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Analysis of Delays in Processing Times in an Ophthalmology Clinic

Kai Yung Natalie Lui

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Kai Yung Natalie Lui

Harrisburg University of Science and Technology

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Abstract

Efficiency is an important component of any medical practice. It facilitates quality care, reduction in wait time, patient and staff satisfaction, and decreased cost. The purpose of this study was to identify bottlenecks in the current processing system in the Eye Center at Hershey Penn State Medical Center. Data was obtained about patients arriving at the clinic for ancillary tests such as visual field testing and retinal imaging. Analysis of this data revealed a statistically significant longer average length of visit for patients who received testing in comparison to those who did not. However, due to the small sample size of this study, we were unable to conclude that patients who received testing had longer wait times between segments. Further work in this field will need to be conducted to examine processes in the clinic in greater detail to identify those in need of improvement and guide future implementation of Lean strategies.

Introduction

Background and Introductory literature

One of the most common approaches to improving process efficiency is using Lean or Six Sigma methodology. Lean thinking stems from the principles of eliminating steps that are not of value (Sommer, 2018). This can be achieved through customer identification and added value specification, value stream mapping, waste identification, waste elimination, and continuous improvement (Sommer, 2018). In contrast, Six Sigma focuses on improving the problematic complex processes and outcomes. In recent years, there have been many studies on the implementation of lean and six sigma methodologies in healthcare organizations to optimize workflow. However, there are a limited number of studies conducted specifically in optometry or ophthalmology settings (Sommer, 2018).

A specialist outpatient clinic in Singapore found success in process efficiency through a different approach (Chong, 2014). They proposed a method to reduce the turnaround time for patients through the use of a discrete event simulation (DES) model and the Design of Experiment (DOE). In particular, the clinic determined the areas of delay to be in patient flow, information flow, internal resource sharing and appointment punctuality. Improvement strategies were run through the simulation, and the results showed a statistically significant reduction in turnaround time after implementing wider distribution of appointment slots, rearrangement of new and follow-up slots and dilation-free exams.

A study conducted at the Wilmer Eye Institute General Eye Services Clinic in 2015 was considered the first to publish a report on implementing Lean management approaches in an academic ophthalmology clinic in the United States (Singman, 2015). They used real-time location systems (RTLS) and lean approaches to improve patient flow and efficiency. RTLS tags were used to track and record the movements of patients and staff throughout the clinic. Lean management approaches were used, which resulted in changes including reorganization of the reception desk, consolidation of forms, creation of task sheets to improve communication, installation of door flags on examination rooms, and training the staff in service excellence (Singman, 2015). Their results showed that despite an increase in the average time patients spent in the clinic, there was a decrease in time spent with the optometrist, doing testing and seeing the ophthalmologist. Most importantly, there was an improvement in patient satisfaction post-implementation of Lean changes.

Another study conducted in an ophthalmology practice in India outlined factors which contributed towards wait time, including punctuality, empathy, motivation of the staff, adequate manpower, culture, value of the organization, appropriate infrastructure, systems, monitoring and technology (Munavalli, 2016). In order to optimize workflow, they employed multi-skilled staff, rearranged the hospital layout to match the workflow, minimized distance travelled by patients and staff, and standardized operations and processes. They also noted that hospital efficiency is best achieved by a team effort.

The ophthalmology department at The Hospital for Sick Children in Canada achieved a 26% reduction in time between patients' arrival and departure over a period of 8 months (Wong, 2016). The Lean changes also resulted in an increase in the average time doctors were able to spend with the patient.

In 2017, ophthalmologists at the Royal Alexandra Hospital in Edmonton Alberta adopted the Lean model to standardize emergency eye exam rooms for more efficient treatment of patients (Nazarali, 2017). The residents complained of delays due to poorly equipped exam rooms and wasted time locating supplies. Tools such as spaghetti mapping were valuable in highlighting areas in need of organization and improvement. The department implemented Lean changes by eliminating wastes from all eight categories, which resulted in an increased audit by 33 points, reduced safety risks, and allowed the residents to focus their time with the patients instead.

