Improving Efficiency at MedZou Community Health Clinic through Technology
MU ITC Interdisciplinary Innovations Fund 2015/2016 Award

MedZou Community Health Clinic is a free clinic for the underserved and uninsured residents of mid-Missouri. As a student-run clinic, it has a wide spectrum of student involvement, including the School of Medicine, School of Nursing, Department of Health Management and Informatics, Public Health, Social Work, Dietetics, and a variety of other undergraduate degrees. Through this project, MedZou sought to improve clinic operations and sustainability through incorporating several technologies aimed at understanding and improving clinic flow, streamlining inventory management, and developing an alarm system for the refrigerators containing medications.

Overall, this project was successful with the overarching goal of using technology to improve several aspects of MedZou. Through many iterations, several of these components have been completed, while others are currently in-progress. For looking at clinic operations and patient flow, tablets using REDCap surveys have been able to track patient encounters, allowing all parts of clinic to instantaneously know the location of the patient. Inventory management has shown that due to the small scale of the inventory and the clinic, that implementing an electronic monitoring system would not be the most efficient way to track usage; thus, a reorganization was started with a continued manual reporting system. The refrigeration temperature alarm system was implemented and worked well. However, because of the unreliability of the refrigerators, the alarm system would be activated at inopportune times, resulting in wasted volunteer time. As a result, MedZou decided to purchase an improved refrigerator that has been working well. For all three components, there have been many changes from the initial plan, all of which were implemented to improve patient care and clinic efficiency. MedZou will continue to explore improvements for the patient's experience in clinic, efficiency for inventory management, and general clinical operations.

Project Leaders:
- Previous - Riyad Haq (2016) MHA/MHSI, Jason Frizzell (2016) MHA, Christopher Lee (2017) M2
- Current - Daniel Shyu (2018) M1, Director of Business & Administration

Project Components:
The goal of this project was to improve clinic operations and sustainability at the MedZou Community Health Clinic through incorporation of several new industry-trending technologies. To accomplish this goal, we planned to implement the following:
1. Real Time Locating System (RTLS)
2. Inventory Management System
3. Refrigeration Temperature Alarm System

Component 1: Real Time Location System (RTLS)

Operating Issues Addressed:

- Prolonged wait-times results in patient dissatisfaction and dissuades patients from returning to clinic for follow-up appointments.
- Ancillary services (Preventative Health Therapy, Social Services) are available, yet greatly underutilized.

Proposed Post-Implementation Benefits:

- Improve clinic flow through ability to:
    - Coordinate teams of care providers and analyze utilization, flow and duration data for care stations.
    - Relay check-in and wait-time information from the front desk to physicians and students that are ready to treat patients.
    - Locate problems in work-flow and target these areas for improvement.

Planned Implementation summary: The RTLS will be composed of wireless tags that will move along with the patient as they progress throughout the clinic. Each service will be equipped with an associated reader that will check in the patient when they arrive at the service and check them out when they leave. This data will then be relayed wirelessly to a receiver and then a computer database to give real time data through a software interface that can be immediately acted upon. The data generated from this system will allow us to conduct advanced analysis such as simulating patient flow based on differing constraints.

Progress: In-progress
Originally, this component was to utilize wireless tags that moved along with the patient; however, this plan was changed due to the constantly evolving nature of the MedZou clinic. With a rotating system of student volunteers and new students in leadership positions every year, it was determined that a simpler method of tracking patients would be more effective. In addition, due to the nature of the clinic, patients do not always utilize the same resources (e.g. preventative health, dietetics, social work, etc.) and have very individualized paths through clinic. Also, several of the resources do not have a specific location, as those teams visit the patient's room; thus, because the patient is not changing location, the wireless tags would not be able to track usage of these optional resources. Finally, patient expressed discomfort with carrying wireless tags throughout clinic. As a result, MedZou has implemented the following plan:

Using the tablets, a REDCap survey was developed to track patients. On the survey, there are places to input the time the patient arrives at clinic, is assigned a room, seen by nursing, etc., as seen in Figure 1.

By collecting these times for each patient, MedZou can track how long the patient spends with each clinical care team. In addition, because aspects of clinic such as Patient Assistance Program (PAP) and Preventative Health Team (PHT) are optional and can occur in different locations inside clinic, this survey helps track both services used by the patient and the times the patient spends with each. Also, clinic volunteers have access to this survey and can receive a live update of who the patient sees in clinic. This research project currently has four medical students and five undergraduate students participating in data collection. Each undergraduate student is responsible for a different aspect of clinic and will record when someone sees a patient. Once enough data has been collected, the medical students will analyze the data to determine where the inefficiencies are located during a patient's visit to MedZou.

Data collection will continue till the end of June, when quality improvement projects will be initiated to improve clinic flow and decrease patient wait times. The remaining funds will be directed toward these projects with planned implementation in the fall of 2018.

Figure 1: REDCap survey that student volunteers use to track patient flow through clinic. PAP: patient assistance program; PHT: preventative health team

Budgetary Allotment:
Projected spend (total): $18,000
Real Time Location System (ability to track 10 patients through 10 activities): $18,000
Actual spend (total): $2,668.80
10 iPad minis, cases, and screen: $2,668.80

Component 2: Inventory Management System

Operating Issues Addressed: MedZou lacks technology-based inventory tracking system due to budgetary constraints; results in inefficient inventory tracking (observation and "hard-copy" tally sheets), which leads to issues with reduced availability of supplies at time of need (negatively impacts patient care), and excess/wasted (expired) inventory (misuse of limited funding).

