Improving Data Quality in the Outpatient Setting: A Case Study of Provider Template Evaluation and Optimization in the Cancer Service Line
(Completed Practitioner Paper)

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Abstract: With the surge in adoption of Electronic Health Record (EHR) systems, Healthcare Providers and Administrators anticipated the ability to receive timely and accurate reports upon implementation. Many EHR vendors provide out of the box reports which are impressive on demonstration, yet in the same presentation these vendors frequently encouraged their customers to customize the EHR based on their needs. While a much needed feature, this can create a mighty web of challenges in regards to reporting. In this study, I examined the challenge of customization in EHR systems as it relates to reporting. I reviewed a customer developed report which was based on best practices by the EHR vendor yet the customization of the EHR resulted confusing results in the roll up format. This report was measured using a data quality assessment for Data Relevancy, Interpretability and Believability. The interpretation of the referenced report resulted in confusing roll up data due to inclusion of appointment schedule templates which were by design to be used on an as needed basis. By removing these templates, we were able to show a more realistic picture of utilization through the roll up metrics.

Introduction and Background

Between August 2013 and May 2014, the University of Arkansas for Medical Sciences (UAMS) transitioned to a new integrated EHR system called Epic. Due to the complexity of this implementation, UAMS chose to utilize a two-phased implementation process (Gamble, 2016). Epic is one of the largest providers of Health Information technology used throughout the world. As of 2016, Epic reports over 190 million users (SearchHealthIT, 2016). Epic is based on the Massachusetts General Hospital Utility Multi-Programming System (MUMPS) programming language and relies on Cache as a core technology for its software (Monegain, 2015). The 32 Epic software modules implemented replaced an estimated 24 of 86 disparate systems utilized throughout the medical center inpatient, outpatient clinics, laboratories, radiology and more. This system implementation brought together 89+ clinic locations, 35+ care areas across 21 inpatient units and 10 hospital outpatient departments (Lane, 2017). The new EHR had many features considered of value to the organization including full integration of the patient experience which was long a desire for both patients and hospital administration.

While the benefits were many, there were equally as many challenges to overcome with some being anticipated yet others unforeseen. Over the years, UAMS had utilized another vendor product for outpatient clinic scheduling. This product had been extensively customized over the years in an effort to support the practice nuances for most clinics. Specifically in the Cancer Service Line, our clinics are comprised of multiple cross-discipline providers, each who require specific scheduling parameters to meet the needs of the patient population. These providers can be scheduled in multiple clinics and surgical areas throughout a work week. Epic introduced UAMS to the terminology of a template for building provider schedules. A

template provides a framework by which a physician's schedule is built on. While other Service Lines have similar templates throughout their clinics, each of our clinics required a unique build with multiple exceptions to be managed per clinic.

Along with the complexity of the legacy system, UAMS decided on a very quick implementation schedule. This presented considerable challenges. Thousands of hours of discovery, training and IT development went into the planning phase in an attempt to replicate and improve interoperability. However, the new scheduling module presented many complex problems, some anticipated and others not fully understood. It was found that the Epic Scheduling module was unable to fit the volume of patients who were currently scheduled in the Legacy system. Epic's schedule template was managed by a strict set of user security rights and rigid template slot requirements. While considerable work was done to mitigate these issues, this resulted in a virtual standstill for patient scheduling the week of Go-Live (System was placed into production) in the outpatient setting. In order to continue seeing patients, user security rights were completely opened for staff and schedule templates were fully opened to allow for patients to be scheduled with overlapping appointments and very few system regulated limitations.

Months after Go-Live, we transitioned to the Optimization Phase of implementation. Each area of the organization had identified specific modules which required enhancements. In the outpatient areas, the focus was the scheduling module for clinic visits as many of the emergency procedures put into place had yet to be corrected. Many of these were simply reflective of the disjointed nature of the processes in place with the legacy systems. During planning, efforts were made to streamline the workflow processes. However with any systemic change of this magnitude, only so much can be done at once without completely disabling the system from both a human and system perspective.

Since Go-Live, several attempts to address the systemic and human process issues have taken place. Many areas underwent LEAN Six Sigma evaluation and other efforts which improved specific processes. In spite of the ongoing work, there continued to be systemic issues with process flow related to the clinic schedule templates. It was clear there was more work to be done.

To effectively evaluate the current state required a multi-disciplinary approach. These efforts are concentrated at the Service Line level with our focus of this project being within the Cancer Service Line. The Service Line administrative team was tasked with specifically identifying the issues to make systemic improvement for access to care for our patients in the outpatient setting. The Cancer Service Line chose to focus on four primary areas of concern:

1) Are provider templates reflective of actual daily clinic activities including time allotted per visit type?
2) Are patients able to obtain new or follow up appointments in a timely manner (patient satisfaction scores and third-next available reports)?
3) Are provider templates structured in such a way that new patient appointment slots are clearly identified for appointment center staff?
4) Are physician templates nearing a capacity threshold of 85% or greater which should trigger consideration of a mid-level provider or expansion of the provider clinic scheduled days. (Are physician templates grossly overbooked or appointments placed outside of regular template time)

To evaluate each of these areas required identification of relevant data points, clear data definitions, understanding of the data source, evaluation of current and needed reports, etc. While the new EHR had several reports available, our organization customized several parts of the scheduling application. These areas of customization added to the complexity in using out of the box reports. Due to this, each report had to be validated in our instance to ensure the customization was captured appropriately. This process continues today with considerable work ongoing.

The Cancer Service Line cares for patients from throughout the country and from all over the world. There are 6 Procedure based clinics and 12 Non-Procedure based clinics. There are over 50 cross-discipline physicians who see patients in these clinical areas, each of which utilize the EHR Scheduling module with separate templates per clinic of practice. Each of these templates are completely unique to the practice as our providers span the gamut of oncology healthcare disciplines, including medical and surgical specialties. Within the procedure based clinics, additional resource templates are utilized based on the equipment / personnel needed to perform the procedure. These areas schedule to over 50 resource templates.

Due to the magnitude of the scheduling module utilization, the UAMS Chief Medical Information Officer was tasked with creating a report which would identify those Service Lines, Clinics and Providers which were not meeting a specific target set by the administration team for utilization. This report provided metrics from three perspectives:

1) In reference to a patient's scheduled appointment.
2) In reference to the provider templated slots available vs utilized.
3) In reference to the total number of hours a provider was template to work in a given area.

As a direct result of this report, the UAMS Service Line Administrative team directed that each Service Line review the template utilization to ensure clinics were in compliance with a given threshold. With this directive, the Cancer SL began ranking the areas identified to have the lowest template utilization rates for a deep dive exploration. From here, we formulated our approach and developed metrics which were felt to evaluate the opportunities for improvement in the utilization metrics being scrutinized. While the project is iterative, the hope for the future is to move from a constant process of evaluation to more of a process of evaluating outliers.