A multi-subspecialty ophthalmology clinic found that the biggest cause of bottleneck formation was due to tasks that spent the most time and was common amongst many patients causing a wait line to form (Ciulla, 2017). In addition, other factors including room availability, patient age and appointment time of day had modest effects. Through the use of Lean six sigma techniques, a follow up analysis showed an 18% decline in mean patient flow time.

An eye clinic in Finland which specializes in cataract procedures used Lean methodology to improve the treatment protocol for Nd:YAG laser posterior capsulotomy (Lindholm, 2018). They found waste in areas such as underutilizing time and skills of the ophthalmologist due to wait times before and after operations. There were also significant delays from waiting to be called and escorting patients to the operating room. By eliminating these wastes, the clinic observed shorter lead times, more utilization of the operating room and increased patient satisfaction.

A unique study by Van Vliet evaluated used a mixed method design to compare Lean methods in eye hospitals in the United Kingdom, United States and the Netherlands (Van Vliet, 2011). The Lean tools used were operational focus, autonomous work cell, physical layout of resources, multi-skilled team, pull planning and elimination of wastes. Despite each clinic having different goals, they all found an improvement in efficiency after initiating lean changes.

A study conducted by Johannessen assessed tactics for reducing wait times and wait lists in specialist clinics (Johannessen, 2018). They argued that there is evidence suggesting that adding more resources will not necessarily improve accessibility or reduce queues. In fact, their findings revealed that long wait times are associated with organization malfunctions. They found success through the use of value stream analysis, targeted improvement, focus on planning and increased front personnel involvement. However, a limitation is that although the study was performed in an outpatient specialist clinic, it's not specific to an ophthalmology setting.

Most of the available literature reflects highly successful implementation of lean and six sigma changes. However, there are also articles which are unsure of the benefits of Lean in a healthcare setting. Daultani admits that there is limited research on the topic and unanswered questions that still need to be explored (Daultani, 2015). Since every healthcare specialty face different challenges, the tools used and the benefits reaped will vary based on the unique setting. In addition, Moraros conducted a literature review assessing the effects of Lean in healthcare. His findings revealed no statistically significant association with patient satisfaction and health outcomes, a negative association with financial costs and worker satisfaction and inconsistent benefits on process outcomes (Moraros, 2015).

Problem statement

In this paper, we set out to analyze delays in patient processing in an ophthalmology/optometry setting. Both electronic and paper data from the Eye Center at Hershey Penn State Medical Center were collected. This clinic provides services in 12 specialties and includes a team of 16 ophthalmologists, 4 optometrists and 2 orthoptists. This paper proposed to collect data on delays in processing time when a patient presents for ancillary testing such as visual field or retinal imaging.

Justification for study

In a busy eye clinic, such as the one at Hershey Penn State Medical Center, doctors see multiple patients with varying conditions on a daily basis. Examinations often include visual field testing, retinal photography, or both. These services are co-located with the clinic but require varying amounts of time to perform and to return the patient to normal patient flow through the clinic process. Therefore, efficiency is crucial to keep the practice running as smoothly as possible. By understanding the bottlenecks in the patient flow, we can target those as areas in need of improvement. This will often have a positive impact on patient and staff satisfaction levels. It can increase quality of care since doctors can focus their time on interactions with the patients. Lastly, it can increase revenue for the clinic by maximizing the number of tests performed daily. Therefore, it is important to streamline the patient flow of the eye clinic to maintain a highly functioning practice.

As an optometrist, this study is highly related to what I do on a daily basis. The lessons learned from these findings will be easily translated to my work and may guide processing changes in my current and future practices.

