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Quantitative Methods in Healthcare: Contributing to Customer Satisfaction and Quality Design

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In today's consumer-driven healthcare market, proactive consumers are demanding convenience as well as quality. How an organization delivers service is becoming as important as the clinical quality (Anderson 1991). As healthcare organizations come to accept this reality, it is becoming apparent that they must arm themselves with improved skills and resources in order to meet these demands. "Mouthing slogans like 'the consumer is king' is easy, but revamping your business to make it customer centered takes more than platitudes . . . " (Appleby 1996). One area of knowledge and skill that is proving useful with regard to quality of service and design is that of management science.

Management science is a field that melds portions of business, economics, statistics, mathematics, and other disciplines in a pragmatic effort to help managers make optimal decisions (Lapin 1994). Whenever an evaluation of hard data can be helpful in reaching a decision, quantitative methods are used to assist managers in selecting the best alternative course of action that will help them in the pursuit of such organizational goals as cost-effectiveness, quality service delivery, and profit.

While good managers are often able to intuitively make reasonable decisions, intuition alone is not always sufficient for selling an "idea" to one's organization. It usually takes established precedents or hard data to influence those with authority. Applying the appropriate quantitative analytical tool to a given problem can produce the hard data needed to influence decision making.

What Are Quantitative Methods?

For healthcare managers and designers, two particular quantitative methods, queuing theory and simulation, have applications that can direct decision outcomes so as to maximize customer satisfaction and produce the optimum design, both of which directly impact profitability.

Queuing theory is one of the earliest quantitative methods, originating in a 1909 paper by A. K. Erlang, a Danish telephone engineer. The objective is to determine how to provide service to customers in such a way that an efficient operation is achieved. Retail businesses have historically utilized queuing theory successfully to determine how best to design delivery of service methods that will decrease waiting times and in turn improve customer satisfaction. An analysis of significant data can determine various characteristics of the queuing system such as mean waiting time, components of the waiting time, and the mean length of the waiting line. This information can be simply acquired and easily analyzed with readily available spreadsheet software, and then used to construct a cost analysis or determine how to achieve a targeted level of satisfactory customer service. (Lapin 1994)

Simulation is a quantitative procedure that describes a process; a series of organized trial-and-error experiments are then conducted to predict the behavior of the process in operation. Simulation helps to predict the issues resulting from the variation that occurs day to day in the process due to random chance. These simulations seek to duplicate reality as closely as possible within practical limits. Consequently, those issues identified can be addressed during planning activities with decisions being based on realistic data. Given that simulations are often conducted via the computer, a number of alternative operating policies can easily be modeled such that the optimum situation can be identified (Lapin 1994).

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What Is the Value of This Methodology?

In today's marketplace these tools are infrequently applied by healthcare managers or architects during the programming portion of the design process. It is at this early stage that accurate data is needed relative to operational patterns and processes. Critical data such as staffing levels, patient/staff flow, quantity of rooms, and number of occupants are often based on precedents or assumptions. This leads to re-establishing unnecessarily high staffing levels, potentially bad workflow, or programming in inappropriate quantities or ill-sized spaces. Often new flow concepts are rejected due to uncertainty when hard data could provide a comfort level with a proposed process.

One of the results of poor planning can be increased waiting times or appointment backlog. The new savvy of healthcare customers, combined with their busy lifestyles, has decreased the tolerance for extended waiting periods associated with the typical visit to the physician's office. (Weber 1998). "Consumers not only demand quality they also demand speed" (Katz 1991). There is also a great dissatisfaction with the delayed access as a result of appointment backlog. One guaranteed way to make patients happy is to cut the time they wait to see the doctor (Appleby 1996).

With wait times in healthcare settings causing dissatisfaction, the Institute for Healthcare, a Boston Research Group, applied classical quality management principles, including queuing theory, to help develop a system for change. The efforts produced dramatic results, with waits for appointments cut by 70 percent (Nordhaus 1997).

An ambulatory care center opened in 1992 at Johns Hopkins Hospital in Baltimore greatly emphasized patient convenience prior to its design. A computer simulation model, developed by Hamilton/KSA, was based on 8,000 patients a week using the proposed center. The computer model was able to provide information on the necessary staffing levels and procedures to streamline patient flow (Anderson 1991). From these data an operating efficiency can be determined that is useful for other analyses that impact space programming.