Methods

In reviewing the process for evaluating our primary areas of concern, I formulated a plan which included specific steps for the project. Many of these steps are considered iterative for each provider template and clinic area and are noted as "Ongoing" in the status. The overall review will remain in progress as we continue to review all of our clinic schedule templates. See Figure 1:

As this project began, an initial stakeholder meeting was hosted with the Service Line Medical Director,

Project Management Dashboard

Project Name:	**MSIQ Graduate Project** **Data Quality and Information Reporting Challenges after Implementation of a new Electronic Health Record System in the Outpatient Hospital Setting**
Project Manager:	**Anne Marie Morse, BBA**
Report Date	3/5/2017
Project Status	**On track**
Completed	75%

Task Table

Tasks	Start	End	Days	Status
Set kick-off meeting with Stakeholders	8/15	8/19	4	Complete
Review of Objectives and Anticipated Outcome	8/22	8/26	4	Complete
Organize multi-faceted team meetings to review templates	8/22	8/26	4	Complete
Review of provider templates and utilization reports for areas of improvement	8/22	10/31	70	In progress
Identify Schedule Templates to use for POC	8/22	8/26	4	Complete
Implement Schedule Template changes for POC	8/26	8/31	5	Complete
Meet with providers one on one to review templates and request feedback	9/5	11/30	86	Ongoing
Review findings and develop recommendations	9/5	11/30	86	Ongoing
Evaluate POC Template for Utilization Metric improvement	10/1	10/5	4	Ongoing
Meet with key stakeholders to review recommendations for operationalizing	10/1	10/31	30	In progress
Begin work through the approval process of governing entities	10/1	10/31	30	Ongoing
Submit final documents for entry into Epic as evaluations are completed	11/1	1/1	61	Ongoing
Monitor reports for indicators of changes implemented	12/1	3/31	120	Ongoing
Submit First Draft Report for Approval; Schedule Oral Defense	3/20	3/31	11	Not started
Finish Final Project Report	4/1	4/30	29	Not started
Oral Defense	5/1	5/15	14	Not started

Figure 1: Project Management Dashboard

Administrator, Nursing Director, and Clinic Manager. The project goals were discussed and agreed upon along with discussion of past history to ensure an understanding of the issues. This group articulated several past attempts at resolving template issues which fell flat of the expected outcome. As this meeting concluded, the team felt confident in the plan and expressed excitement to see the issues brought to a successful resolution in the coming months.

Next, a multi-disciplinary team was brought together for weekly meetings in an effort to provide a forum for open communication. These meetings included staff from all parts of clinic activities including new patient scheduling, access (front desk) staff, nursing, the medical director, billing and several administrative team members. These meetings continue to be used to encourage discussion of concerns including scheduling issues (new patients and return patients), provider template issues, documentation requirements issues, overall clinic flow and more. While there is no formal agenda, this meeting frequently utilizes the entire hour plus some as the conversation leads. With these teams in place, our focus transitioned to the data.

Data Collection and Initial Evaluation

In the early phase of the project, I began pulling historical views of the UAMS Clinic Activity Summary report to extract a 13 month view of the data. It was felt this would give us a large enough snapshot to normalize the data being reviewed and allow for trending. This report can be ran utilizing specific date parameters, however the information is cumulative based on the requested timeframe. This report compiles the utilization information from several different angles (Appointments, Slots and Hours). See Figure 2:

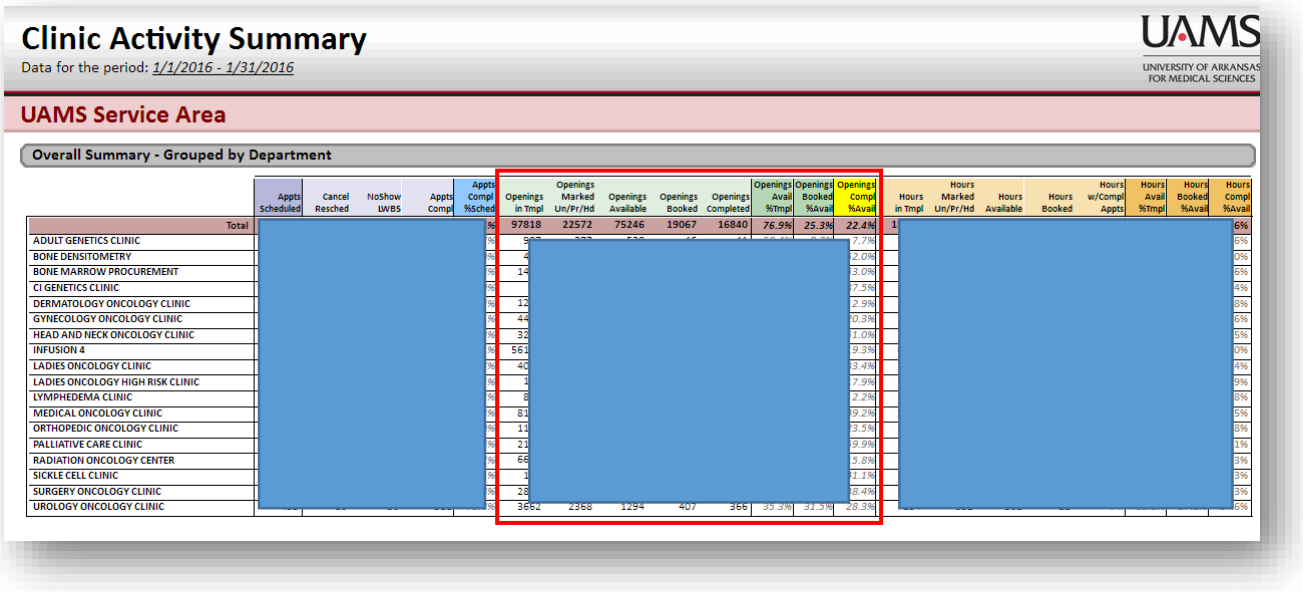


Figure 2 - UAMS Clinic Activity Summary Report for all Cancer SL Clinics – This graphic displays the original Summary Report being presented by clinical area. Across the top are the metrics which are being evaluated with those in the red box being the utilization metrics. These metrics are comparing the provider schedule template to the number of template slots which result in a completed patient visit.