Methodology

Electronic data was obtained from the IT Department at Hershey Penn State Eye Center EMR for the time period of Jan1-Dec 31, 2019, and subsequently via a paper survey distributed to the clinic staff over a period of 1 work week ending on Feb 21, 2020. The surveys were conducted for half of the clinic day for each doctor surveyed. Data submission was anonymous. The EMR dataset consisted of 38,265 entries pertaining to check in/check out times and dates, length of visit, and whether any additional testing or imaging was done (see Table 1). Of those

38,265 entries, 11,234 patients were reported to have ancillary testing done. The manual survey dataset consisted of 143 entries pertaining to start and stop times at each step of the visit, including check in/check out, time with the technician, time with the physician, and time for additional testing (see Figure 1). Within this dataset, only 16 patients were reported to have ancillary testing done.

Both datasets were analyzed using Microsoft Excel and R studio software. Datasets were first cleaned to remove outliers, then analyzed using two sample independent t-tests. In both datasets, we evaluated average length of visit in groups that did not have additional testing versus groups that did. In the EMR dataset, we also compared average minutes early for patients who did not have additional testing versus those that did. We also compared the average length of visit for each type of testing performed. In the survey dataset we compared wait time for patients who did not have additional testing versus those that did.

Report heading	***Data***
Sessions	*The total number of 4hr blocks within the timeframe selected {we look at the first checked-in appt to the last checked-out appt add the minutes and then divide by 240)*
Appointments	*The total number of "checked-out" appointments*
Visits/Session	*Appointments divided by Sessions*
Resource	*Resource that was scheduled*
Day of the week	*Day of the week*
Appt Date	*Date of the appointment*
Appt Time	*The Resource scheduled time*
Checkin	*The actual time of "checkin" marked by the MOA in scheduling*
Min Early	*This is the time (early/late) that the patient actually checked in as compared to the scheduled appointment (negative=early)*
Checkout	*The actual time of "check out" marked by the MOA in scheduling*
Seen By Tech	*The actual time of the first occurrence of "Seen by Nurse" is updated on the Ambulatory Organizer *Ophthalmology techs must use the "nurse"*

Pt in Room	*The actual time the first occurrence of room location is updated on the Ambulatory Organizer*
Seen By Student	*The actual time the first occurrence of "Seen by Student" is updated on the Ambulatory Organizer*
Seen By Therapist	*The actual time the first occurrence of "Seen by Therapist" is updated on the Ambulatory Organizer*
Seen By Provider	*The actual time the **first** occurrence of "Seen by Midlevel"," Seen by Resident" **or** "Seen by Provider" is updated on the Ambulatory Organizer*
Checkin to Nurse	*Seen by Nurse time <minus> Checkin time*
Checkin to Student	*Seen by Student <minus> Checkin time*
Checkin to Therapist	*Seen by Therapist <minus> Checkin time*
Nurse to Provider	*Seen by Nurse <minus> {first occurance of "Seen by Midlevel, "Seen by Resident" or "Seen by Phyrician"}*
Checkin to Checkout	*Checkout <minus> Checkin*
Appt Type	*Appointment type in scheduling*
Photo Order	*If the provider placed an order to have an Ophthalmic photo taken during the visit we display the order for the specific test.*
Exam_Reason	*Reason for Exam as entered into the scheduling application by the Medical Office Associate at time of scheduling the appointment*
Nurse	*The Nurse that updated the "Seen by Nurse" in the Ambulatory Organizer*

Table 1. An overview of the variables included in the EMR dataset and the meanings behind each variable.

Ophthalmology Patient Flow Evaluation.

Appointment Time: ____

Check in time:

Start: ____________________ Finish: ______________

Time with the Technician: ________ (initial)

Start: ____________________ Finish: ______________ Dilation Time: _________

Time with resident:

Start: ____________________ Finish: ______________

Time with physician (Part A):

Start: ____________________ Finish: ______________

Time with physician (Part B):

Start: ____________________ Finish: ______________

Time with technician in completion of the appointment:

Start: ____________________ Finish: ______________

Additional Testing:

____________________ Start: ____________ Finish: __________ Initial ____________

____________________ Start: ____________ Finish: __________ Initial ____________

____________________ Start: ____________ Finish: __________ Initial ____________

Checkout time: ____

Notes: ____

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Figure 1. A sample of the survey distributed to the staff at the Hershey Penn State Eye center. Start and finish times were obtained at each step of the medical visit.