Quantitative methods, including simulation via software such as *MedModel*, can be used to determine the number of rooms required and the appropriate size of rooms based on occupancy. Given the operating efficiency, patient volumes, and task duration for a process such as surgery cases or physician office visits, the number of operating rooms or exam rooms required can be determined. In addition, queuing theory can determine average wait times, which, combined with patient

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volumes and number of providers, can be used to calculate the number of patients waiting at any given time. This information is then accurate for determining the size of any staging or waiting area.

When the University of Cincinnati Hospital was planning for a new surgical intensive care unit (SICU), it was determined that a computer simulation would be the best tool for accurately determining the number of beds required. The ability to change variables within the simulation allowed the decision makers to weigh the relative merits of various SICU sizes and combinations. It became clear in reviewing the results that the SICU needs are affected by the specific medical policies of the practicing physicians and the current mix of patients, among other factors (Zilm 1983). With this many factors impacting an outcome, it becomes critical that a quantitative method of evaluating them be used. To base a decision on qualitative analysis alone would have clearly resulted in a decision leading to an undesirable outcome.

A Recent Application of Quantitative Methods

In an effort to evaluate what impact queuing theories and other quantitative methods can have on customer satisfaction and good design, an analysis of an active internal medicine practice was made.

A time-flow analysis was performed at the Sycamore Primary Care Center (SPCC), a multi-specialty group teaching practice affiliated with Kettering Medical Center and Wright State University School of Medicine in Dayton, Ohio. The study was conducted to analyze and potentially modify the flow of patients through their ambulatory encounter, as well as to assess the appropriate allocation of staff to optimize the flow of patients. In addition, some modest information about waiting on the phone, waiting for prescriptions, and overall patient satisfaction with service was acquired.

From these data a simplified simulation, using Quickquant software, was run to determine the mean number of persons in the system and the mean number of persons waiting at a time.

Study Design

The patient encounter was broken down into its component parts, including a variety of options for the flow of a patient through the SPCC. As a resident physician teaching practice, physicians often come into and out of the exam room to discuss the case with a faculty supervisor. Patients were asked to complete a flow diagram during the encounter, documenting the duration at each step in their process.

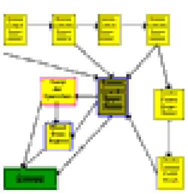

Diagram 1. Sycamore Primary Care Center Patient Encounter

- PDF file (11 Kb; Acrobat Reader required/get Acrobat Reader)
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Results

Seventy-five patients completed surveys over a two-week period. Using a queuing theory analysis, mean waiting times were determined. The results were divided into key aspects of the patient encounter.

- Patients, on average, arrive seven minutes before their scheduled appointment
- Patients wait an average of 12 minutes before being brought into the exam room
- Patients then wait in an exam room an additional 14 minutes before being seen by the physician. (Patients wait 12 minutes during a.m. appointments vs. 16 minutes during p.m. appointments before being seen by the physician)
- The patient therefore waits 26 minutes, on average, before being seen by the physician
- Patients spend 34 minutes from the time the physician begins first contact with them until the time they leave the exam room. Some of this time is not contact time with the physician but includes time the physician is out of the exam room
- The checkout process lasts 6.5 minutes, on average
- When a patient fills a prescription at the pharmacy, it takes 7.8 minutes, on average
- Patients estimate that they wait on the telephone an average of 1.7 minutes before being served
- The mean number of patients in the system over an eight-hour period is 17
- The mean number of patients waiting at a given time is 12
- Overall satisfaction for service by patients was 4.2 (on a one to five scale, five being excellent)

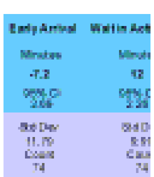

Figure 1.
Sycamore Primary Care Center Patient Flow Analysis

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Conclusions

Breaking down the patient encounter into its component parts demonstrates its complexity and highlights the many people and steps involved in the seemingly "simple" process of a visit to the doctor's office. Each part of that visit occurs in a different physical location and is conducted by a different person or combination of persons.

- Patients wait a long time (26 minutes) before being seen by the physician. The 12-minute wait before being brought into the exam room is quite clearly caused by waiting for the medical assistant. This indicates a shortage of medical assistants. Either the physician being behind schedule or an inadequate number of medical assistants could cause the additional wait of 14 minutes in the exam room before being seen by the physician. At the time of the study, the number of physicians is increased by approximately one half during the afternoon, with the same number of staff. The wait is four minutes longer in the afternoon, implying the extended wait in the exam room is more likely a staff shortage.
- The checkout process appears to be efficient
- Prescriptions are filled in an efficient manner
- Patients seem to have an adequate overall level of satisfaction. This is believed to be in part due to the positive nature of the waiting experience.

