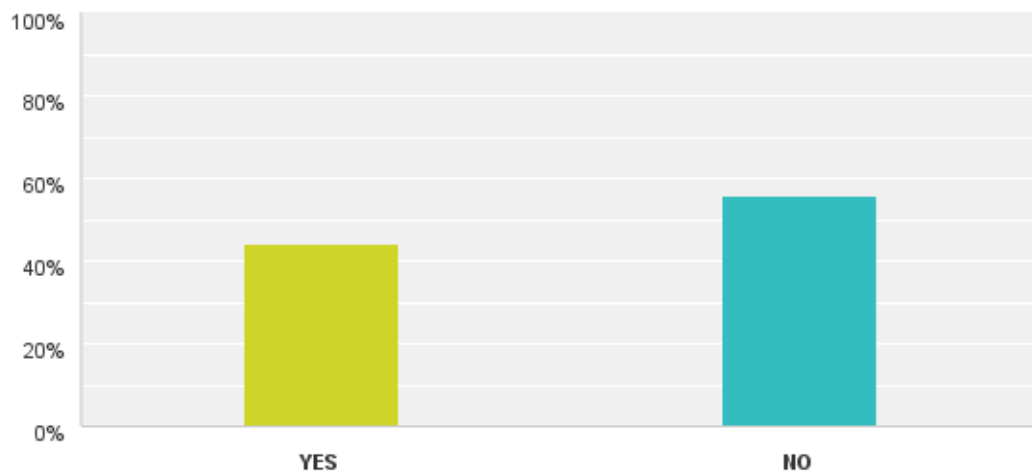


Figure 15. Patient-Provider Discussion of Health Information Exchange.

Q6 Please select which benefits you believe were achieved as a result of HIE between Conemaugh and Altoona VA.

Answered: 56 Skipped: 7

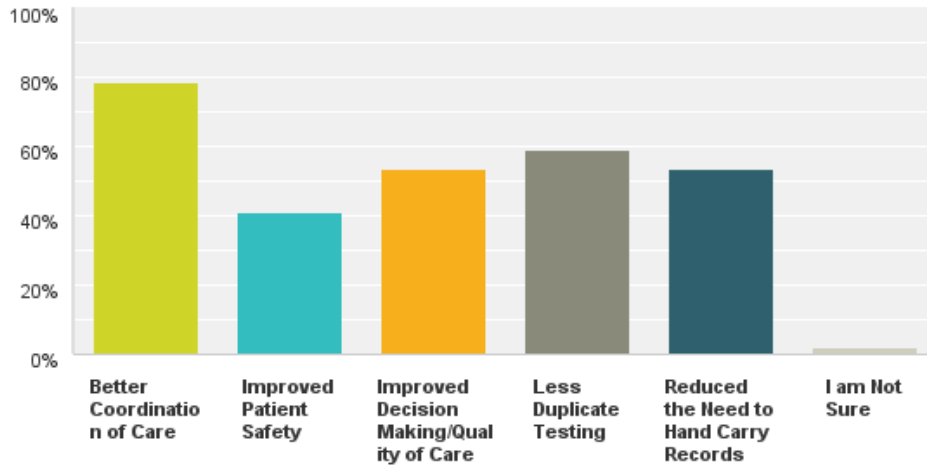


Figure 16. Patient perceived benefits of Health Information Exchange (HIE).

Veterans responding to the survey have had a positive experience with health information exchange between Altoona VA and Conemaugh. The majority of patients believe that coordination of care across providers has improved and has reduced the need for Veterans to hand carry their paper records to providers. More than half of survey respondents believe that decision making and quality of care has also improved and duplicate testing has been reduced because of the electronic exchange of medical information. Additional surveys continue to be distributed to grow the sample size for patients that have had their data exchanged in production. Three provider surveys were completed by Conemaugh staff during the reporting period.

Continuing Review: Protocol A – 16192.3

Current local IRB approval was set to expire on July 15, 2014. Continuing review documents were submitted to the Conemaugh IRB during the first week of July. Approval was received on July 8, 2014. After approval was received, documents were forwarded to USAMRMC HRPO on July 9, 2014. Acknowledgement of receipt was confirmed by letter on July 24, 2014.