For the purposes of this project, it was decided that the view which evaluated the utilization of template slots provided the data in its most usable form for reference. This subset is highlighted by the red box in Figure 2. In evaluating this initial picture of data, our team decided to focus on the non-procedure based clinics due to the complex nature of procedure based clinics. The non-procedure clinics include Adult Genetics, CI Genetics, Dermatology Oncology, Gynecology Oncology, Head and Neck Oncology, Ladies Oncology, Medical Oncology, Orthopedic Oncology, Palliative Care, Sickle Cell, Surgical Oncology, and Urology Oncology. The procedure based clinics would be evaluated in a separate process in the future.

Due to the standardized format of this report, the comparative view had to be manually extracted into Microsoft Excel for evaluation and graphical depiction. The data was captured beginning January 2016 ending with January 2017. To make the illustration easier to interpret, we separated our medical based clinics from the surgical based clinics and we chose to set a threshold of 65% – 85% utilization as depicted by the dotted red lines. This threshold was chosen by the Cancer SL as it was felt this was an attainable goal to start. Our long term goal is to be at or above 85%. This resulted in the graphical illustration in Figure 3a & b which groups the clinics by Medical vs Surgical clinics:

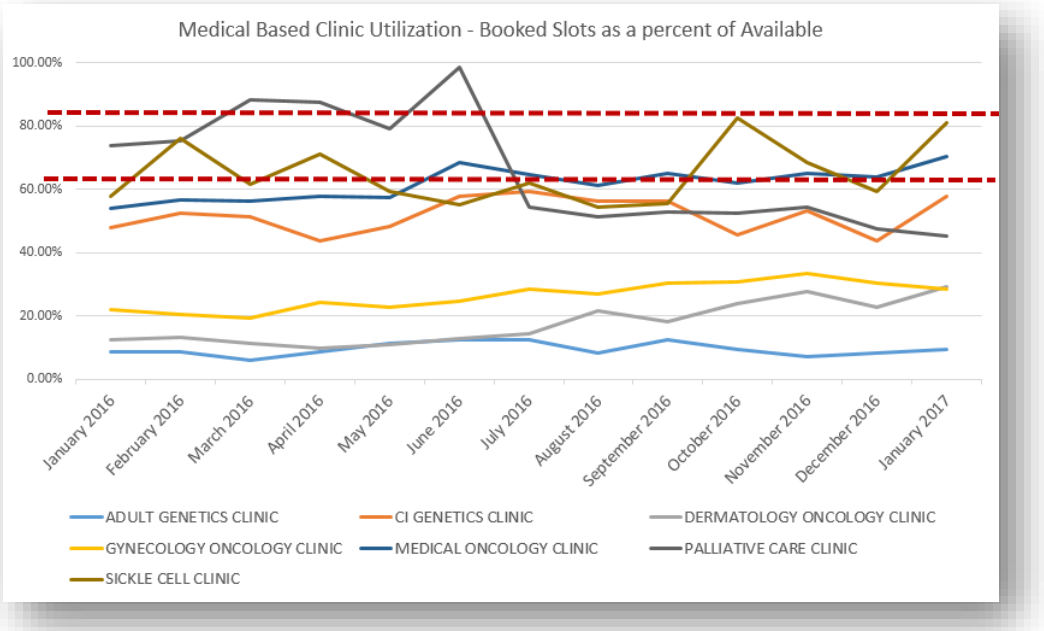


Figure 3a - Clinic Utilization graphs grouped by Medical or Surgical Clinic Type – This graphic displays the original utilization metrics as reported and evaluated by UAMS Service Line Administration. This graph demonstrates the threshold utilizing the dotted red lines. As you will notice, the majority of clinics represented are under the minimum threshold.

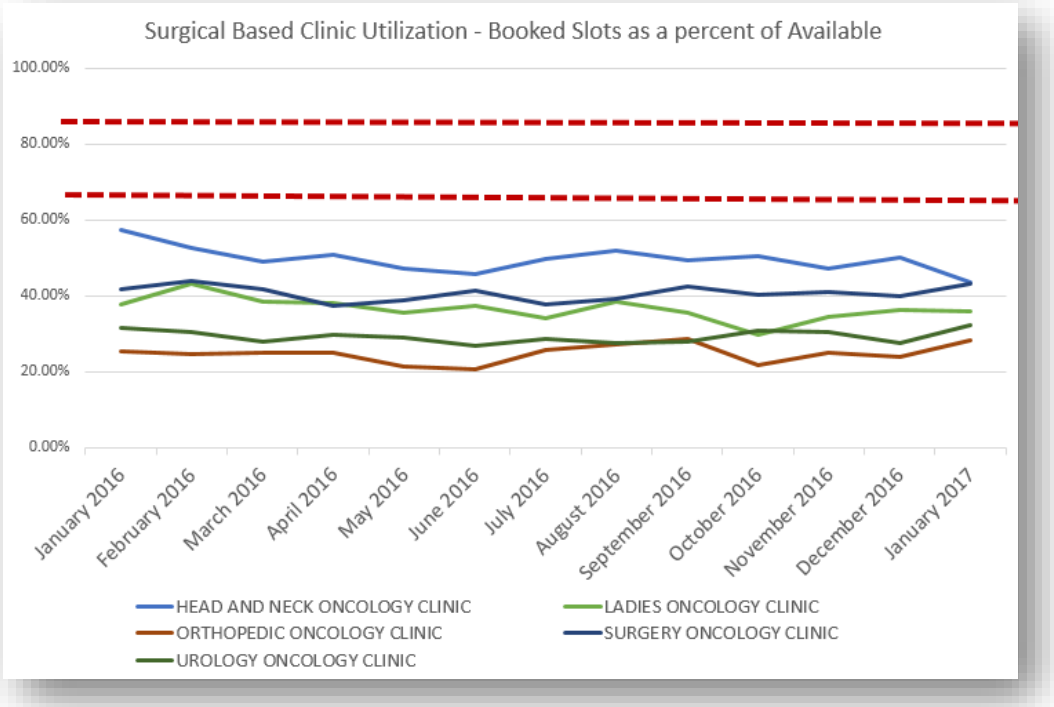


Figure 4b - Clinic Utilization graphs grouped by Medical or Surgical Clinic Type – This graphic is the same as Figure 3a, but represents the Surgical Clinics exclusively. Once again, these clinics are grossly under the required threshold.

During our weekly Clinic Scheduling Workgroup meeting, we reviewed this information for comparison to the initial impressions of the staff. This visual was met with great concern of the believability of the data evaluated. The staff voiced concerns with the picture of considerably low utilization in comparison to their day to day woes of staffing demands and reported increase in completed appointment volumes. Staff were routinely seeing a large amount of overbook and out of template patients scheduled along with clinic end times regularly extending past 5pm in some areas. This initial reaction to the data clearly gave an indication supporting the need to evaluate the accuracy of the data. In reviewing the clinic volumes, the staff reactions were fully supported as their volumes continue to depict growth as seen in the Fiscal Year volume comparison chart (See Figure 4).

