Six Sigma Lean Methodologies to Improve Efficiency and Reduce Patient Time in Clinic in an Occupational Health Clinic

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The DNP Project committee for Kiersten Camp certifies that this is the approved version of the following DNP Project:

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Abstract

Cost effective, quality, error-free medical care is essential to positive health outcomes. The healthcare system has historically had difficulty with application of quality improvement processes because of the complex processes and systems and the transactional nature of the business. *To Err is Human* shed light on the disparities in health care delivery and quality of care issues (Institute of Medicine, 1999). In addition, the Affordable Care Act in 2010 has challenged the healthcare system to provide quality care in an efficient manner and reduce waste to gain the most financial benefit (US Department of Health and Human Services, 2012). Like other facets of healthcare, the occupational health clinic is attempting to provide quality, cost effective care in an attempt to minimize lost productivity and save money for the company.

One way the healthcare system has responded is by the application of Lean Six Sigma principles borrowed from the manufacturing world. Lean Six Sigma provides a structured method of approaching quality improvement along with tools for sustainability by focusing on waste reduction and reduction of process variation (Koning, 2009).

This project utilized the Six Sigma quality improvement process to create baseline metrics of existing processes within the occupational health clinic, collect real-time operational data and analyze ways to improve efficiency and decrease patient time in clinic. Through this process, it was determined that the greatest impact on patient time in clinic resulted from three primary variables: Issues with clinic flow, lack of appropriate standing orders for the nursing staff and inefficiencies with the scheduling process in the clinic. Through control of these variables, the clinic was able to identify process improvements to improve efficiency and quality and reduce costs.

Table of Contents

Six Sigma Lean Methodologies to Improve Efficiency and Reduce Patient Time in Clinic in an Occupational Health Clinic

Introduction

Quality and efficiency are the pillars of all good business practice. Healthcare is no exception to that rule. However, the complex healthcare environment sometimes complicates the practice of running an efficient business. In addition to the complexity of the healthcare landscape, facilities, like other businesses, are being tasked to provide high quality care with fewer resources. Because of that, running a highly efficient practice is essential to meeting customer needs.

Textron Aviation is the leading manufacturer of general aviation aircraft, accounting for more than half of all general aviation aircraft flying. It includes the Cessna, Beechcraft and Hawker brands that came together under Textron, Inc. in 2014. Textron Aviation is a global company with 11,000 domestic employees headquartered in Wichita, Kansas. There are approximately 9000 employees working at the facilities in the Wichita area. Textron Aviation has four onsite occupational health clinics averaging approximately 300 patient encounters per week at the busiest clinic, compared to approximately 40 encounters per week per clinic at the remaining three clinics. Staffing for the clinics includes four full-time nurses, one advanced practice nurse, one contract physician, the manager of health services and a data specialist. The staff supports not only the four-onsite clinics in Wichita, but also an onsite clinic in Independence, Kansas; and provides telephonic support to over twenty outlying service center locations across the country. As a support role in a manufacturing environment, clinic staff has been tasked to provide exceptional quality care in a timely manner to maximize productivity of the employees building the aircraft.

Textron's acquisition of Beechcraft in 2014 brought with it the challenges of integrating two medical software systems, different clinic processes, standard practices and combining employee cultures. While great strides have been made to integrate company forms and processes, clinic flow continues to be problematic for a variety of reasons, including space constraints, training issues and workload that are impacting patient time in clinic and nurse burnout. This has necessitated the need for a process to improve clinic efficiency and maximum productivity.

Healthcare has historically relied on more traditional methods of quality improvement including Donabedian's framework of Structure, Process and Outcome to evaluate the interdependence of processes and quality measures (Donabedian, 1966). It was not until 2003 that Lean Six Sigma, a proven quality improvement method utilized for years in the manufacturing world, was introduced in healthcare (Six Sigma and Healthcare, 2016). Lean Six Sigma focuses on waste reduction to improve cost, efficiency and process flow utilizing standardized tools and methods to focus on those processes that are critical to satisfaction and quality (Koning, 2009).

Project Purpose

This project aims to utilize the principles of Six Sigma for the following purpose:

- To create baseline metrics of existing clinic processes;
- To collect operational data and analyze ways to improve clinic efficiencies and decrease patient time in clinic; and
- To implement controls for sustainability.

The initiative will be funded solely by Textron Aviation and will focus only on the largest onsite clinic in Wichita, Kansas, in order to facilitate the greatest impact and understand generalizability to other locations and operations. Following the literature review, the Six Sigma

DMAIC (Define, Measure, Analyze, Improve and Control) process will be utilized to collect and measure clinic data, implement a solution to the issues of efficiency in the clinic and analyze the outcomes. Once the outcomes have been identified, a long-term sustainability plan will be put into action.

Literature Review and Principles of Six Sigma

There are many continuous improvement strategies utilized in healthcare. Six Sigma is one of the more recent additions to that arsenal. This literature review aims to describe the principles of Lean Six Sigma and it roots in continuous improvement. It also serves as a review of the link between Six Sigma and healthcare as a quality improvement strategy and how it can be applied in an occupational health setting. The project will consist of a literature review searching PubMed and CINAHL for keywords or combination of keywords, including Six Sigma, healthcare quality improvement, occupational clinic and quality, continuous improvement, clinic efficiency, productivity, and lean.

Six Sigma has deep roots in Japanese manufacturing culture to improve quality (James, 2005). It is based on Deming's management theory that stresses variation reduction by building quality into processes and thereby reducing associated costs. It is rooted in statistical analysis and strong management commitment to process improvement (James, 2005). The term Sigma is a representation of the standard deviation within a process, which is the measure of variation within that process. Therefore, operating at Six Sigma means that 99.999% of the process outputs fall within a certain range of specifications. The higher the sigma value, the more efficient the process is.

Six Sigma as a business principle was coined in the mid-1980's by Motorola (Pande, Neuman, & Cavanagh, 2000). The company was under pressure to provide better performance to compete with the Japanese manufacturers during that time. With financial and quality issues looming, the Chief Executive Officer (CEO) of Motorola implemented Six Sigma to track performance and compare it to customer requirements while aiming for the target of perfect efficiency (Pande, Neuman, & Cavanagh, 2000). Following the turnaround of Motorola, other businesses quickly adopted the principles of this quality management system.

There are six generalized themes that drive the basics of the system: customer focus, data-driven management, process capability and improvement, proactive management, collaboration, and drive for perfection with a tolerance for failure. There is an intense customer focus in Six Sigma. It is a requirement to understand both the customer's requirements and expectations. Without this, there is no way to measure true success. Those customer expectations and requirements are then grounded in data. Decisions are made, and business performance measured, based on the available data, rather than on assumptions and opinions. The idea is to maximize the data to the benefit of the processes and organization.

The process is the medium for success. The more efficient and capable the processes, the better the competitive advantage, the lower the cost and the less number of errors, thereby boosting business performance. Proactive management requires ambitious goal setting, frequent process review and questioning all norms. This leads to collaboration and an understanding of how a process or role leads to the bigger performance of the overall organization. Finally, the organization that implements the principles of Six Sigma strives for perfection, but the leaders of the initiative understand that failures may occur and are ready to course correct when necessary. Innovation involves risk and with risk sometimes comes failure (Pande, Neuman, & Cavanagh, 2000). At Textron Aviation, a three-circle approach for continuous improvement is utilized, capitalizing on the six previously discussed principles of Six Sigma (Figure 1).