Key Research Accomplishments

Arm 1:

- BCMA deployment at Miners Medical Center
- Continued data collection and data analysis according to research protocol

Arm 2:

- Two years in production phase with Altoona VA Medical Center/VLER
- Significant progress on inclusion of lab results in C32
- Continued maturation of system usage by providers
- Veterans satisfaction from system benefits
- Continued data collection according to research protocol

Reportable Outcomes

- 2014 CMMC Patient Safety Fair – August 20, 2014
- 2014 Veterans Symposium hosted by Veterans Community Initiatives, Inc. – August 20, 2014

Conclusion

The MIDHT project continues to implement and research health information technologies (HIT) within the Conemaugh Health System, located in Southwestern Pennsylvania. Core technologies under investigation include pharmacy robotics, bar code medication administration (BCMA) and health information exchange via the eHealth Exchange. Statement of work is being delivered as expected with a few programmatic delays.

Significant progress has been made on both arms of the initiative. Research activities for Arm 1 have progressed, including an initial analysis on medication errors at CMMC and MYMC and completion of statistical testing on nursing workflow and satisfaction. CMMC is participating in the 14th Virtual Lifetime Electronic Record pilot nationwide via data exchange with the Altoona VA Medical Center (Arm 2). Patient correlations, system users and document exchanges all have increased throughout the year. CMMC is excited to move the Sunquest lab result (C32) functionality into production during October 2014.

Appendices

Appendix 1. Acronym List.

<u>Acronym</u>	<u>Description/Definition</u>
API	Application Programming Interface
BCMA	Bar Code Medication Administration
CAL	Common Access Layer
CHS	Conemaugh Health System
CMMC	Conemaugh Memorial Medical Center
COTS	Commercial Off The Shelf
CPP	Consumer Preferences Profile
CVMH	Conemaugh Valley Memorial Hospital (dba "CMMC")
DQ	Document Query
DoD	Department of Defense
FHA	Federal Health Architecture
GUI	Graphical User Interface
HAPI	HL7 Application Programming Interface
HIE	Health Information Exchange
JIRA	Bug tracking software
JKS	Java KeyStore
LDAP	Lightweight Directory Access Protocol
MHS	Military Health System
MIMC	Conemaugh Miners Medical Center
MIDHT	Military Interoperable Digital Hospital Testbed
MIS	Management Information Systems
MPI	Master Patient Index
MYMC	Conemaugh Meyersdale Medical Center
NGC	Northrop Grumman Corporation
NIST	National Institute of Technology
NWHIN	Nationwide Health Information Network (now called "eHealth Exchange")
OID	Object Identifier
ONC	Office of the National Coordinator for HIT
OpenDS	Open Directory Service
PD	Patient Discovery
PHI	Protected Health Information
QD	Query for Documents
RD	Retrieve Documents
SAML	Security Access Markup Language
SAN	Storage Area Network
SOW	Statement of Work

SSO	Single Sign On
SSL	Secure Socket Layer
SVN	Subversion
TATRC	Telemedicine & Advanced Technology Research Center
UC	Universal Client
UDDI	Universal Description Discovery and Integration
USAMRMC	United States Army Medical Research and Materiel Command
VA	U.S. Department of Veterans Affairs
VLER	Virtual Lifetime Electronic Record
VPN	Virtual Private Network
WSDL	Web Services Description Language
XDS	Cross-Enterprise Document Sharing

Appendix 2. Physician BCMA and eMAR Survey.

Physician - BCMA and eMAR System

Thank you for taking the time to complete this anonymous survey. We are interested in your responses about how the new Bar Code Medication Administration (BCMA) and electronic Medication Administration Record (eMAR) system has impacted your delivery of patient care. By completing and submitting this survey, you are consenting to take part in this study.

Instructions:

Please read each item carefully and rate the technology provided to you for this research study. If you need assistance completing this survey, please contact John Hargreaves at (814) 269-5277.