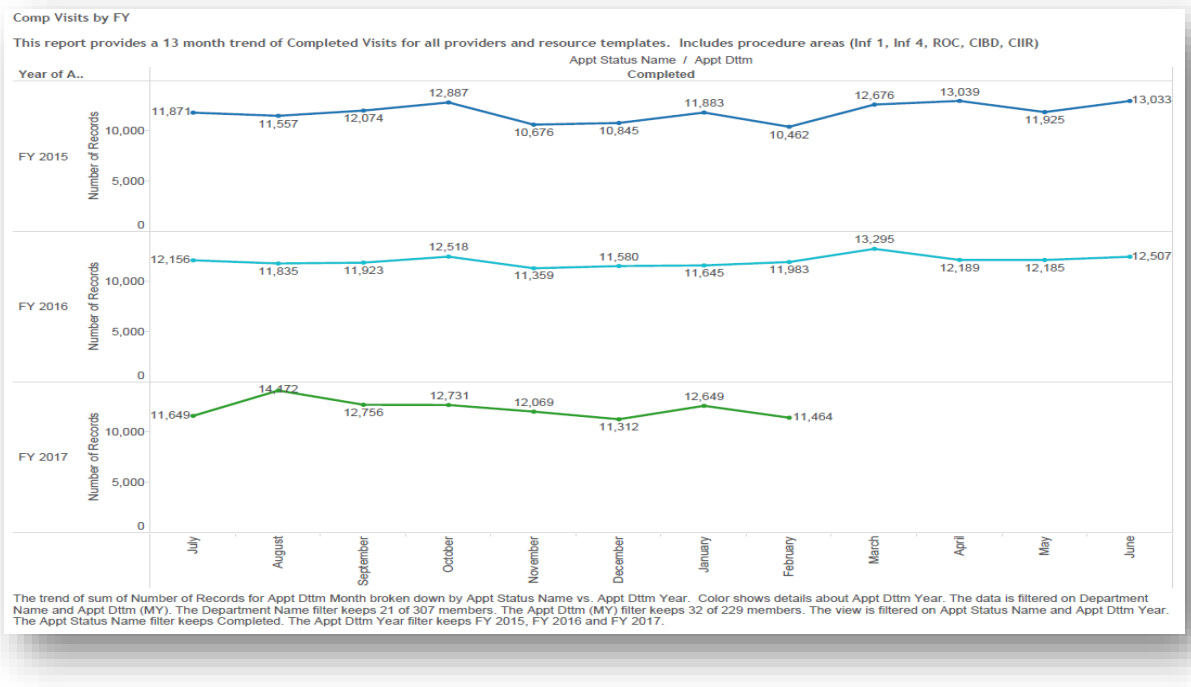


Figure 5 - Cancer SL Completed Visit Volumes by Fiscal Year

Data Quality Assessment

To begin a deeper look into the Data Quality required that I meet with the report writer to gain a better understanding of his data extraction process. According to Dr. Richard Wang in his paper, "Dimensions of Data Quality: Toward Quality Data by Design", he describes several attributes by which Data Quality is defined. For the purposes of this project, my assessment took into consideration the following dimensions:

1) Data Relevancy as defined as whether the data user feels the data is applicable and helpful to the problem or situation at hand.
2) Data Interpretability is considered to be an issue when data is coded or formatted for a specific task, yet other users of the data lack the expertise required to interpret this code or format.
3) Believability is the extent to which the data is considered true and creditable

(Lee, Pipino, Funk, & Wang, 2006).

1. DATA RELEVANCY

The Epic EMR system is built on a platform of a relational database structured by over 15,000 data tables. Epic creates a form of a data subset called Clarity which is an application that extracts data from Chronicles. Chronicles is the complete database management system within Epic. Clarity extracts and stores specific data on a dedicated analytical reporting server in a relational format (Epic, 2017). Each module within Epic Clarity has separate tables which are joined utilizing foreign keys to make the data accessible for the entire patient experience. Using the Epic Data Dictionary, our report writer was able to evaluate the tables needed for the information requested.

During our assessment, we reviewed the source tables along with the joins created and the methodologies used to blend this data. The primary source table for this information is the Appointment table. This table contains 80+ attributes in various forms including numeric, DateTime, Varchar, and more. A unique identifier is used as the Primary Key along with foreign keys for hundreds of tables to support interoperability. Care was taken to join and extract the specific fields needed to prevent a duplication of patient encounters. One patient can have many encounters throughout the course of care and treatment with some occurring the same day. Due to this, several additional tables were also sourced to capture the complete picture of each patient encounter to be measured.

As the data was explored, we discussed the data definitions provided within the Data Dictionary. Through this process, we looked specifically at the exclusion criteria to ensure understanding of the information being removed. Due to the complex nature of healthcare data, we focused on capturing the right fields from the right table to ensure the relevancy of the data. An example of a Data Dictionary is provided in Figure 5.

Table	Field	Datatype	Description
PATIENT			Include patients who had surgery that meet inclusion CPT,SNOMED, or ICD-9 criteria between 1/1/2007 and 1/30/2009
PATIENT	DOB	Date	The birthdate for the patient
PATIENT	PATIENT_ID	Integer	A unique ID for the patient
PATIENT	DATA_SOURCE_ID	Varchar(10)	An identifier for the source of the patient record data (UU, IHC, DH for example)
DIAGNOSIS			Include ICD-9 CM discharge codes within one month of surgery. A list of included codes is in table 2 of Stevenson et al. AJIC vol 36(3) 155-164.
DIAGNOSIS	DIAGNOSIS_ID	Integer	A unique ID for the diagnosis
DIAGNOSIS	DIAGNOSIS_CODE	Varchar(64)	The code for the patient's diagnosis
DIAGNOSIS	DIAGNOSIS_CODE_SOURCE	Varchar(64)	The nomenclature that the diagnosis code is taken from (ICD9, etc.)
DIAGNOSIS	CLINICAL_DTM	Date	The date and time of the diagnosis's onset or exacerbation

Figure 5 - Example of a Data Dictionary (USDHHS Agency for Healthcare Research and Quality, 2012)

Because we are specifically looking at the template based calculations, we focused on the metrics for each of these as noted below:

1) **Openings in Template** – Total count of the regularly scheduled template slots per the given timeframe. For example, if a provider is in clinic one half day per week and uses 20 min template slots for those 4 hours, this would equal 12 template slots per week.