Three-Circle Approach for Continuous Improvement

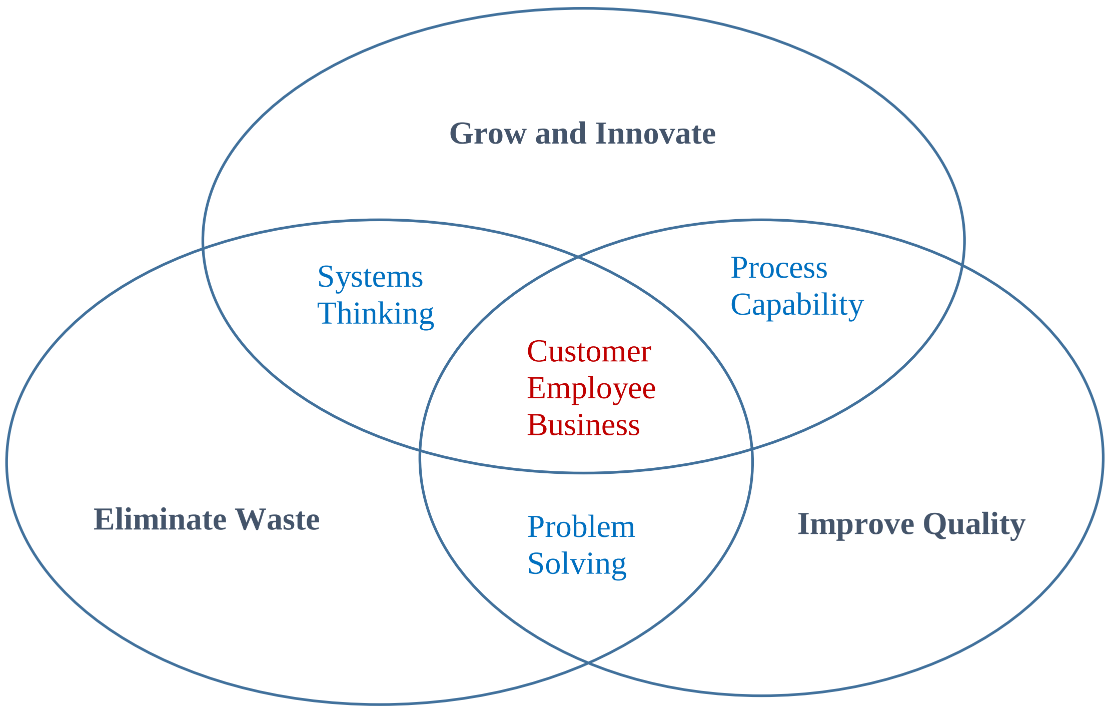


Figure 1. Textron Six Sigma, 2015

Lean is the concept of reducing waste, inefficiencies and cost in any process, essentially removing all non-value-added pieces from the process. This ensures the right product, at the right time, meeting customer requirements. Six Sigma focuses on reducing the variation in processes and minimizing defects using statistical analysis. When the two are used together it is referred to as Lean Six Sigma (LSS). Lean Six Sigma seeks to merge the best qualities of both methodologies thereby producing the most efficient results (Lean Process Six Sigma and Manufacturing, 2016). The LSS framework combines the two process improvement methodologies by following five distinct steps: Define, Measure, Analyze, Improve, and Control (DMAIC). Each phase of the DMAIC process has a set of tools and deliverables, allowing for a common, structured approach to problem solving and process improvement (McCarty, Daniels, Bremer, & Gupta, 2005) (Figure 2).

- Define: Develop a problem statement for the process to be improved and establish scope of focus areas.
- Measure: Identify what needs to be measured and collect the data. Team determines how the current process is performing compared to the requirements.
- Analyze: Uses the collected data to determine failure modes in the process. Identify causes to the problem and develop a hypothesis.
- Improve: Find and implement a solution to the causes.
- Control: Document the solution and new process for long-term sustainability.

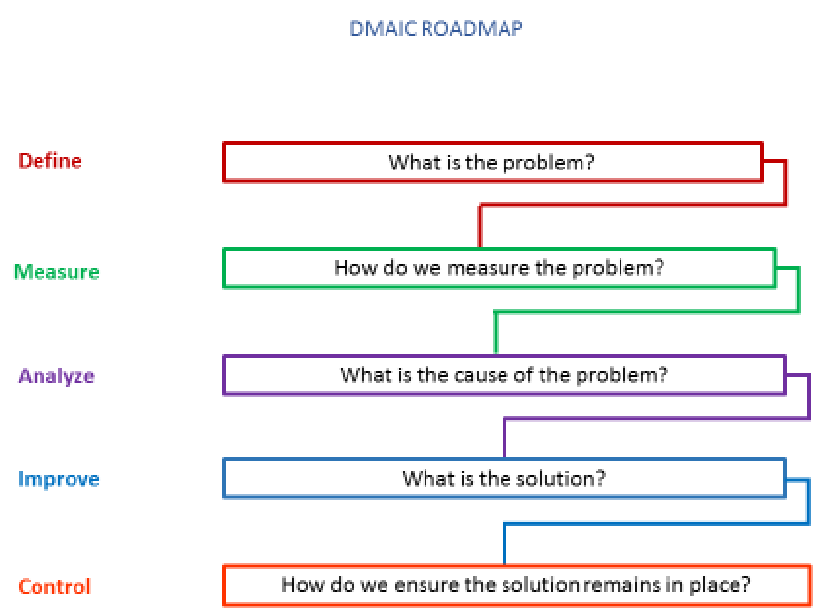


Figure 2: Textron Six Sigma, 2015

Six Sigma and Healthcare

While the healthcare industry differs greatly from the manufacturing world, there are still some similarities. Both rely on complex processes to meet their business goals and meet their customers' needs. However, the healthcare industry has been slow to adopt quality improvement strategies like Six Sigma. The complexity of the healthcare environment, coupled with the human interaction and transactional nature have made it difficult to translate the manufacturing principles to the healthcare system (Carrigan & Kujawa, 2006). Over time, however, the healthcare industry has learned that by adopting the principles of Lean Six Sigma, members of the system can eliminate non-value-added activities, remain competitive, reduce errors and take care of patients in an efficient, cost effective manner (Sperl, Ptacek, & Trewn, 2013). Lean Six Sigma's focus on world-class processes can help healthcare facilities improve quality, patient safety and access to care.

A variety of healthcare settings have utilized these tools to improve the performance of their practices and enhance patient care. Surgical settings have utilized Lean Six Sigma to address issues with cost and length of stay (Mason, Nicolay, & Darzi, 2015; Toledo, Carroll, Arnold, Tulu, Caffey, Kearns, & Gerber, 2013). Emergency rooms have used the continuous improvement strategy to have a positive impact on patient satisfaction and improve processes (Dickson, Anguelov, Vetterick, Eller, & Singh, 2009; Dickson, Singh, Dickson, Wyatt & Nugent, 2009). Hospitals have also successfully used Lean Six Sigma for a variety of both clinical and process improvement projects, including improving patient access to care (Bush, Lao, Simmons, Goode, Cunningham, & Calhoun 2007), clinical efficiency (Pocha, 2010; Agarwal, Gallo, Parashar, Agarwal, Ellis, Khot, Spooner, Tuzcu, Kapadia, 2016), improving scheduling (Huddle, Tirabassi, Turner, Lee, Ries, & Lin, 2016), improving care coordination (Breslin, Hamilton, & Paynter, 2014), and reducing infections (Carboneau, Benge, Jaco, & Robinson, 2010).

Only a few articles focused specifically on clinic efficiency and patient wait times. Fischman (2010) used the DMAIC principles to improve clinic efficiency and timeliness of care in an internal medicine clinic. Through process mapping, the staff was able to develop a baseline and then evaluate the major contributors to total visit time. Armed with that information, possible solutions to the delays were identified and a list of interventions generated. Time-study data were collected on Monday's in the clinic over several weeks following implementation of the interventions and positive results were realized in total encounter durations.