1. How often do you access the electronic medication administration record (eMAR) module available through Care Portal?

- Frequently
- Sometimes
- Seldom
- Never

2. The new eMAR module has improved my decision-making and efficiency because I can now electronically access if/when ordered medications were administered from various locations.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

3. Adverse drug events have reduced because of the bar coding technology and additional nursing safeguard warnings/alerts in place to reduce medication errors.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Don't Know

Physician - BCMA and eMAR System

4. The new Bar Code Administration Administration (BCMA) system and Care Portal eMAR module have improved physician communication with pharmacy and nursing.

- Yes
- No
- Not Sure

5. I would recommend our new BCMA system and Care Portal eMAR module to other acute care hospitals.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

6. How many years have you been a practicing physician or physician assistant?

- Not Applicable
- 0-5 Years
- 6-10 Years
- 11-15 Years
- 16-20 Years
- 20+ Years

7. Please select your affiliation.

- Physician - Conemaugh Physician Group
- Physician - Hospitalist
- Physician - Independent
- Physician Assistant
- Resident

8. Do you have BCMA and eMAR experience outside of Conemaugh?

- Yes
- No

9. Please provide comments on this topic as necessary.

Physician - BCMA and eMAR System

Thank you for your time and input.

Appendix 3. Pharmacy Robotics Survey.

Pharmacy Survey – Robotic Dispensing

Thank you for taking the time to complete this anonymous survey. We are interested in your responses about how the McKesson Robot-RX® system has impacted your delivery of patient care. By completing and submitting this evaluation form, you are consenting to take part in this study.

Instructions:

Please read each item carefully and rate the technology provided to you for this research study. If you need assistance completing this form, please contact John Hargreaves at (814) 269-5277.

1. From your perspective, the McKesson Robot-RX® system has increased filling accuracy.

Strongly Agree Agree Neutral Disagree Strongly Disagree

2. From your perspective, the McKesson Robot-RX® system has significantly reduced missing medications.

Strongly Agree Agree Neutral Disagree Strongly Disagree

3. From your perspective, the McKesson Robot-RX® system has minimized issues with expired medications.

Strongly Agree Agree Neutral Disagree Strongly Disagree

4. From your perspective, the McKesson Robot-RX® system has significantly reduced the amount of checking time needed and medications are delivered to the floor quicker.

Strongly Agree Agree Neutral Disagree Strongly Disagree

5. How would you rate the Robot-Rx® system and associated components with respect to ease of use.

Very Easy Easy Neutral Difficult Very Difficult

6. What percentage of the hospital's medications has been impacted by this system?

100% 95-99% 90-94% 85-89% 80-84% <80% Not Sure

7. You have been able to spend more time on clinical activities since the new system was implemented?

True False N/A

8. If true, how many minutes per day?

Pharmacy Survey – Robotic Dispensing

9. From your perspective, the McKesson Robot-RX® system has improved patient safety through a reduction in “near misses” and reportable medication errors.

- Strongly Agree Agree Neutral Disagree Strongly Disagree

10. Would you recommend this system to other hospitals?

- Yes No Not Sure

11. How long have you been a pharmacist or technician?

- 0-5 Years 6-10 Years 11-15 Years 16-20 Years 20+ Years

12. Please provide additional comments on this topic as necessary.

Appendix 4. Nurses' Medication Administration Survey.

Medication Administration System Survey – Nurses' Assessment Survey

1. Welcome

Thank you for participating in the Medication Administration System Survey –

Nurses' Assessment Survey (MAS-NAS) project.

Completing this form indicates you recognize that this is a research project. As a token of our appreciation, you will receive a \$20.00 incentive from Shreeetz when you have completed the survey. After completion, please call 814-269-5277 to arrange receipt and please have your "SUM" available. We reserve the right to withhold incentive for any reason related but not limited to that which compromises the survey intent, data validity, completion compliance, or respondent eligibility.

If you previously completed a MAS-NAS, please complete this survey so we can learn how barcode/eMAR has changed how you administer medications. We will compare nurses' responses on this MAS-NAS with previous surveys completed in 2012 to learn the impact of converting to barcode/eMAR on CHS nurses.

If this is your first MAS-NAS, we would like to learn your beliefs about the system.