2) **Openings Marked Unavailable / Private / Held** – Total count of all regularly scheduled template slots that were marked as unavailable / private / held in the given timeframe. If a provider takes vacation hours for a regularly scheduled clinic, those slots are marked as Unavailable time.
3) **Openings Available** – Total openings in Template – the Openings marked as Unavailable / Private / Held = Openings Available
4) **Openings Booked** – Total count of the available regularly scheduled template slots which had a patient appointment booked as of midnight the night before the appointment date.
5) **Openings Completed** – Total count of the openings booked which resulted in a Completed Patient Encounter.
6) **Openings Available as a percent of Template Openings** – Openings Available / Openings in Template
7) **Openings Booked as a percent of Available Openings** – Openings Booked / Openings Available
8) **Openings Completed as a percent of Available Openings** – Openings Completed / Openings Available

2. Data Interpretability

The report referenced for this project has been validated for correctness per standard IT report development procedures. However, the perspective by which the report is interpreted leads to concerns of its usefulness for specific situations. The format of the particular roll up report by clinic and service line leaves itself open to the appearance that clinics are performing at a grossly low utilization rate. This appearance can quickly lend itself to alarm if not understood what all templates are included in this roll up. In fact, if the templates are evaluated at the level of the majority of appointments, the clinics are operating at a majority above 65%. Our highest volume clinics frequently exceed an 85% utilization rate as their providers understand the importance of getting patients seen in a timely manner for both diagnosis and treatment.

In reviewing these questions with the report writer, it was found the resource templates did not have a unique identifier which could be queried to denote whether or not the resource was used as a primary source for scheduling. While some clinics utilize resource templates as a primary schedule, the majority of clinics simply had resource templates in place to capture those patients who simply needed to see a nurse for a wound check or other nursing related needs. Those templates were designed to be utilized on an as needed basis and were never expected to be filled in regular clinic operations. This resulted in all resource templates being counted in the denominator and providing a sense of clinic underutilization in the roll up calculations. These conflicting illustrations are clearly seen in a comparison of Figures 3 and 6.

3. Data Believability

Throughout these efforts, believability was an early indicator of concern as noted by our clinical staff. In review of the preliminary reports, staff stated they did not feel the data represented the day to day workings of the clinics reported. As the conversation continued with the report writer, we discussed what templates were included in the roll up scores per department / clinic as well as into the Service Line calculations.

Within Epic, schedule templates can be created for providers or resources within an organization. Throughout the outpatient clinics, there are a variety of methodologies used with some areas scheduling primarily to providers, others primarily to resources, and some who utilize both types of templates. At the recommendation of the Epic Technical Services team, it was decided at go live for each clinic area to have a resource schedule opened for nurse only visits.

While this recommendation makes sense in a fully optimized setting, we are still early in the optimization phase of our implementation. To validate these concerns, I reviewed each group of clinic templates to better understand where the bulk of available template slots were coming from. In some clinics, over 50%

of the available template slots were residing in the resource template. On further review, these templates have a <1% utilization rate in the same clinics.

Results

With these findings, I decided to re-run the 13 month trending comparison of Booked Slots as a percent of Available for only the Physician providers in each clinic. The differences from Figure 3a & b to Figure 6a & b are remarkable. Three of our medical clinics report greater than 85% utilization over two or more months. In review of our surgical clinics, the original report showed all clinics with <60% utilization. In an exclusive review of the physician providers, all surgical clinics are at or above the 65% threshold for the majority of reporting months.

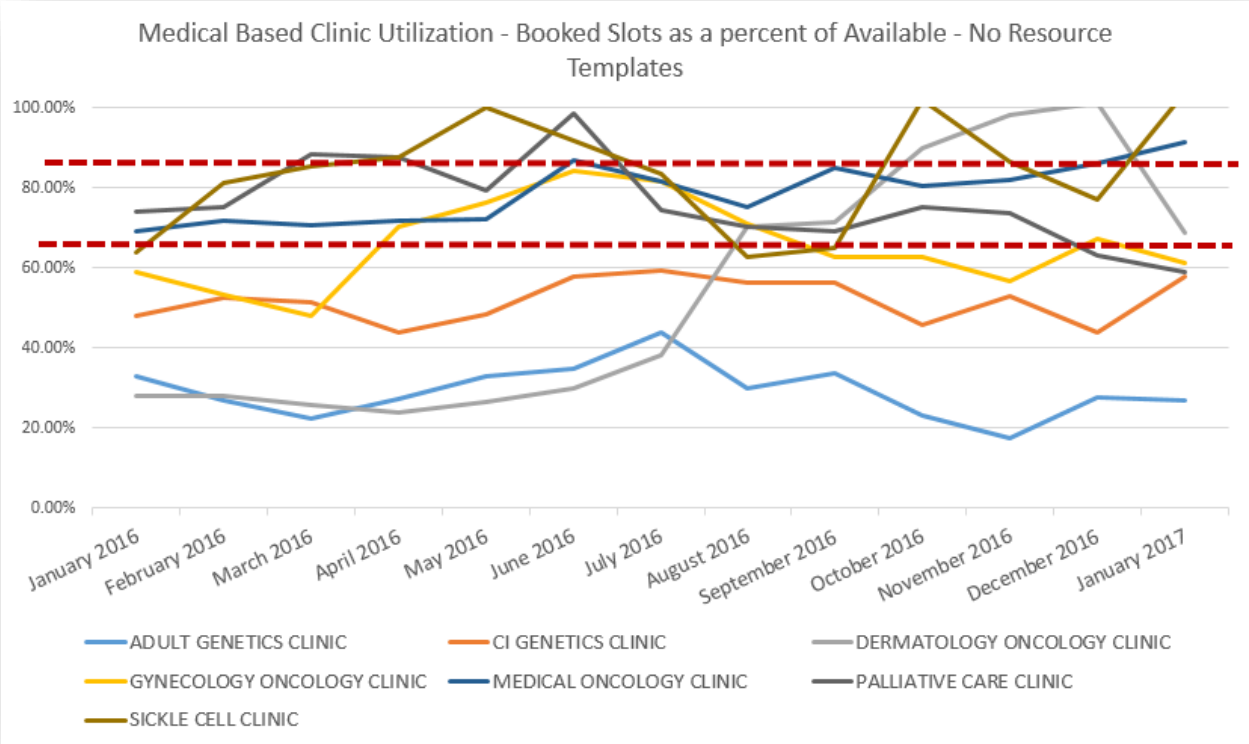


Figure 6a Booked Slots as a percent of Available - Physician templates only – In contrast to Figure 3a, when evaluating our Physician providers exclusively, the majority are within the threshold with 3 clinical areas regularly exceeding the threshold.