Results

The first portion of the analysis focused on the EMR dataset since it represents an overview of the patients who present to the clinic over the course of one year. Despite initial impressions of content, the wait times between each step of the visit were not recorded in the EMR dataset, thus, only average length of a visit was available. This was found by calculating the difference between the check in to check out time. The average for the no-testing group was 77 minutes, whereas the average for the testing group was 99 minutes. In order to determine whether there was a significant difference between these two values, a two-sample t test was conducted. The results gave a t-value of -61.84 (p=2.2e^-16), indicating that there is a significantly longer visit for those in the testing group as expected.

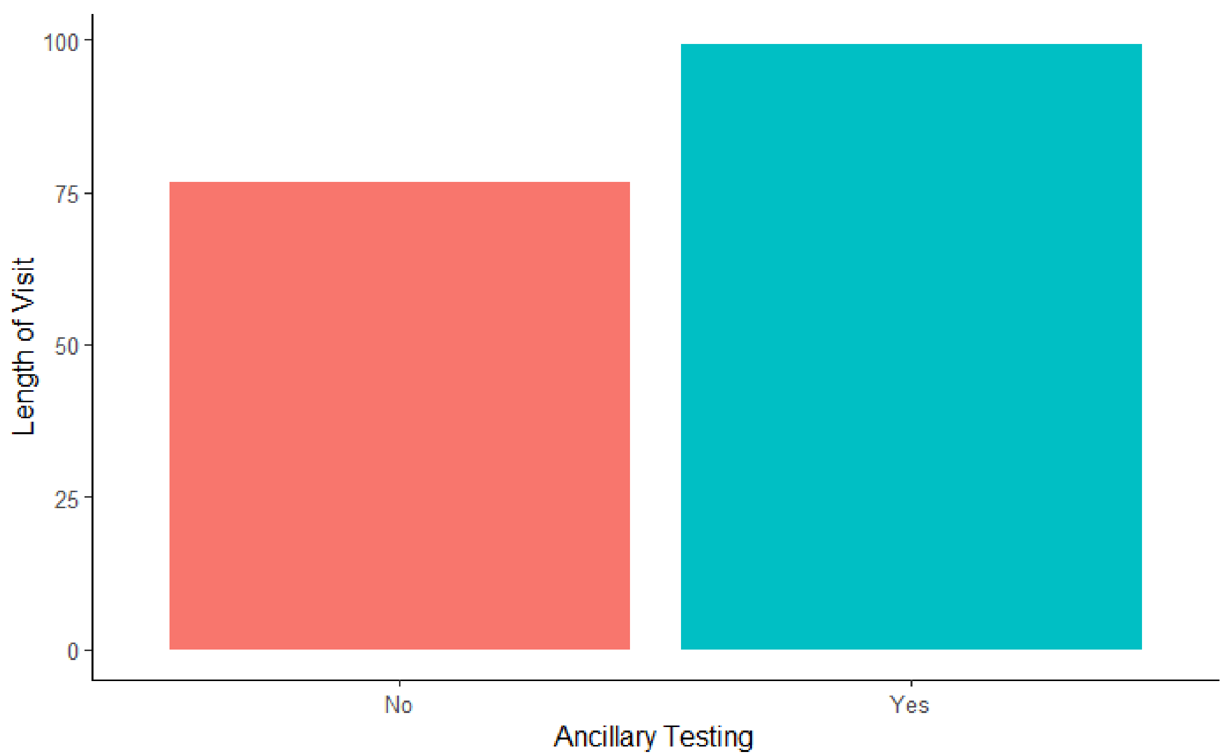

Figure 2. A graph comparing the average length of visit for patients who did not receive ancillary testing and patients who did. This graph is based on the EMR dataset

Another variable that was measured was the number of minutes the patient arrived early for their appointment, which was determined by the difference between the actual check in time versus the appointment time. These values were compared between the testing and the no-testing group. On average, patients who did not receive any ancillary testing was 9 minutes early for their appointment, whereas patients who did receive ancillary testing was 10 minutes early for their appointment. A two-sample t test gave a t-test value of -3.57 (p=0.00035), indicating that patients who had testing done at their appointment arrive statistically significantly earlier than those who did not.