Jackson (2008) used Six Sigma methodology to reduce patient wait times in a phlebotomy clinic. By identifying potential failure modes in the process, including walking stat specimens to the hospital, early doctor's office pickup times, and inadequate capacity to meet demand, the clinic could adjust the clinic flow and decrease wait times through evaluation of pre-post wait times. Report cards were then generated to ensure sustainability of the new processes long-term.

Jayasinha (2016) studied a hospital-based pediatrics clinic that used Six Sigma principles to reduce patient wait times by making check-in and discharge processes more efficient. Patient flow was improved by an Emergency Room thereby reducing patient weight times using this quality improvement system with a subsequent positive impact on overall hospital length of stay (El Sayed, El-Eid, Saliba, Jabbour, & Hitti, 2015). Lin, Gavney, Ishman, & Cady-Reh, (2013) applied Lean Six Sigma to an otolaryngology clinic to reduce waste and improve patient flow through the clinic. Post-intervention, which included removal of bottlenecks from the clinic, alignment of staff hours with high patient volume and reduction of non-value-added tasks, the clinic could realize a reduction in patient wait times by 12.2% on average.

In Canada, a hospital emergency department utilized Lean principles when they began recognizing a decrease in patient satisfaction and extended wait times. By using a structured method of quality improvement, they could reduce waste and improve patient satisfaction (Ng, Vail, Thomas, & Schmidt, 2010). While the literature search revealed many examples of the application of Six Sigma in various healthcare settings, it did not produce any results regarding application in an occupational health clinic. This project will focus on filling that gap.

Method

The overall goal of this project was to utilize the principles of Lean Six Sigma and the DMAIC process to collect baseline data on clinic processes, collect and analyze operational data and to implement improvements while putting in place a long-term strategy for sustainability. The DMAIC process is used when a process is not performing correctly or not meeting customer needs (Pande, Neuman, & Cavanaugh, 2000). Each of the five phases of the DMAIC process has deliverables and gates to complete to proceed to the next phase.

Completion of each tool results in data and proposed interventions to reduce patient time in clinic. The results are reviewed with a Black Belt (Six Sigma leader). The Black Belt facilitates the process and holds a higher certification in the Six Sigma, much like a black belt in the martial arts. The reviews include a structured assessment of the design, measure, analyze, implement and control phases of the process. These will be described below.

Design, Setting and Sample

The project followed the DMAIC process through the Define, Measure, Analyze, Improve and Control phases utilizing the Textron Six Sigma playbook of tools. The project was conducted in the largest of the onsite health clinics in Wichita, Kansas, and focused only on provider clinic visits and nursing-scheduled patient encounters such as for vaccination, hearing testing or physical exams. Emergencies and acute injury or illness were not included for purposes of this project because to those circumstances are out of the span of control of the clinic staff. The employee population utilizing the clinic is largely male (81%), blue-collar manufacturing employees and approximately fifty-one percent of the total employee population is represented by the International Association of Machinists Union (IAM). The current clinic staff participated on the team and a Black Belt champion within the organization was identified to participate. No additional new resources were introduced beyond current clinic resources.

The DMAIC process mirrors an experimental research project in some respects. The researcher must define the problem utilizing the Six Sigma tools, collect the data in the measure phase, analyze the data to determine next steps, implement solutions to improve the process and establish controls for sustainability. For purposes of this project, the DMAIC headings will be utilized to show the sequence of the continuous improvement process.

Data Collection

Data included defining the steps to the patient visit from entry to the clinic through check-out, identifying key stakeholders in the process, and collecting time in and time out data via the time stamp in Occupational Health Manager (OHM), the clinic's electronic medical record.

Data was collected during all phases of the DMAIC process utilizing various Six Sigma tools provided by Textron Aviation (Appendix A) as a part of the internal Six Sigma program at the organization. The playbook, which is a collection of Six Sigma tools organized within the DMAIC framework, has been modified for this project and tools selected based upon the appropriateness for the clinic environment and transactional processes. All Six Sigma and data collection tools discussed for the remainder of the project are documented in the Appendices B through H. In addition, pre-intervention data relative to average clinic visit time was collected via OHM.

Define

For the define phase, an In Frame, Out of Frame tool (Appendix B) was utilized to narrow the focus on the processes with the greatest criticality to quality, efficiency and expedient care. In Frame, Out of Frame is a visual representation of what information was included in the project and what information was excluded to narrow the scope and keep the project manageable. It was determined that the largest clinic (Mid-Continent), the scheduled visits, the clinic processes and staff were all in-frame and therefore considered. Conversely, it was determined the other clinic locations, staff headcount and emergency care were out-of-frame since the staff does not have direct control over those variables.

Detailed process maps of the clinic operations were completed to understand where the bottlenecks present a barrier to clinic efficiencies (Appendix C). A process map is a visual representation of a process and helps staff to see the real process, including any waste, duplication, and flow issues (Textron Six Sigma, 2011). It is at this point that the clinic visit was mapped out via visual diagram from the time patients enter the clinic until they exit upon discharge.

Excluding emergency care, patients enter the clinic typically for one of four processes. These include returning to work following an absence for a medical condition, a follow-up visit with the company doctor or nurse practitioner, reporting of a new injury or illness, and medical surveillance physicals dictated by OSHA. When the patient enters the clinic, they are greeted by a nurse who checks them in via the computer and triages the purpose of the visit. Depending on the visit reason, the nurse may then move the patient into a large treatment room and perform vital signs, first aid treatment or lab work. If the patient needs to see a provider, the patient is moved back to the waiting room until the provider is ready and requests the patient to come back to an exam room. Upon conclusion of the provider visit, the patient is moved again to a check-out room where the nurse processes the paperwork, calls the supervisor with any restrictions and schedules any follow-up appointments or visits. If diagnostic testing is warranted the patient must exit the clinic to an outside supplier of the diagnostic services. Based upon the process map, the bottlenecks in the clinic often are created by excessive patient movement, internal process requirements, such as correct data on a return to work note, and the sheer number of process steps required.

A supplier, input, process, output and customer (SIPOC) exercise (Appendix D) was completed by the Health Services staff during our weekly project meetings to ensure all stakeholder buy-in and to understand customer requirements. The SIPOC tool helps to define all the inputs needed to make the process run correctly, identifies the suppliers for those inputs (i.e., staff, patients, supervisors, providers, etc.), lists the requirements for the process steps, identifies all the outputs of the process (i.e. discharge paperwork, patient restrictions, phone calls to supervisors, etc.) and identifies all of the downstream users of the outputs.

The process begins with the employee checking into the clinic and finishes when the employee exits the clinic. Then, it is important to understand the outputs of the process including quality care, HIPAA compliance, timely reporting and patient experience. The customers of the process include the employees that serve as patients, the supervisors who are relying on employees to be returned to work safely, the production staff who expects minimal lost productivity from the employees during this process, the safety team that must investigate the root cause of new injuries and the government agencies for which compliance requirements for reporting must be met.

The suppliers necessary for the process success include the medical staff, information technology to support the electronic medical record, operations for providing appropriate space for the clinic and Human Resources who must assist in adequately supplying enough staff to maintain service. To meet the customer requirements, complete the process and effectively deliver the outputs, there are input requirements including a private space to conduct the visits, a space to complete documentation via electronic medical record, competent and adequate staffing, and timely notification to customers of outcome of visits. The use of the SIPOC allows a critical look at the process to begin understanding sources of variation and areas of concern with the process variables.