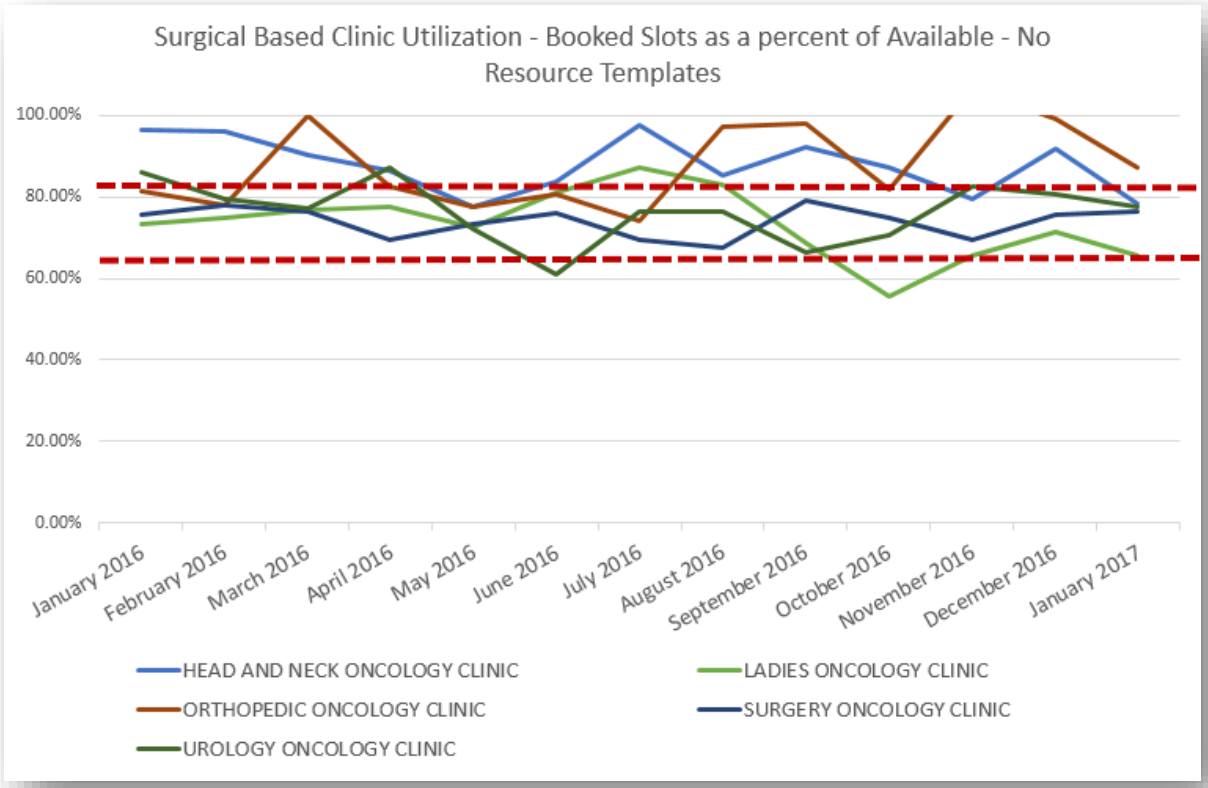


Figure 6b - Booked Slots as a percent of Available - Physician templates only – This graphic is exclusive to our Surgical Clinics and once again shows an impressive improvement in the schedule utilization when evaluating the Physician Providers only.

In review of the differences, the 13 month trending comparison was impressive. However even more visually significant was the review of the 13 month average differences between utilization rates with and without resource templates. As pictured in Figure 7, the majority of clinics showed at least a 30% or greater improvement in their utilization rates with the Orthopedic Oncology clinic showing the most notable change in a 63% difference. In reviewing this clinic in particular, they were found to have 2 providers with an average of 240 templated slots available per month. However the resource template was found to have an average of 680 template slots available per month. By removing the resource slots, the utilization rate for Total Openings booked of available improved from approximately 17% to over 80% (Figures 7 & 8).

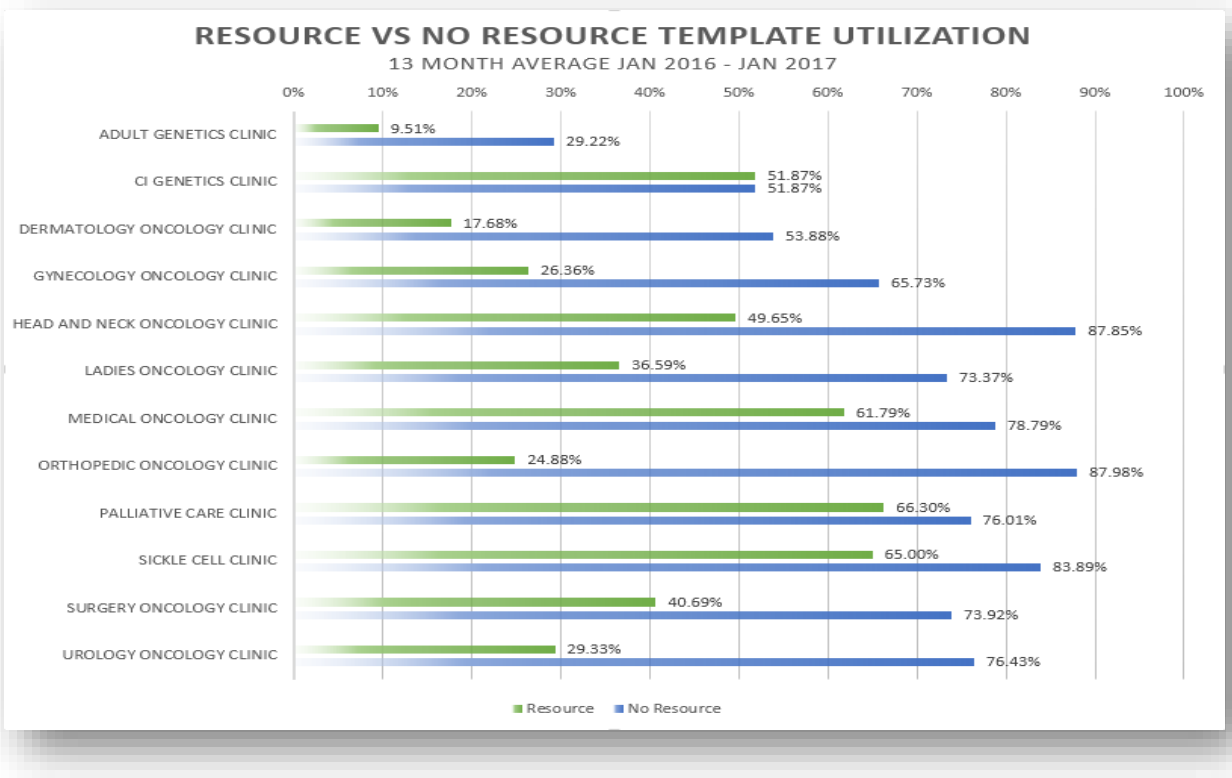


Figure 7 - Resource vs No Resource comparison – This graphic displays the change noted from the original report which included the Resource Templates vs those which excluded the Resource Templates and only represented the Physician providers.