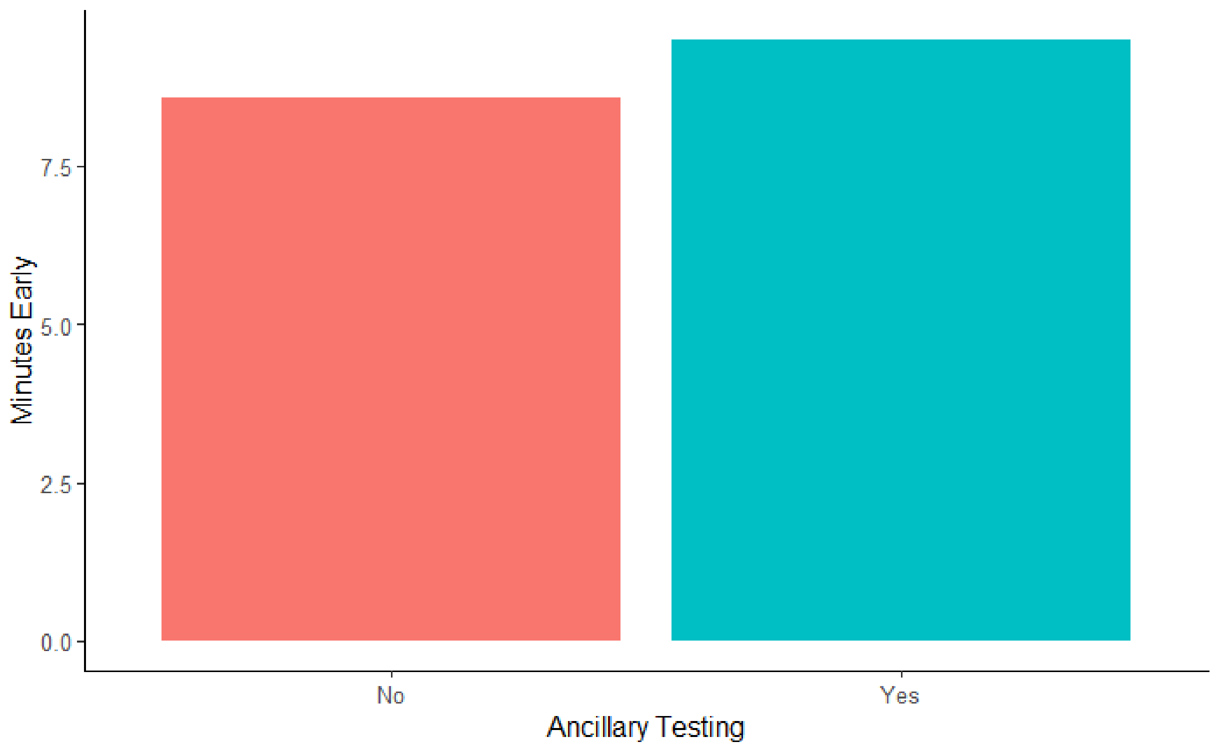

Figure 3. The comparison of the average number of minutes that patients arrived early to their appointment for those who did not receive ancillary testing and those who did.

The next graph displays the difference in length of visit depending on the type of ancillary testing that was performed. In comparison, the OCT, Goldman Visual Field and A-Scan biometry took the shortest time, whereas patients who needed anterior segment ultrasound and fluorescein angiography required the longest time.