Please create a five digit confidential identifier called SUM. This allows us to maintain your privacy while being able to compare surveys taken at different times. Even if this is your first survey, please compute your SUM. We ask you to calculate the following number and place it in the space provided. The number is the SUM of the last five digits of your social security number added to the last five digits of your home telephone number. If your telephone number changed, please use the number you previously used. Only the SUM of those two numbers should be recorded on the first page of the survey. If your sum has more than five digits, record only the last five. See example below:

Last five social security numbers = 52348
+
Last five home telephone numbers = 58721
SUM = 111067

ENTER 11067 (last five)

After calculating your SUM, please:
Add your SUM on the next page and complete the survey.

Thank you for your participation in this important project!

2. Introduction

*** 1. SUM:**

*** 2. Date of completing the survey:**

Medication Administration System Survey – Nurses' Assessment Survey

*3. Nursing Unit:

- Meyersdale Medical Center
- Miners Medical Center
- Ashman 6 ICU
- Ashman 7
- Ashman 8
- Ashman 9
- Ashman 10
- Rose 6 ICU
- Rose 7 CICU
- Rose 7 Telemetry
- Rose 8
- Rose 8 PCU
- Rose 9
- Rose 10
- E4
- E6
- GS 4
- GS 5
- GS 6
- ASU
- PACU
- Crichton Rehab
- Med Surg 7
- RICN
- Maternity
- Pediatrics
- Geropsych
- Aloysia Hall
- Behavioral Health
- School of Nursing
- Float
- TCU

Medication Administration System Survey – Nurses' Assessment Survey

Other (please specify)

The following statements describe experiences and beliefs about the current medication administration system you use. By current medication administration system, we mean the institutional structures and operational policies that direct and support the process and procedures of delivering/administering pharmaceutical products to patients. This includes all activities from medication ordering to dispensing to administration and documentation as well as all supplies and technologies associated with the current medication system, such as computer terminals, medication storage units, drug/drug interaction information, patient education sheets, infusion pumps, tubings, syringes, etc that are required in the process of getting medications to patients.

Completing this survey should take about 10 minutes.

By completing this survey, you are indicating consent to participate in this evaluation.

Please read each statement and circle the number that best expresses your own experiences and beliefs.

There are no right or wrong answers.

Do not write your name on the survey.

Please indicate the degree to which you agree or disagree with each item by using the following RATING SCALE.

Choose:

1 if you strongly agree with the statement.

2 if you moderately agree with the statement.

3 if you slightly agree with the statement.

4 if you slightly disagree with the statement.

5 if you moderately disagree with the statement.

6 if you strongly disagree with the statement.

NA if the statement does not apply to you.

Example: The current medication administration system provides adequate information about possible medication side effects.

Answer: If you believe that you always have access to the type and amount of information you need to be able to assess for and manage potential side effects of medications you administer, you should circle 1 because that statement best expresses your belief.

3. Questions

4. Because of information available through the current medication administration system I know both the intended actions and side effects of medications I administer.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

5. I find the drug alert feature (drug/drug or drug/food interaction) of the current medication administration system helpful.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

Medication Administration System Survey – Nurses' Assessment Survey

6. The current medication administration system makes it easy to check active medication orders before administering medications.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

7. The current medication administration system provides me with information to know that a medication order has been checked by a pharmacist before I administer the medication.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

8. The current medication administration system promotes 2-way communication between clinicians (MD, Pharmacist, RN) about medication orders.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

4.

9. I have access to the systems that support medication administration (physician's orders, drug information) when I need them.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

10. The drug information available through the current medication administration system is easy to get when I need that information.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

Medication Administration System Survey – Nurses’ Assessment Survey

11. I know where all the medications I need are stored (either on the unit or if they need to be procured from the pharmacy).

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

12. The current medication administration system helps me to be efficient at medication administration.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

13. The current medication administration system makes it easy to check that I am following the “5 rights” when I administer medications.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

14. The turnaround time for receiving medications needed “stat” or for patients newly admitted to the unit is adequate.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

15. The current medication administration system is effective in reducing and preventing medication errors.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

16. The current medication administration system is user-friendly to the nurses who administer medications.

1 2 3 4 5 6 NA
Strongly Moderately Slightly Slightly Moderately Strongly Not
Agree Agree Agree Disagree Disagree Disagree Applicable

Medication Administration System Survey – Nurses' Assessment Survey

17. The equipment and/or supplies needed to administer medications are readily available to me.

- 1 Strongly Agree 2 Moderately Agree 3 Slightly Agree 4 Slightly Disagree 5 Moderately Disagree 6 Strongly Disagree NA Not Applicable

18. Information available through the current medication administration system helps me to know what to do should my patient have any bad reactions from a medication.