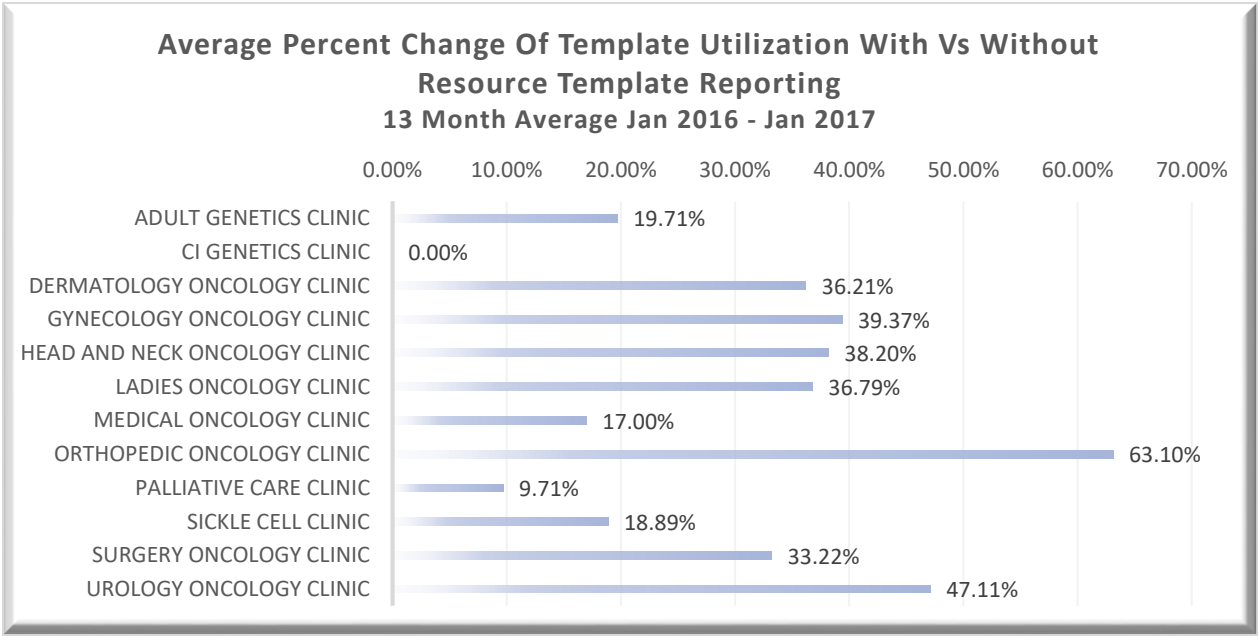


Figure 8 - Average percent change

For those clinics which utilize the resource templates as their primary scheduling modules, we will develop specific metrics to ensure an appropriate utilization rate. These efforts will be pushed in the next phase of review.

Discussion

Throughout this report, the focus has been to identify areas of opportunity in regards to scheduling practices within the Cancer Service Line. These efforts were focused on maintaining truth in scheduling, decreasing scheduling restrictions and decreasing appointment types. Each of these were in effort to improve access for our patients to our providers in a timelier manner.

As a part of our research, we reviewed the available reports and found an opportunity to better interpret the data based on removing the resource templates from the calculation. For most clinics, the improvement was remarkable with greater than 30% over the reported utilization rate. By removing the resources, the calculation was found to provide a more accurate depiction of the day to day clinical operations occurring within our clinics. These calculations were met with favorable support of their findings as they better reflected the sentiments of the staff in each clinic. The updated calculation helped to more clearly identify areas which potentially could benefit from additional provider and/or support staffing. This coupled with evaluating providers templates to identify utilization of regular vs overbook vs out of template scheduling painted a picture which had previously been more challenging to ascertain.

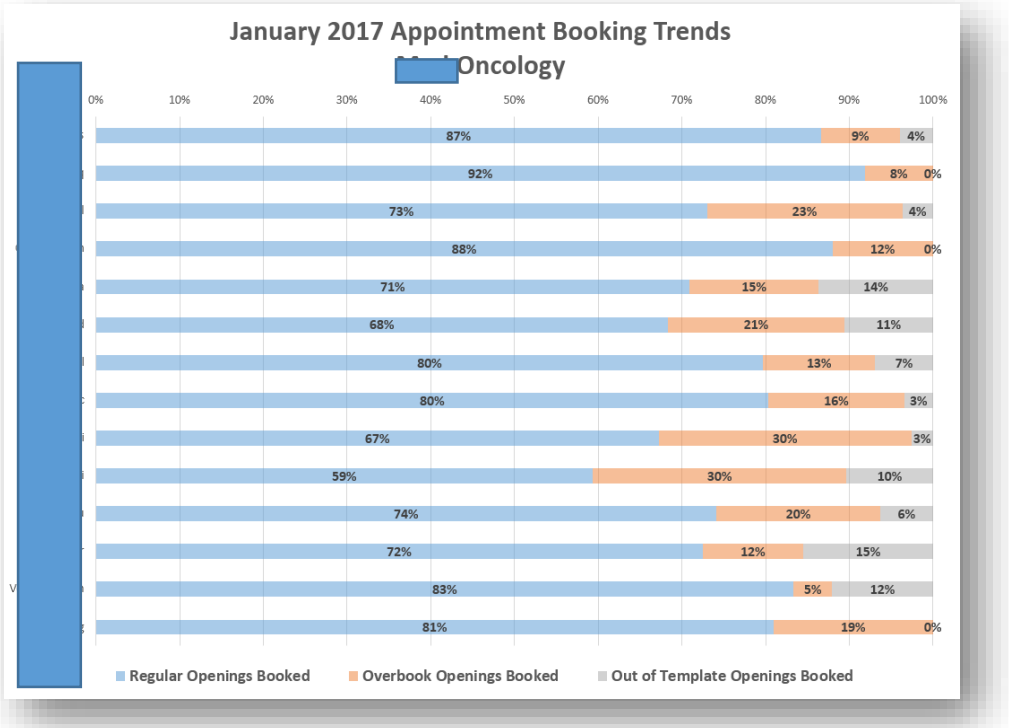
Future Directions

After review of the updated utilization reports, the next steps are to take the provider templates and to perform a one on one review with each provider. The providers were asked a series of 4 questions:

1) Does your regularly scheduled clinic finish on time?
2) Does a patient visit regularly run longer than their scheduled time?
3) What pain points do you notice through your clinic day?
4) How much time do you want your new patient visit types to be allotted vs follow ups? How many new / return / overbook patients do you want to see in a ½ day?