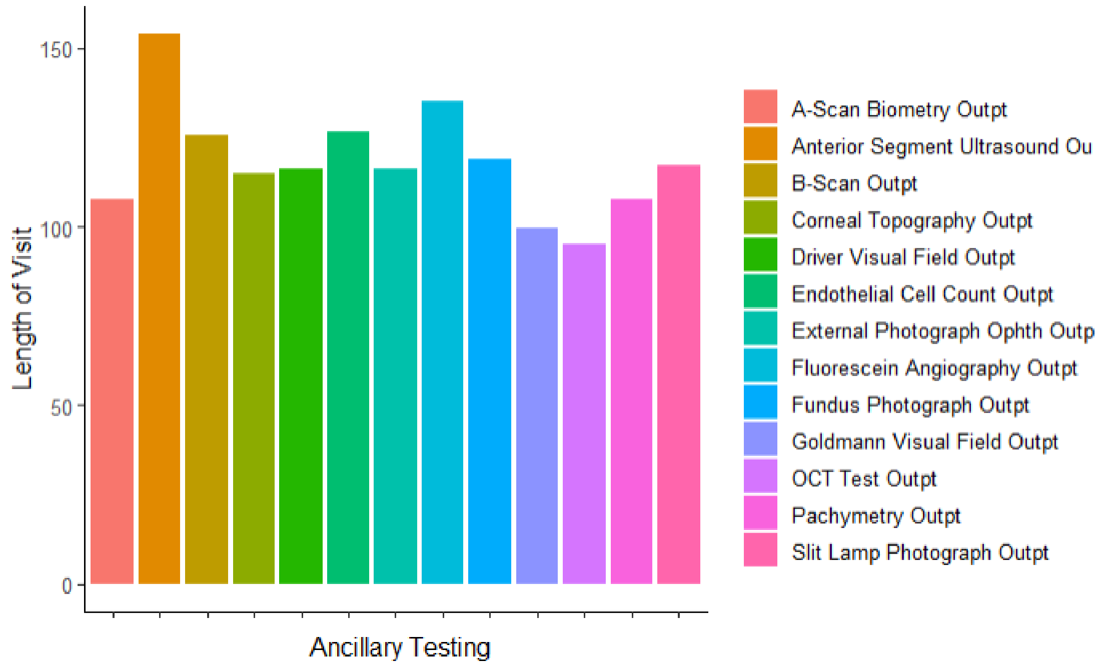

Figure 4. A graph comparing the average length of visit to the type of ancillary test performed.

In the survey dataset, the average length of visit between the two groups were once again compared to determine whether these results agreed with the results from the larger dataset. The average length of visit in the no testing group was 67 minutes, whereas those in the testing group was 98 minutes. These values closely resemble those obtained from Figure 1. We were able to find that patients who received ancillary testing had a statistically significantly longer visit than those who did not.