- 1 Strongly Agree 2 Moderately Agree 3 Slightly Agree 4 Slightly Disagree 5 Moderately Disagree 6 Strongly Disagree NA Not Applicable

19. I have to keep stashes of medications to be sure I have medications I need when I need them.

- 1 Strongly Agree 2 Moderately Agree 3 Slightly Agree 4 Slightly Disagree 5 Moderately Disagree 6 Strongly Disagree NA Not Applicable

5. Open-ended

20. Please add any comments you wish about the current medication administration system and the degree to which components of the current system support your ability to administer medications safely and professionally.

21. If you could change one thing in the current medication administration system, what would it be?

6. BCMA

22. Did you work on an inpatient nursing unit at CHS before BCMA (Admin-Rx) was implemented?

- Yes No

Medication Administration System Survey – Nurses' Assessment Survey

7.

Comparing now (using barcode/eMAR) with the old system, please respond to the following 7 statements.

23. It is easier to do all the checking steps needed during the medication administration process.

- Strongly Agree Moderately Agree Slightly Agree Slightly Disagree Moderately Disagree Strongly Disagree Did not use old system

24. This is a safer system for patients.

- Strongly Agree Slightly Disagree Did not use old system
 Moderately Agree Moderately Disagree
 Slightly Agree Strongly Disagree

25. With the new system, it is easier to access information I need to administer medications.

- Strongly Agree Slightly Disagree Did not use old system
 Moderately Agree Moderately Disagree
 Slightly Agree Strongly Disagree

26. I am more satisfied with this new medication administration system than with the previous one.

- Strongly Agree Slightly Disagree Did not use old system
 Moderately Agree Moderately Disagree
 Slightly Agree Strongly Disagree

27. I have more time to spend with patients.

- Strongly Agree Slightly Disagree Did not use old system
 Moderately Agree Moderately Disagree
 Slightly Agree Strongly Disagree

28. Barcode/eMAR has made the medication administration process more efficient for me.

- Strongly Agree Slightly Disagree Did not use old system
 Moderately Agree Moderately Disagree
 Slightly Agree Strongly Disagree

Medication Administration System Survey – Nurses' Assessment Survey

29. Medications are more readily available when I need them for patients.

- Strongly Agree Slightly Disagree Did not use old system
 Moderately Agree Moderately Disagree
 Slightly Agree Strongly Disagree

8. Closing

*30. Overall, how satisfied are you with the current medication administration system? Please select.

- 1 - Completely Dissatisfied 2 3 4 5 - Neither satisfied nor dissatisfied 6 7 8 9 10 - Completely Satisfied

*31. How long have you been using the BCMA system (Admin-Rx) with patients?

- Less than 1 month 4-6 months 10-12 months
 1-3 months 7-9 months

Please provide the following information about yourself and your background.

32. Gender:

- Male Female

33. Age:

34. Highest nursing degree:

- LPN Diploma AS/AD BS/BSN MS/MSN

35. Number of years employed as a nurse:

*36. Number of years employed by Conemaugh:

37. Number of hours worked in a typical week:

Medication Administration System Survey – Nurses' Assessment Survey

38. Typical shift rotation schedule:

- All Shifts Rotate D/E 7A-7P
 Evenings Rotate D/N 7P-7A
 Nights All Days

39. Typical weekly schedule:

- mostly weekend/holiday rotate weekdays/weekends/holidays
 mostly Monday-Friday

*40. Current position:

- staff/direct patient care (staff RN/NIC) education
 leadership/management Student

Other (please specify)