Proposed Post-Implementation Benefits: Obtaining an inventory management system will allow us to efficiently track our inventory and receive automated inventory reorder and expiration notifications.

Planned Implementation summary: The inventory management system will allow us to associate every item with a barcode and use barcode scanners to scan the item's barcode when taking or checking out a product. MedZou has an approximate 50% annual turnover rate for volunteers, therefore this technology process will be intuitive enough for new volunteers to use and rely less on the error prone manual tracking. The data we can obtain through this system will allow us to understand our utilization patterns and ensure that products aren't wasted.

Progress: project on hold
Due to the yearly turnover of student leadership, this project was placed on hold in 2017 and is being revamped this year. While MedZou initially considered the use of an electronic inventory tracking system, it was soon determined that despite the intuitive nature of this software for new volunteers, the level of adherence to the protocol was expected to be low based on other projects.

However, this year, MedZou is planning on restarting this project with the intent of tracking the oft-used materials. Using the remaining funds, additional supply cabinets will be purchased for specific clinics, such as diabetes, musculoskeletal (MSK) nights, as well as for general clinic usage. The goal for this year is to reorganize the inventory room and identify the materials that MedZou currently has in stock. In the future, there are plans to develop a system using tablets to track the supplies that are used every clinic, such as gloves. The inventory team has set up regularly scheduled brainstorming meetings throughout 2018 to generate ideas for effective, sustainable, user-friendly inventory tracking protocols for implementation in 2019. For this component, there are two medical students and two MHA students who are leading this project. Furthermore, industrial engineering undergraduate students will be developing their senior capstone project based on MedZou's inventory system and improving its efficiency.

Budgetary Allotment:
Projected spend (total): $5,700

Inventory software package (software, scanner, and printer)	$2,000
Additional barcode scanners, office/medical/diabetes/MSK supply cabinets	$3,600
Inventory management supplies (barcode printer paper and wax ribbon)	$100

Actual spend: $0

Component 3: Refrigeration Temperature Alarm System

Operating Issues Addressed: Errors in refrigeration temperature monitoring have resulted in significant product waste.

Proposed Post-Implementation Benefits: Installing a temperature monitoring system will decrease refrigeration issues and reduce the medication waste, saving thousands of dollars that can be spent on other services or additional medications for patients.

Planned Implementation summary: The temperature sensors will alert MedZou volunteers to possible temperature regulation issues, so they can be resolved quickly, and the medications stored within the refrigerator can be maintained at the proper temperature, preventing loss of valuable supplies.

Progress: implementation complete
- iMonnit temperature sensors were received and installed in March-May 2016 but were found to be malfunctioning shortly thereafter. The sensors were replaced and reinstalled in September 2016 and have been functioning correctly.
- Implementation has been an iterative process, with continual adjustments to the settings and notifications to minimize false alarms (door opening during clinic), while retaining early notification of possible dangerous temperature fluctuations. Two MHA students were involved with this project.
- Overall, the sensors have allowed us to prevent medication waste due to refrigeration issues. In addition to installation of the sensors, we purchased a new refrigerator which features tighter control/regulation of internal temperature to reduce medication waste due to refrigeration issues.

- However, due to the inability for the original fridges to reliably maintain the correct temperature, the alarm would be frequently activated at inopportune times. Because the MedZou clinic is located off-campus and requires several hours for the directors to fix, it was determined that a new, more efficient refrigerator was needed. With a built-in refrigerator and remote alarm system, there has been no medication waste.
- In the future, further analyses will be conducted on all of the devices to determine their efficiencies and potential alternative solutions.

Budgetary Allotment:
Projected spend (total): $500
Refrigeration Monitoring/Alarm System (temperature sensor, system setup and online interface) $500
Actual spend (total): $2,801.70
iMonnit Temperature Sensor System $455.10
Refrigerator w/ Temperature Regulation $2,346.60

Future Direction

For each of the above components, there are several steps that will be taken to continue this project of improving MedZou's efficiency. With *Component 1: Real Time Location System*, the team is currently in the middle of data collection that will guide future quality improvement projects. With patient wait times being one of the main aspects of the clinic that needs to be improved, this project will allow us to identify which parts of clinic take more time than estimated; thus, a possible change would be to revise the order in which patients get seen by the various clinic components. For *Component 2: Inventory Management*, there is a pressing need to first determine the current status of MedZou's inventory. With a lack of past data on supply usage, this is an urgent clinic need and several projects are being started this year. New cabinets will be purchased with the leftover funds to better organize the inventory room into categories for each specialty clinic. Also, while the barcode scanning system was not implemented, other technology-based solutions are currently being explored, including the use of tablets requiring just a single action to check out a product. Finally, for *Component 3: Refrigeration Temperature Alarm System*, the project has been completed at a higher cost than expected. While the proposed solution was extremely effective, the system still required a volunteer to spend several hours to fix the temperature; thus, a new system was purchased and has been efficient and reliable. For the future, other aspects of MedZou will be evaluated based on their efficiency and alternatives will be proposed. As a free clinic with yearly student leadership turnover, there are many challenges in developing and implementing new systems. With the progress MedZou has made through the IIF Grant and will continue to make, there has been a significant improvement in the patient-centered care that the clinic strives to achieve.