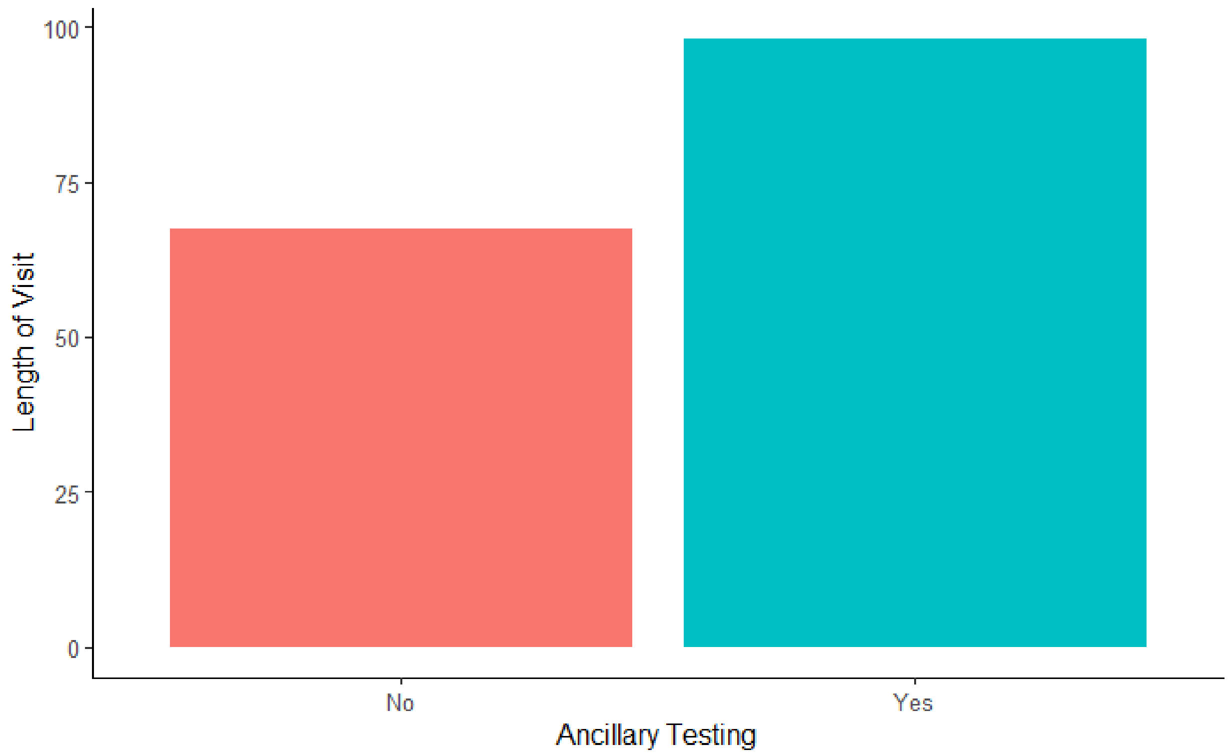

Figure 5. A graph comparing the average length of visit in patients who did not receive testing versus those who did. This graph is based off of data from the survey dataset.

The patient wait times between each step of the exam was totaled and the average wait time was compared for the no-testing and the testing group. On average, patients who did not receive testing waited for 46 minutes, whereas those who received testing waited for 54 minutes. A two-sample t test yielded a t value of -0.85 (p=0.40), indicating that patients in the testing group did not wait significantly longer than those in the no-testing group. A power test showed that we would require 310 participants in each group, for a total of 620 patients to obtain a statistically significant result for the difference seen.