41. Compared to your nursing peers, how do you rate your computer skills?

- Above Average Average Below Average

42. Do you use a computer at home?

- Yes No

43. How do you rate your skill at obtaining patient care information from the Conemaugh computer systems?

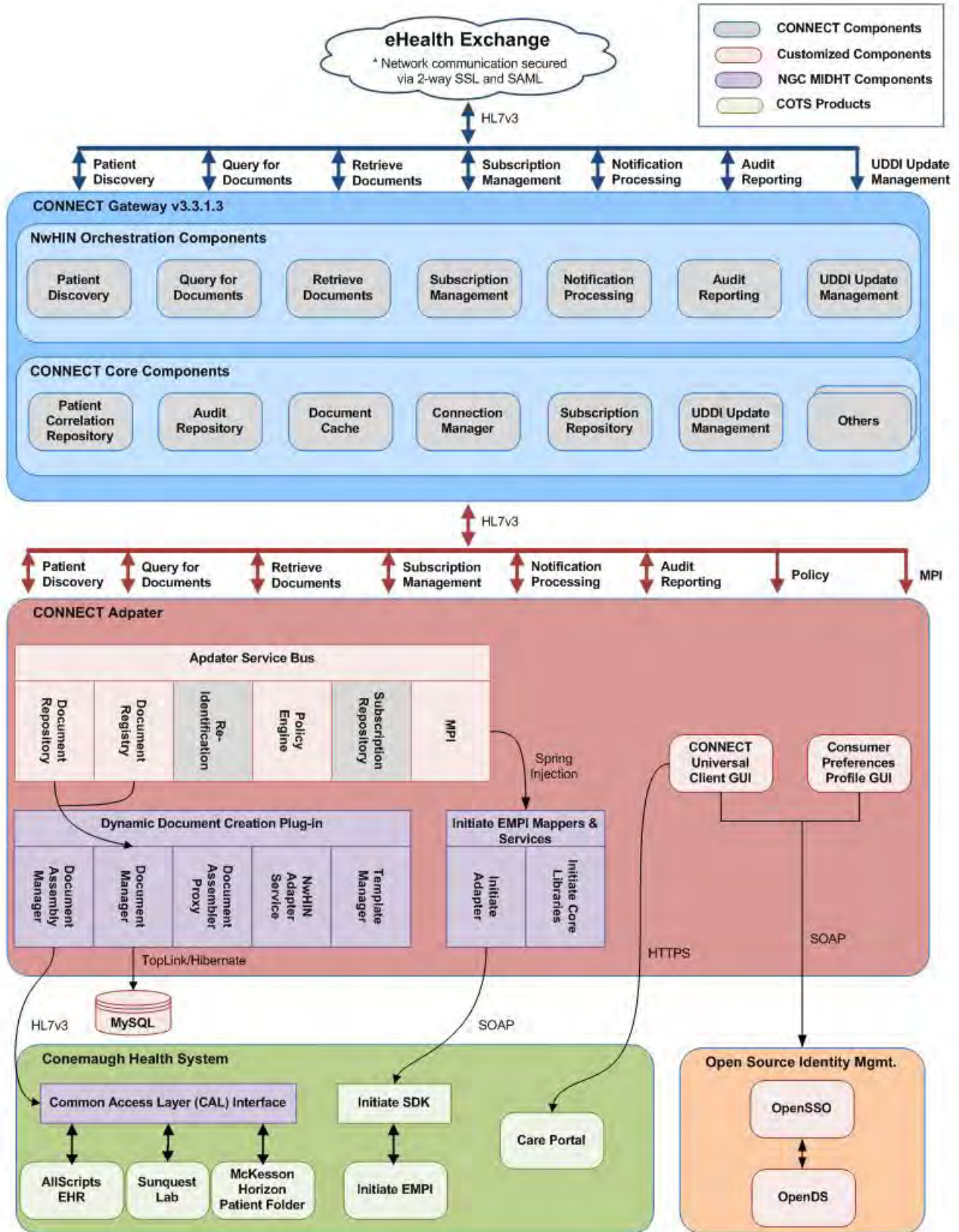
- Excellent Good Fair Poor

44. Did you ever use barcode/eMAR in another hospital before working at CHS?

- Yes No

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Appendix 5. eHealth Exchange Architecture.



Appendix 6. References.

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