Measure

In the measurement phase, a cause and effect matrix (Appendix E) was utilized to determine the potential sources of variation in the process. A cause and effect matrix uses a diagram to identify the potential causes in the process that are driving variation in the output. This generally focuses on looking at the relationship between the people, method, the measurement, and the environment (Textron Six Sigma, 2011). The cause and effect matrix is a decision-making tool to use when it is necessary to prioritize choices that must be weighed against other key factors (i.e. customer requirements, cost, ease of implementation, resources, etc.). This helps to identify the most important areas of the process to focus on when it is impossible to implement all available solutions.

Using the data derived from the define phase, the tool was completed scoring the items in the steps of the process in rank of relative importance on a 1, 3 and 9 scale, with 9 being the most important. These are scored on the same scale against the items which are critical to satisfaction within the process. The key process input variables included a) having a private space to visit with and treat employees to maintain HIPAA compliance and make employees feel more comfortable sharing any medical concerns, b) scheduling appointments versus handling walk-in traffic to have more control over the process and flow, and c) having an interface between the electronic medical record system and the official recordkeeping system utilized by safety and the rest of the business. It also included improving clinic flow to minimize waste in the process via transportation, having standing orders for the nurses for the return to work process, thus decreasing the time in clinic and improving the scheduling process to maximize efficiency.

The input variables were scored in relation to the items which are critical to satisfaction including compliance, service level and efficiency. The higher the scores, the higher the influence on the process. Some process variables ranked high in areas of compliance, while others scored higher in relation to efficiency. Overall, the key process steps to consider for the cause and effect matrix revolved around improved clinic flow, increased autonomy for the nursing staff, and improved control over the clinic schedule.

The baseline capability of our current measurement system (OHM and nursing staff) was tested to understand if training or adjustments were necessary to improve the measurement system. This was performed by pulling a report of time stamp data and reviewing for missing data points. Likewise, staff was polled on how they enter time in and time out data to evaluate for consistency. It was determined that there were some gaps in time reporting during the exercise.

Nurses were not consistently entering the time out when an employee left the clinic and in some circumstances, particularly when the clinic was busy, were not getting the employee checked-in to the clinic as soon as they entered the door, skewing the time data. Likewise, nurses were sometimes not coding the same type of visits in the same manner, making it difficult to track visit reason accurately. Therefore, staff education was completed to ensure consistency in how time-in and time-out were completed and how encounter codes for specific visit types were utilized.

Then, a failure modes effects analysis (FMEA) (Appendix F) was completed to understand any potential failures that may be encountered during the process that lead to further barriers. A failure mode effects analysis is a tool designed to aid in risk identification and mitigation (Textron Six Sigma, 2011). This tool is important to understand all potential failures to the process, how often those failures occur, how severe the consequence to the process failure and ways to mitigate those issues. Without a good understanding of potential failures, it is difficult to focus on long-term sustainable improvements. When a process step has a high severity impact on the process or customer, a high likelihood of occurrence and a low detection rate, it makes it difficult to adjust the process accordingly to prevent the issues. However, after completing an FMEA, corrective actions can be put into place for sustainability purposes with the process steps that run this risk and the tool can be rescored later to ensure that the process changes have indeed been successfully sustained.

After determining the severity of the failure in relation to how easy the failure is to detect and how likely it is to occur, the risk priority number (RPN) was calculated to determine which failures had the greatest risk to clinic efficiency and time in clinic. The process steps with the highest RPN's are the process steps that need the greatest attention. The RPN was then put into a Pareto chart to provide a graphical representation of the risks (Figure 3). The Pareto rule implies that 80% of the effects, which in this case relates to clinic efficiency, are a result of 20% of the causes.

Based upon the Pareto rule, clinic flow issues, lack of robust standing orders for the nurses and walk-in traffic volume are the top three contributing factors for time delays and inefficiencies within the clinic. By focusing on corrective actions for these three processes, clinic efficiency could be improved and the RPN decreased.

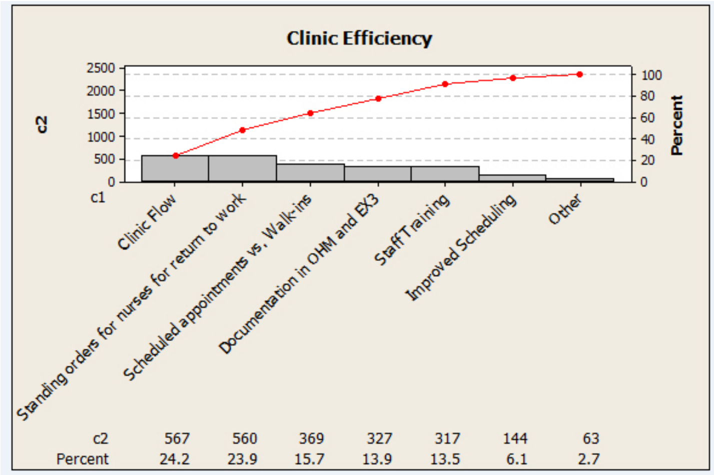


Figure 3. Pareto chart from FMEA

Analyze

Clinic Flow

The analyze phase of the DMAIC process included completion of a waste walk to determine any non-value-added operations. The waste walk assesses seven types of waste including transportation, inventory, motion, waiting, overproduction, over processing and defects (Textron Six Sigma, 2011). Overproduction in a service environment is when a service impedes the process because it is cumbersome or unnecessary. Examples of this include underutilization of automation, long-process set and having excessive inventory. Over processing is simply performing work that is not necessary to meet the customers' needs from a quality or cost (Textron Six Sigma, 2011). By performing a waste walk, it assisted in identification of additional opportunities for improvement were identified.

To document the waste, particularly in transportation, a spaghetti diagram was developed for clinic activity to show the excess patient and staff movement (Appendix H). The spaghetti diagram showed excess patient movement and excess staff movement during a patient visit. Excess transportation decreases visit efficiency and customer satisfaction.

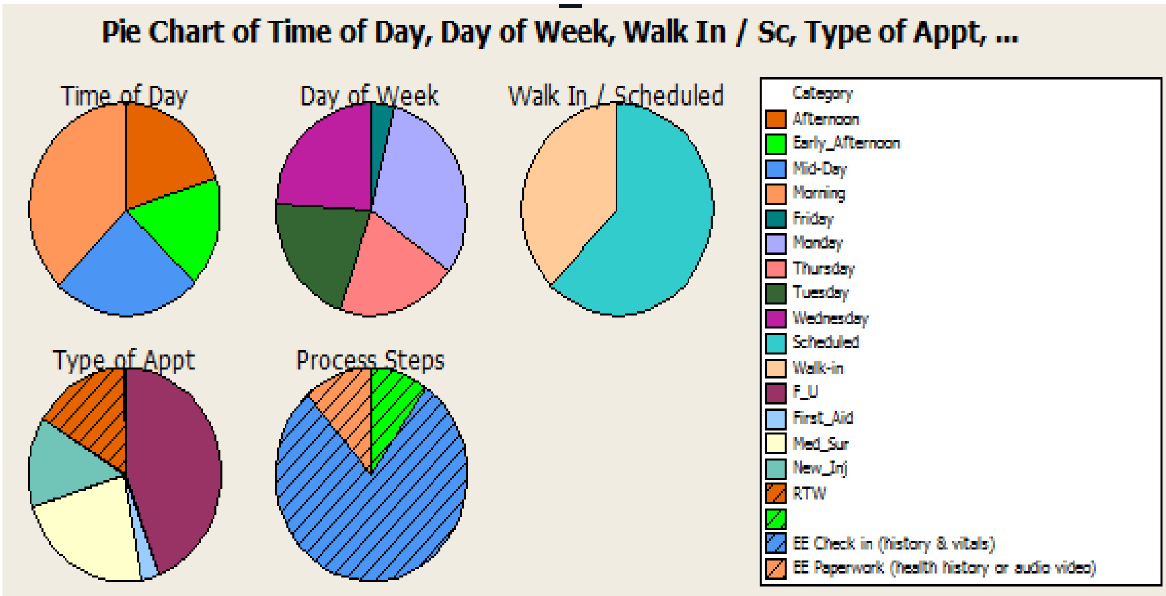
A data collection sheet was developed to better understand how the staff was spending their time during a patient visit (Appendix G). This data was analyzed using MiniTab to understand the correlation between the time in clinic and various clinic activities. Finally, pie charts were created to provide a graphical representation of the potential variables that were identified in the define and measure phases (Figure 4). This helped to examine the process more closely to determine if all non-value-added work has been eliminated, that the process flow made sense and was easy to follow, and to determine the root cause of problems needing improvement.