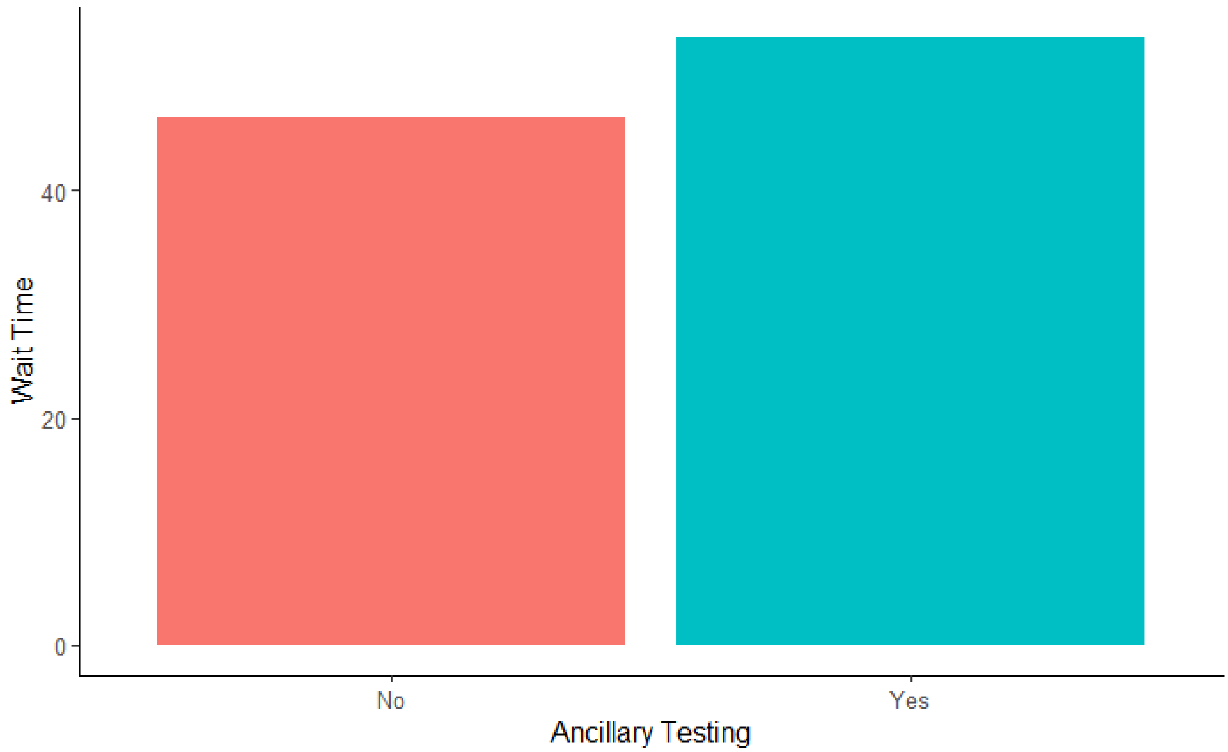

Figure 6. A graph comparing the difference between wait times in patients who did not receive ancillary and those who did.

Discussion

Interpretation of Results

Based on the results of these analyses, we can conclude that patients who presented at Hershey Penn State eye center and who required additional testing, had both a longer length of visit and presented earlier to their visits than those who did not. We were also able to determine which ancillary test resulted in the longest length of visit. Based on the data collected from surveys, we found that patients who required testing had to wait longer than those who didn't require testing, but the values were not clinically significant. Despite being unable to conclude that the reason for the delays in the clinic's patient flow is due to bottlenecks in the ancillary testing step, the results may still be able to provide some useful insight to the clinic.

However, there may be discrepancies in our results that have not been accounted for in this initial study. There are many reasons why a patient's exam may take longer than average other than the wait time. For instance, two patients may arrive for an eye exam, but one just needs a routine eye exam with no ocular problems, while the other patient presents with a far more complex case with multiple comorbidities. Furthermore, we did not consider that the longer length of visit may be due to any additional time it takes to run the specific ancillary test so we cannot assume that the difference is purely due to wait time. Since the design of this study was observational, variables between each patient were not controlled. This suggests that there are many confounding variables that were not able to be included in this analysis.

Implications for Community

Efficient patient flow and minimization of wait times are crucial to running an effective outpatient clinic. By understanding the sources of delay, we can improve the effectiveness and profitability of a clinic. In the case of the Hershey Penn State Eye Center, we found that overall, patients tended to arrive early for their appointments. This means that the clinic is doing a good job in avoiding delays in the workflow due to patient arrival times.

Limitations

We were not able to significantly conclude that wait times differ between the testing and no-testing groups, due to the small sample size. In this survey sample, only 16 out of 143 patients received additional testing.

In addition, this study is limited to the wide confidence intervals in the results due to a small data set. The data collected from the electronic health records contained outliers that needed to be removed and did not contain sufficient detail. The manual survey dataset was limited in scope and also needed to be manually input from paper to electronic format, which is subject to human error.

Conclusions and Recommendations

Efficiency is one aspect of a medical clinic that can be easily overlooked but holds great importance in operating a successful clinic. Studies suggests that it can improve quality of care, reduce patient wait time, promote patient and staff satisfaction and increase revenue. Therefore, the focus of this study was to identify whether a source of delay at the Hershey Penn State Eye Center was related to bottlenecks from ancillary testing. The results from the limited data collected represent a general overview. Unfortunately, we were unable to identify whether longer visits were specifically due to longer wait times between visit steps. Therefore, this study should be repeated with a larger sample size and specific data elements to obtain results that better represent the flow of the clinic. We suggest modifications in the electronically collected data but acknowledge that this may be difficult to accomplish. If so, a more detailed paper data collection instrument for a longer period of time could collect sufficient relevant data. In this study, we focused on the objective data, but it may also be helpful to collect subjective data on patients' *perceived* wait times. Patient satisfaction and perceived wait times are also important factors in the success of a practice, so collecting this data would provide valuable information for the clinic. If these changes can be accomplished, improvement techniques such as Lean are likely to be useful in guiding improvements in patient flow and satisfaction.

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