Given that this was to be a resident teaching facility, it was anticipated that there would be above-average waiting times. Consequently, one of the project goals was to design a unique, interesting waiting experience. This experience includes, among other amenities, a playroom and interactive computer kiosks (Weber 1998). Research has shown that providing distractions that entertain and physically involve the customer help to increase satisfaction (Katz 1991).

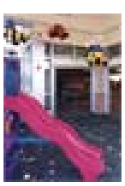

Figure 2. Playroom designed to physically involve patients create a unique, interesting waiting experience.

Suggestions

For healthcare management:

- Additional staff involved with patient care would improve efficiency
- New staff should be focused on the process of bringing patients into the exam room and caring for them during the office experience. These staff would therefore be medical assistants · Priority should be given to adding staff in the afternoons.

For designers:

- An accurate number of patients waiting at any given time is a good indicator for the size of the waiting area. Additional data could be gathered indicating the average number of guests that are with each patient. This would then indicate a more accurate occupancy rate.

Figure 3. Waiting room design uses quantitative tools to maximize customer satisfaction.

Summary

The use of quantitative methods will not always be appropriate, depending on the nature of the problem and the expediency of the process. However, an effective designer or manager must know where, when, and how to use quantitative methods to assist in making optimal decisions. This familiarity with the analytical tools available provides a definite advantage.

Advantages to be gained from utilizing quantitative methods are:

- The manager is able to break down a process into its component parts and study them carefully to improve on the total process
- Simulations allow a manager to anticipate a variety of scenarios, volume changes, or outcomes and plan for them accordingly. It is especially valuable in designing programs to handle the variations that occur in the real world from day to day or season to season
- The availability of hard data gives the decision maker increased confidence in justifying one alternative above another

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- Having experience in using quantitative methods, a decision maker is likely to have improved problem-solving skills when utilizing traditional intuitive or judgmental powers alone
- By justifying patient flow patterns and utilization rates via simulation, hard data is available from which to produce an accurate space program allowing for maximum benefit from the investment of physical resources.

For issues such as customer satisfaction, using quantitative methods adds a quantitative perspective where traditionally only a qualitative or intuitive approach has been taken. This quantitative approach has proven that appropriate data can influence decision making in a positive manner. Quantitative methods, like many other modern business practices, will be a valued tool for the healthcare industry as it tries to reinvent itself in this customer-driven marketplace.