Standing Orders for Nurses

The lack of robust standing orders for the nurses was identified through analysis of the process map (Appendix C). Some of the excess waste in transportation resulted from nurses not having the autonomy to handle certain internal processes. The excess waste in transportation in turn leads to additional time in clinic, thereby reducing efficiency. Based upon the data in the pie charts, the greatest need for increased autonomy came in the areas of the return to work process and medical surveillance. The standing orders have a direct impact on improved clinic flow and efficiency.

Clinic Traffic Volume

The pie charts showed that the heaviest clinic traffic occurs in the morning prior to lunch and early in the week. Most of the visits are scheduled visits, though there is considerable walk-in traffic present.



Follow-up appointments are almost half of the clinic visits, followed by medical surveillance physicals. Our original thought was that return to work visits and injuries were a much greater percentage of the visits than the data actually shows. The history and physical during all visits consumed the greatest amount of time in clinic. This data is useful, particularly when looking at how to change the scheduling process to improve efficiency.

The data was further analyzed creating bar charts to show highest traffic times in the clinic, busiest day of the week and when walk-in traffic was most prevalent (Appendix I). This allowed staff to understand clinic volume and flow and make recommendations for change based upon the data.

Utilizing the time stamp data from Occupational Health Manager, and time data from the data collection sheets, patient encounter times were evaluated from arrival at registration until interaction with a provider is completed and discharge has occurred for total time in clinic. OHM records both time in and time out for this purpose. All time data sets were analyzed using Minitab 12.0 (Minitab Inc, 2007). A value of P=0.05 was used throughout to determine significance. Pearson's Correlation testing was completed to determine the relationship between total time in clinic to the variables of day of the week (p=0.182), walk-in vs. scheduled visits (p=0.295), type of appointment (p=0.019), number of staff member handoffs during the visit (p=0.118), number of available providers (p=0.560) and number of available nurses (p=0.208). Based upon the results of the Pearson's Correlation, it was determined that only the type of appointment was statistically significant in relation to the amount of time in clinic. This indicates that variables once considered impactful to the amount of time a patient spends in the clinic are not as important as the reason the patient is there and the nature of the care to be provided. Therefore, improving the way each type of visit is handled through internal process changes should improve the amount of time the patient spends in the clinic.

It was determined through graphical analysis that the highest traffic time in the clinic is on Monday morning between the hours of 7:00 A.M. and 9:00 A.M. for both walk-in and scheduled visits. For scheduled visits only, the highest volume occurs on Tuesdays between 9:00 A.M. and 11:30 A.M. and Wednesday afternoon between the hours of 2:00 P.M. and 4:00 P.M. Mondays see the highest volume of return to work visits and scheduled follow-up appointments, followed by follow-up appointments on Wednesday afternoon. The average total time in clinic is 29 min for all visit types with the greatest amount of time occurring with medical surveillance physicals and follow-up appointments leading in time in clinic.

Through use of the Six Sigma tools and detailed analysis of the clinic visit data, it was determined that by focusing on improving the flow of the clinic, adjusting internal processes for each type of visit, creating robust standing orders for the nurses and improving how appointments are scheduled, clinic efficiency can be greatly improved while decreasing the amount of time the patient spends in the clinic. This will improve patient satisfaction and decrease cost through productivity savings.

Improve

For the improve phase, the clinic staff identified clinic solutions during scheduled brainstorming activities, based upon the factors identified as critical to satisfaction and on exploration of the value of the solution impact on quality, cost and efficiency. At this point, the tools have narrowed the project scope, helped to focus on the critical areas of need for improvement and identified potential solutions. Based upon the data analysis, there are several recommendations to improve efficiency and potentially decrease patient total time in clinic.

Clinic Flow

First, reorganize the current resources and relocating staff commons areas to allow staff to check patients into the clinic, put them into an exam room and conduct visit through discharge without additional patient movement will improve both patient privacy and clinic flow. The current IT resources would be sufficient for this change and would simply require reorganization of the current desk space. This eliminates waste via transportation and likely overproduction in duplication of documentation. Also, to eliminate waste via overproduction, IT should be engaged to create a software patch between the two documentation systems to which the staff must document. This would allow single entry of critical patient data, thereby decreasing documentation time and allowing for additional time with patients.

Understanding that appointment type, particularly medical surveillance, is a significant variable for time in clinic. Improvements can be made to the medical surveillance process to improve efficiency by creating an electronic copy of the health history form, OSHA required forms and training that employees can complete online prior to their visit to the clinic for the exam. Upon yearly review, the information can then be updated rather than completing in entirety each year.

Standing Orders for Nurses

Creating standing orders for the nurses for employees returning to work we can further reduce the amount of time the employee is in the clinic processing. By providing additional autonomy via creation of the standing orders, it will limit the amount of time the nurses spend in consultation with the provider on matters of return to work policy. In addition, standing orders allowing the nurses to perform medical surveillance physicals under protocol will eliminate the need for the patient to wait on provider availability and reduce waste in the process from transportation.

Clinic Traffic Volume

Finally, with a better understanding of clinic volume in relation to appointment type, day of week and time of day, there are several ways to regain control over the clinic traffic. First, creating a triage system for the nurse working the front desk would allow staff to better understand whether the patient must be seen in an urgent manner or can be scheduled later. A scheduling tool can be utilized to create blocks of scheduling time based upon appointment type and amount of time necessary for each appointment type, allowing the staff to better distribute the appointments across the entire week. Communications to the entire employee population about calling to schedule an appointment will be an important piece to the success as it will be essential to limit the amount of non-emergent walk-in traffic. Reorganizing the staff schedules to ensure that appropriate resources are available in the morning and during times of heavy scheduling for medical surveillance physicals should help improve overall time in clinic. While one nurse is completing physical exams, the other can be assisting with walk-in traffic and scheduled visits to ensure the most efficient flow possible.

Control

By implementing these few, cost-effective solutions, clinic efficiency can be greatly improved. Following implementation of the changes, it will be beneficial to have ongoing staff education and dialogue regarding process changes to ensure no course correction is necessary. Then, after several months of operation with changes in place, the Six Sigma tools will be resurrected to ensure that sustainability has been maintained and no other risks to the processes have been identified. This will ensure long-term success and truly meet the definition of continuous improvement.

Protection of Human Subjects

A copy of the tools was provided to the staff along with an explanation of the methodology for the project. No personal identifiable information was collected as a part of this project. The request for Quality Improvement determination was sent to the Human Subjects Committee for review and approval.