During this discussion, a random sampling of the provider's clinic days are reviewed to evaluate their template utilization (Figure 9). For these purposes, we are reviewing their utilization of regularly scheduled appointments in comparison to overbook and out of template appointments. The sampling was taken during the months of May 2016 and January 2017. We are looking for high overbook or out of template scheduling as this may indicate the need for changes in the template including the addition of clinic hours, a mid-level provider, additional support staff, etc.

The initial provider meetings occurred between March and July 2016 with schedule change recommendations being implemented between July and September 2016. The initial review of this data is focused on the utilization of overbook and out of template schedule slots. Future meetings will be scheduled on an annual basis to ensure the templates still reflect a realistic picture. While this information is still under review, the process to improve these booking trends are still undecided.



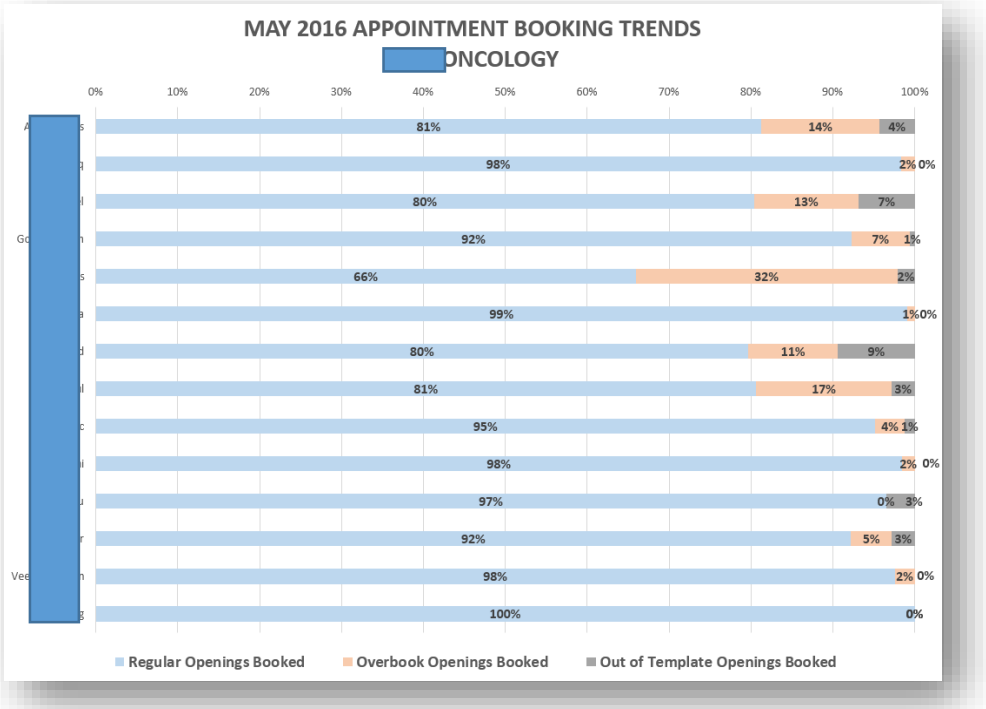


Figure 9 - Appointment Booking Trends by Provider – As the evaluation of provider templates continues, the above graphics help administrators to identify providers who are potentially in need of additional clinic hours / days or additional mid-level support staff such as Advanced Practice Registered Nurses or Physician Assistants to help manage their patient volumes.

Conclusion

As of this report, the processes discussed are ongoing along with further fine tuning of the plan of action. While the project deliverables are not complete, they are clearly outlined with articulated goals and a strong workgroup to continue driving the process. With any project of this magnitude, there are constant opportunities to improve processes on all fronts throughout the patient experience. Our focus for this iteration has been to identify those systemic issues which are preventing patient access and to develop a clear plan for ongoing monitoring and thresholds for actions. For a system to be able to report out accurately, it must be reflective of the day to day workings of the areas which it represents. Our efforts have brought this need to light and a recognition of its value. The administrative report referenced within is currently undergoing updates by our Informatics team to address the concerns and improve on the utilization metric.

It is clear that the teams of people working in the Cancer Service Line have the patient as their center of focus. Our efforts have been recognized by upper administrative staff taking the time out of their schedules to attend our workgroup meetings. Their comments have been reaffirming of our actions throughout this process and I am excited to see the continued progress of these efforts.

References

Advisory Board. (2017). *About Us*. Retrieved from Advisory Board: https://www.advisory.com/about-us

Caldwell, E. (2014, May 9). *UAMS Journal*. Retrieved from Service Lines: Restructuring Healthcare Delivery: http://journal.uams.edu/article/service-lines-restructuring-health-care-delivery/

Epic. (2017, January 31). *Epic Glossary*. Retrieved from Epic Userweb: https://galaxy.epic.com/?#Browse/page=1!130!540!999999,3119206,3118786

Gamble, K. (2016, May 25). *Health System CIO.com*. Retrieved from http://healthsystemcio.com/2016/05/25/rhonda-jorden-vice-chancellor-cio-uams-chapter-1/

Institute for Healthcare Improvement. (2017). *About Us*. Retrieved from Institute for Healthcare Improvement: http://www.ihi.org/about/Pages/default.aspx

Lane, C. (2017, April 11). Associate Vice Chancellor for Academic Research & Enterprise Systems. (A. M. Morse, Interviewer)

Lee, Y. W., Pipino, L. L., Funk, J. D., & Wang, R. Y. (2006). *Journey to Data Q!uality*. Cambridge: Massachusetts Institute of Technology.

Monegain, B. (2015, February 26). *Data Warehousing*. Retrieved from Healthcare IT News: http://www.healthcareitnews.com/news/what-does-intersystems-cach%C3%A9-have-do-epic

Peckham, C. (2016, August 25). *Medscape EHR Report 2016*. Retrieved from Medscape: http://www.medscape.com/features/slideshow/public/ehr2016#page=5

SearchHealthIT. (2016). *Epic Systems Corp*. Retrieved from SearchHealthIT: http://searchhealthit.techtarget.com/definition/Epic-Systems-Corp

USDHHS Agency for Healthcare Research and Quality. (2012, December). *US Department of Health & Human Services Agency for Healthcare Research and Quality*. Retrieved from Improving the Measurement of Surgical Site Infection Risk Stratification / Outcome Detection: https://www.ahrq.gov/research/findings/final-reports/ssi/ssiapc.html