Conclusion

The five phases of the DMAIC process (define, measure, analyze, improve, control) serve to provide a structured method of a deep-dive into processes that are underperforming. Each step has available tools to assist in defining the critical elements of the process to be reviewed and guide the team to potential solutions. When patients spend an extended amount of time in the clinic, manufacturing production time is lost, patient satisfaction goes down and costs rise. The project helped identify potential clinic efficiency improvements to reduce cost, improve quality of care and customer satisfaction.

Unfortunately, during this project, the clinic was notified that its resources will be outsourced. Therefore, implementation and evaluation of the recommendations are not possible at this time. If the clinic continued as analyzed, more data collection would be needed to more fully understand what is driving time in clinic since only appointment type was statistically significant during the evaluation. The data captured was also a two-week snapshot in time and additional investigation with data collection over several months could demonstrate a different outcome.

Lean Six Sigma in healthcare is a relatively new strategy and much is still to be learned. I was unable to find any examples of the application of these principles in an occupational health setting which often is a hybrid of a primary care and urgent care clinic. This project provided an opportunity to apply the principles of Six Sigma in an occupational setting and bridge the existing gap in literature.

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Appendix A

Permissions

Beechcraft | Cessna | Hawker

TEXTRON AVIATION

August 29, 2016

To whom it may concern:

Kiersten Camp has permission from Textron Aviation to utilize the Textron Six Sigma playbook and tools for the sole purpose of completion of the requirements for her Doctorate of Nursing Practice project with the University of Kansas School of Nursing.

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Appendix B

In the Frame / Out of the Frame

Concept: "What's not explicitly out of scope, it's implicitly in scope."

Objective: Define and clarify scope of project

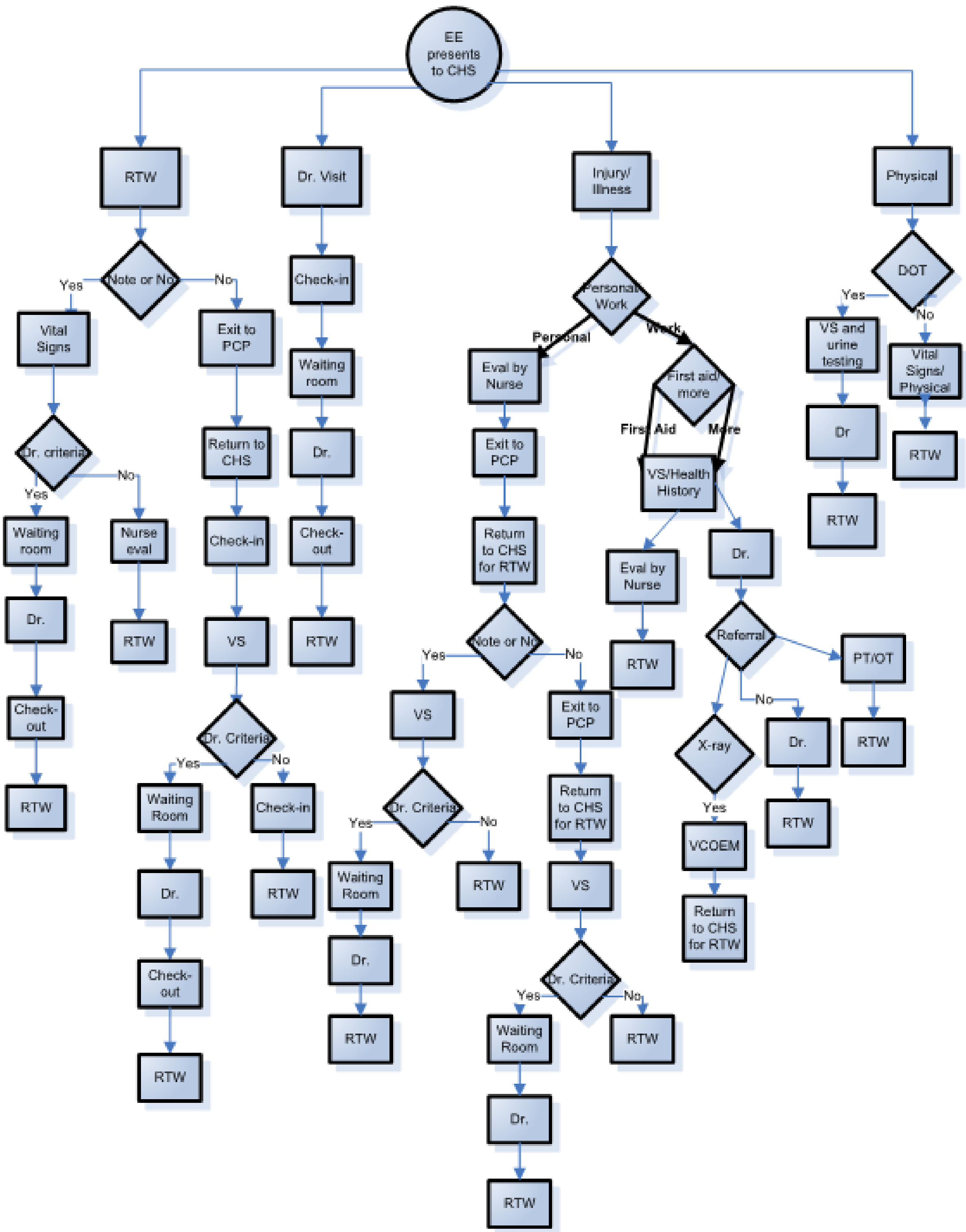
Instructions: Draw a large square "picture frame" on a flip chart (or use tape on a wall). Using post-it notes, use this metaphor to help the team identify what falls inside the picture of their project and what falls out. This may be in terms of scope, goals, roles, or even process steps. Write one item per post-it. Discuss and reach consensus. It is okay to have items on the border. The team will need to either get further clarification from the champion or address later.

Usage Tips

Facilitation Tips

Out of Frame	Emergency Walk-ins
	Clinic Space Constraints
Pawnee	Hiring New Staff
East Campus	In the Frame
Independence	Mid-Continent
	Scheduled Clinic Visits
	Documentation
	Patient Wait Times
	Clinic Processes
	Health Services Staff and Customers

Appendix C


EE presents to CHS
RTW
Dr. Visit
Injury/ Illness
Physical
Note or No
Yes
No
Vital Signs
Exit to PCP
Dr. criteria
Nurse eval
Waiting room
Dr.
Check-out
Return to CHS
Check-in
VS
Dr. Criteria
Waiting Room
Personal/ Work
Personal
Work
Eval by Nurse
First aid/ more
First Aid
More
VS/Health History
Return to CHS for RTW
Referral
PT/OT
X-ray
VCOEM
DOT
VS and urine testing
Vital Signs/ Physical
Dr

Appendix D

SIPOC

Suppliers	Inputs	Process		Outputs	Customers	
(Providers of the required resources)	(Resources required by the process)	(Top level description of the activity)		(Deliverables from the process)	(Anyone who receives a deliverable from the process)	
Nursing Staff	Private space	Employee check-in	EE enters HS	Understanding Reason for Visit	Employee	Supervisor
Operations	Office space for telephonic consults and medical records review	HIPAA compliance			Private environment to discuss patient medical issues with patient/Less patient movement/more efficient care delivery	
IT/EMR Vendor	Data entry points outside of patient view	HIPAA compliance			Secure computer network for medical information	Employee
					Dedicated non-patient area for medical record review	
Health Services staff	Competent staff	Quality care	Review of Health Services Processes	Quality Care	Good outcomes	Employees
Human Resources/Operations	Adequating staffing to meet patient demand	Cost containment			Timely intervention	
Operations	Functional equipment	Quality care			Expeditous return to work	
Health Services staff					Expeditous return to work	Production
Health Services staff	Adequate/appropriate supplies	Quality care			Minimal interference with department business needs	
Operations	Functional space to maximize clinic efficiency	Clinic efficiency		HIPAA compliance	Medical information kept confidential	Employees
Operations	Timely response	Clinic Efficiency		Patient Experience	Expeditious return to work	Employees/Supervisors
Human Resources	Adequate staffing	Quality care			License protection	Staff
Human Resources	Adequate number of data entry points for staff	Clinic efficiency			Company protection	
Health Services staff	EMR/EX3	Documentation		Timely Reporting	Internal compliance requirements	Textron/EHS
					Compliance with laws/regulations	Health and Human Services/OSHA
	Timely notice to safety			Root cause corrective action	Employee Safety	Safety team/ employees
Health Services Staff	RTW Form	Documentation		Discharge Paperwork	Internal requirements	Employee/ Supervisor
			EE leaves HS			

Appendix E

Cause & Effect Matrix

Question: What are the most important process steps?
What are the most important Input Variables?
What is the correlation between the Inputs and CTSs?
Objective: Clear understanding important Process Steps for meeting CTSs.

Relative Importance (10 is high (good) 1 is low)		1	3	3	9	9	9	3	3			Process Step / KPIV Influence Rating (Feed high scores into FMEA)
	CTS / CTQ's	Compliance	Service Level	Efficiency								
Step / Item #	Process Steps / KPIVs (From Process Map or Fishbone)	rate 0,1,3,9 9 high influence (good), 0 is no influence										
	Private space to visit with and treat employees	9	3	1								21
	Scheduled appointments vs. Walk-ins	1	9	9								55
	Interface for OHM and EX3	3	1	9								33
	Improved Clinic Flow	9	9	9								63
	Standing orders for nurses for return to work	3	9	9								57
	Improved Scheduling	1	9	9								55

Appendix F

FMEA

Process Step	Key Process Input	Potential Failure Mode	Potential Failure Effects	Sev	Potential Causes	Occ	Current Controls	Det	RPN
Clinic Flow	Patient Movement	Mulitiple staff hand-offs and excessive movement	Poor customer experience and inefficient operations	7	Poor facility layout	9	None	9	567
Standing orders for nurses for return to work	Provider guidance	Standing orders not utilized	Increased wait times while nurse asks provider for guidance	5	No clear standing orders related to return to work process	9	None	7	315
Standing orders for nurses for return to work	Provider guidance	Lack of consistency in practice	potential employee discrimination complaints and union issues	5	No clear standing orders related to return to work process	7	None	7	245
Scheduled appointments vs. Walk-ins	OHM	Appointments are not scheduled	Increased walk-in traffic, increased wait time	9	Poor compliance in use of scheduling tool	9	Scheduling tool in OHM	3	243
Documentation in OHM and EX3	OHM	Documentation not completed	State and Federal compliance requirements not met	7	Clinic volume does not allow nurses enough time to documentation thoroughly	9	Weekly audits with EHS, weekly injury review	3	189
Staff Training	Health Services Team	Continue with old practices/habits	No change in clinic efficiency	7	Lack of time to train contract staff	7	None	3	147
Staff Training	Health Services Team	Continue with old practices/habits	No change in clinic efficiency	5	Poor compliance	5	None	5	125
Scheduled appointments vs. Walk-ins	OHM	Appropriate amount of time not scheduled for appointment type	Increased wait times due to clinic volume	9	Wrong appointment type chosen for patient encounter during scheduling	3	None	3	81
Improved Scheduling	OHM	Appointments are not scheduled or are scheduled incorrectly	Increased wait times, clinic inefficiency	9	Poor compliance in use of scheduling tool	9	None	1	81
Private space to visit with and treat employees	Clinic space	Limited capacity	HIPAA issues, poor customer experience, excessive movement	7	Poor facility layout, capacity not compatible with volume	9	Limited scheduling	1	63
Documentation in OHM and EX3	EX3	Documentation not completed	State and Federal compliance requirements not met	7	Data entered by single nurse at alternate location--potentially missed data	3	Weekly audits with EHS	3	63
Improved Scheduling	Health Services Team	Clinic volume continues to exceed capacity	Increased wait times, clinic inefficiency	9	Underestimate time required for appointment type	7	None	1	63

Scheduled appointments vs. Walk-ins	OHM	Staffing not adequate for volume	Not enough staff to care for patients efficiently	9	Staff calls in sick. Not enough contract staff available to cover, vacations	5	None	1	45
Documentation in OHM and EX3	EX3	Documentation not completed	Delays safety investigations	5	Untimely entry or inaccurate information into system	3	None	3	45
Staff Training	Health Services Team	Continue with old practices/habits	No change in clinic efficiency	9	Staff turnover	5	None	1	45
Documentation in OHM and EX3	EX3	Documentation not completed	Internal requirements not met	3	Incomplete or inaccurate information	3	None	3	27
Documentation in OHM and EX3	OHM	Software program malfunctioning	Slows efficiency	3	Internet servers down	1	Charting on paper and scanning in information when software is working	1	3

Appendix G

Time Employee came into the clinic______________________

Date:________________ Mon ☐ Tues ☐ Wed ☐ Thur ☐ Fri ☐

Patient ID: ______________ Walk-in ☐ Scheduled ☐

Type of Appointment:
- Return to Work ☐
- Follow-up ☐
- New Injury ☐
- Recordable ☐
- First Aid ☐
- Medical Surv. ☐

- Process Steps:
  - ☐ EE check-in (history and vital signs) Time in_______ Time out_______
  - ☐ Employee Paperwork (Health History) Time in______ Time out________
    - EE Visit and Documentation

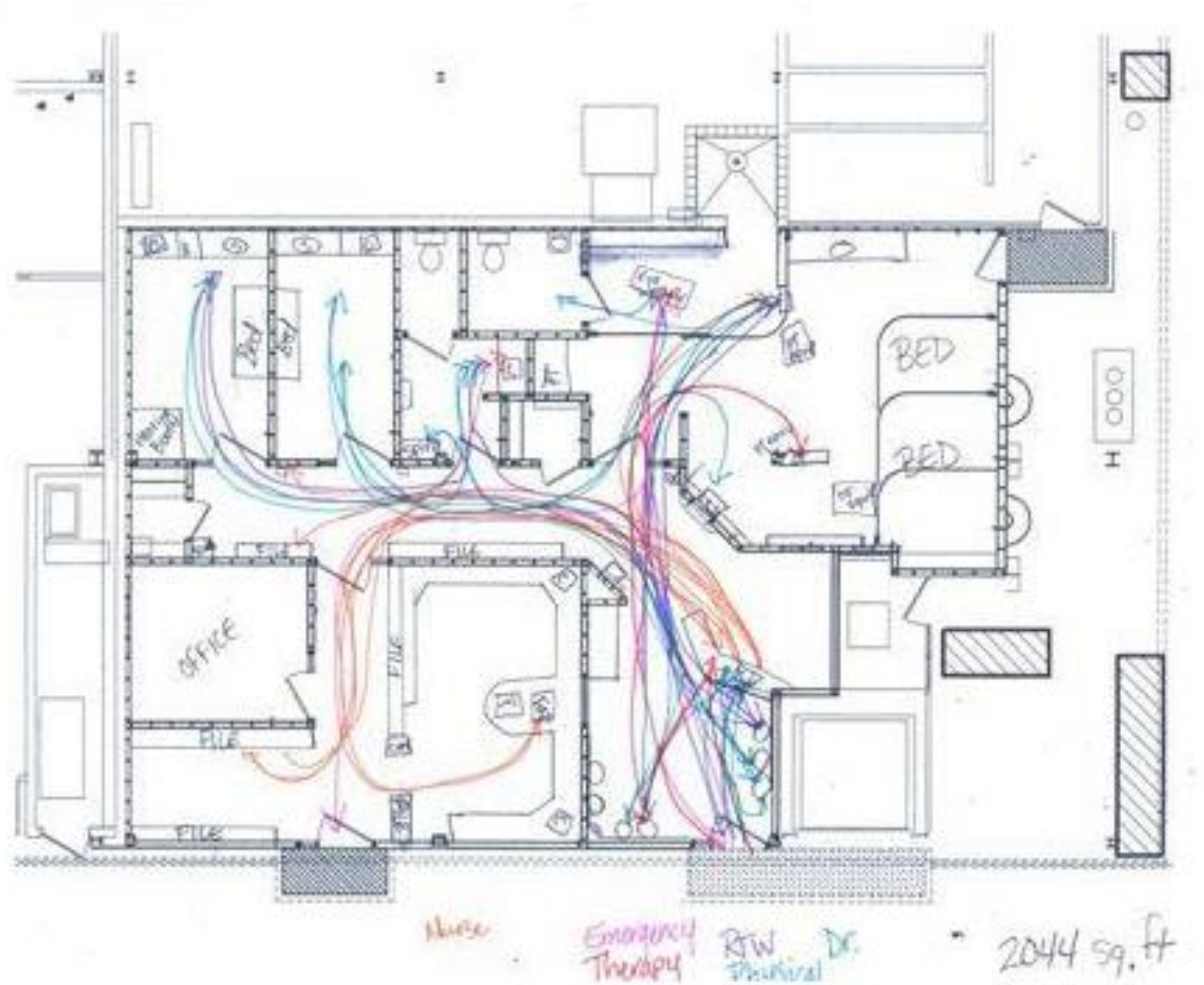
      Provider
      - ☐ Exam and OHM Time in_____ Time out_______ Initials_____

      Nurse
      - ☐ Exam Time in_____ Time out_______
      - ☐ 301 Time in______ Time out________ Initials____
      - ☐ HIPAA release Time in______ Time out________
      - ☐ Referral Time in______ Time out________ Initials____
      - ☐ Call restrictions Time in______ Time out________ Initials_____
        - Supervisor response Time in______ Time out________
      - ☐ Restrictions in OHM Time in______ Time out________ Initials____
      - ☐ Email to ESC Time in ______ Time out________
      - ☐ EX3 Time in______ Time out________ Initials____
      - ☐ Scanning Time in______ Time out________
      - ☐ Info to Broadspire Time in______ Time out_______ Initials_____
      - ☐ Employee Paperwork Time in______ Time out_______

- Number of Employee Handoffs 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐
- Number of available providers during visit 0 ☐ 1 ☐ 2 ☐ 3 ☐
- Number of available nurses during visit 1 ☐ 2 ☐ 3 ☐ 4 ☐

Time Employee left clinic ____________________

Appendix H



BED
BED
OFFICE
FILE
FILE
FILE
FILE
FILE
Nurse
Emergency
Therapy
RTW
Physical
Dr.
2044 sq. ft

Appendix I

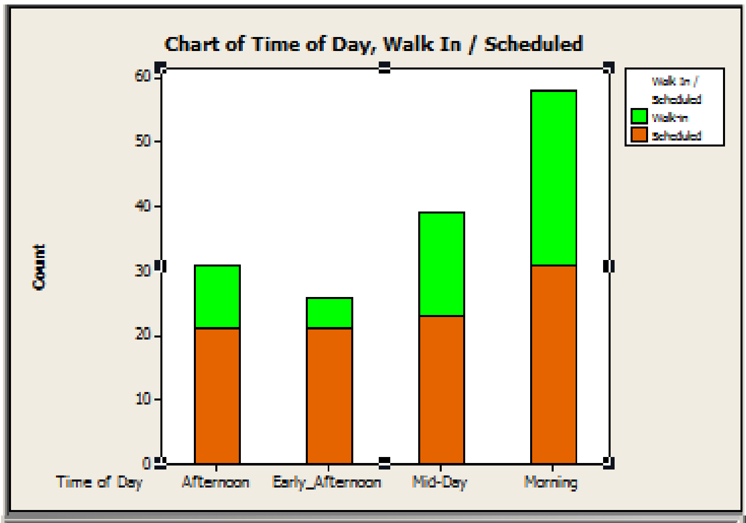


Chart of Time of Day, Walk In / Scheduled
Count
0
10
20
30
40
50
60
Walk In / Scheduled
Walk-in
Scheduled
Time of Day
Afternoon
Early_Afternoon
Mid-Day
Morning

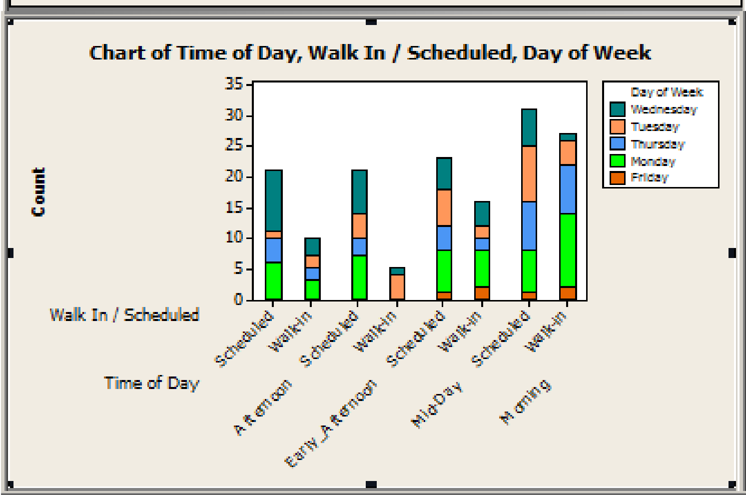


Chart of Time of Day, Walk In / Scheduled, Day of Week
Count
0
5
10
15
20
25
30
35
Day of Week
Wednesday
Tuesday
Thursday
Monday
Friday
Walk In / Scheduled
Scheduled
Walk-in
Scheduled
Walk-in
Scheduled
Walk-in
Scheduled
Walk-in
Time of Day
Afternoon
Early_Afternoon
Mid-Day
Morning

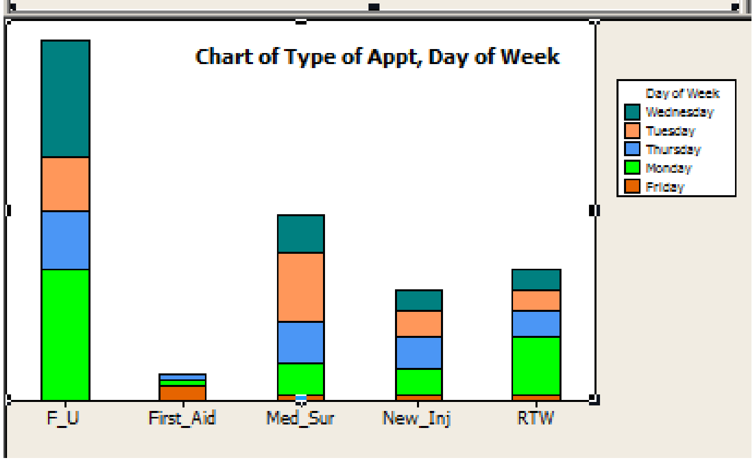


Chart of Type of Appt, Day of Week
Day of Week
Wednesday
Tuesday
Thursday
Monday
Friday
F_U
First_Aid
Med_Sur
New_Inj
RTW