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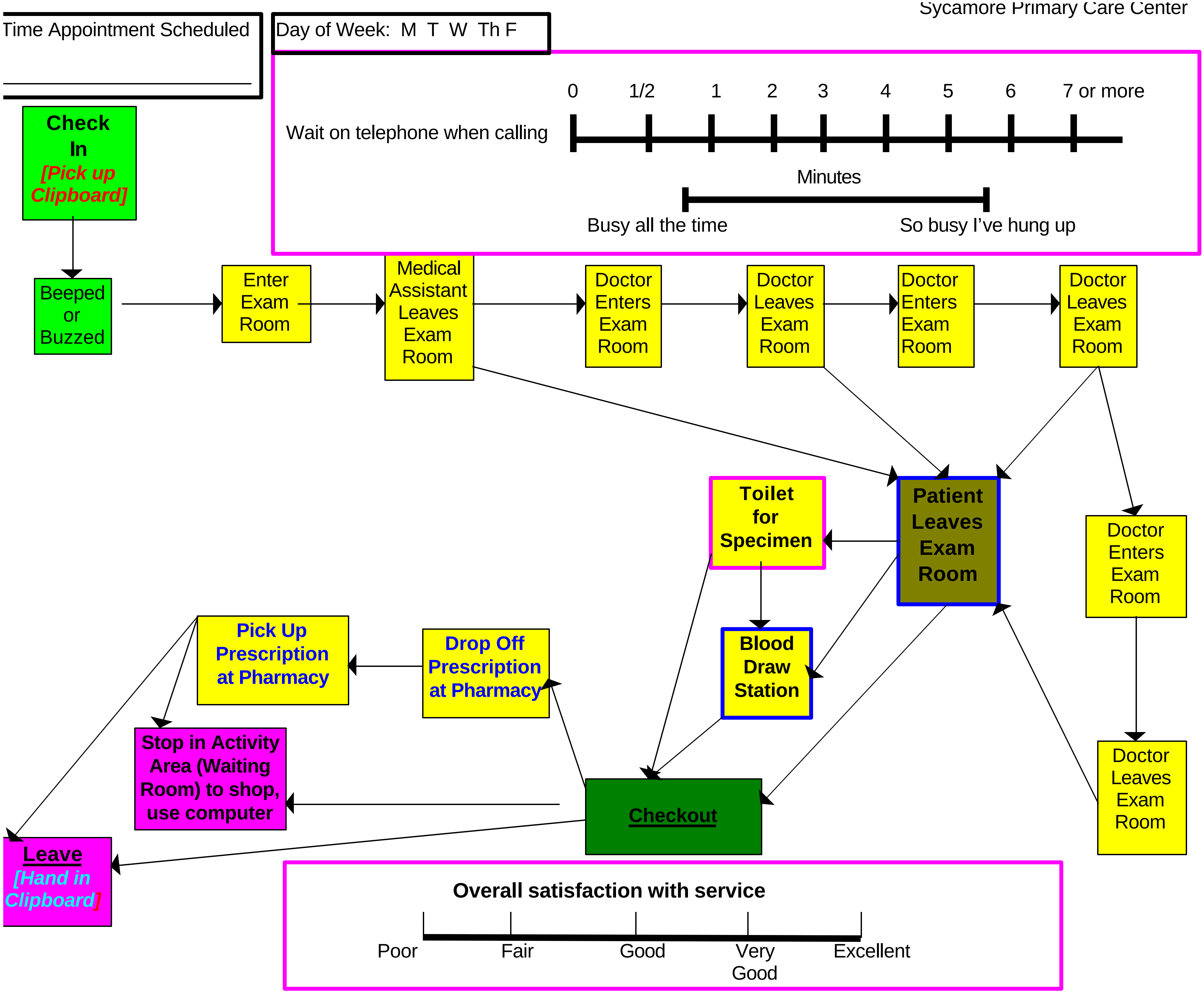
Time Appointment Scheduled
Day of Week: M T W Th F
Wait on telephone when calling
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1/2
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7 or more
Minutes
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So busy I've hung up
Check In [Pick up Clipboard]
Beeped or Buzzed
Enter Exam Room
Medical Assistant Leaves Exam Room
Doctor Enters Exam Room
Doctor Leaves Exam Room
Doctor Enters Exam Room
Doctor Leaves Exam Room
Toilet for Specimen
Patient Leaves Exam Room
Doctor Enters Exam Room
Blood Draw Station
Pick Up Prescription at Pharmacy
Drop Off Prescription at Pharmacy
Stop in Activity Area (Waiting Room) to shop, use computer
Checkout
Doctor Leaves Exam Room
Leave [Hand in Clipboard]
Overall satisfaction with service
Poor
Fair
Good
Very Good
Excellent

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For the healthcare industry, customer satisfaction is becoming the new measure of quality delivery of care and design. Historically, good common sense and intuition have served managers and designers well with regard to decision making; however, this effort sometimes falls short. Recently, reflecting the influence of business practices, more quantitative analytical tools are being utilized.

Quantitative methods such as queuing theory and simulation have been proved useful when looking at issues such as waiting times in healthcare settings. Retail businesses have long used queuing theory successfully to determine how best to design delivery of service methods that decrease waiting times and, in turn, improve customer satisfaction.

Research using queuing theory and computer simulation was conducted recently at an internal medicine practice at the Sycamore Primary Care Center, affiliated with Kettering Medical Center and Wright State University in Dayton, Ohio. Data were collected with regard to wait times, service delivery times, and customer satisfaction. From these data, conclusions could be drawn and recommendations made for improving the service delivery process.

With the data collected, a simulation was run to determine mean number of patients in the system and the mean number of patients waiting at a time, which can be used for waiting room design purposes.

Both the literature search and the data-gathering process bore out the hypothesis that quantitative analysis serves as a useful tool that can be applied in many ways to the benefit of the healthcare manager and designer.

This methodology serves to provide the decision-maker with supportive quantitative data as opposed to more readily available qualitative data. The quantitative data are valuable for predicting how a system or process will function and providing measurable characteristics of the process, which are useful for evaluation purposes. The ability to evaluate a process will be useful in predicting whether that process will improve customer satisfaction.

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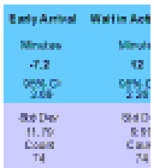
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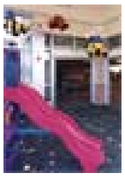
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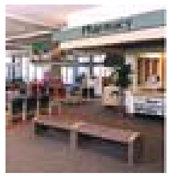
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Abstract

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Patient Flow Analysis

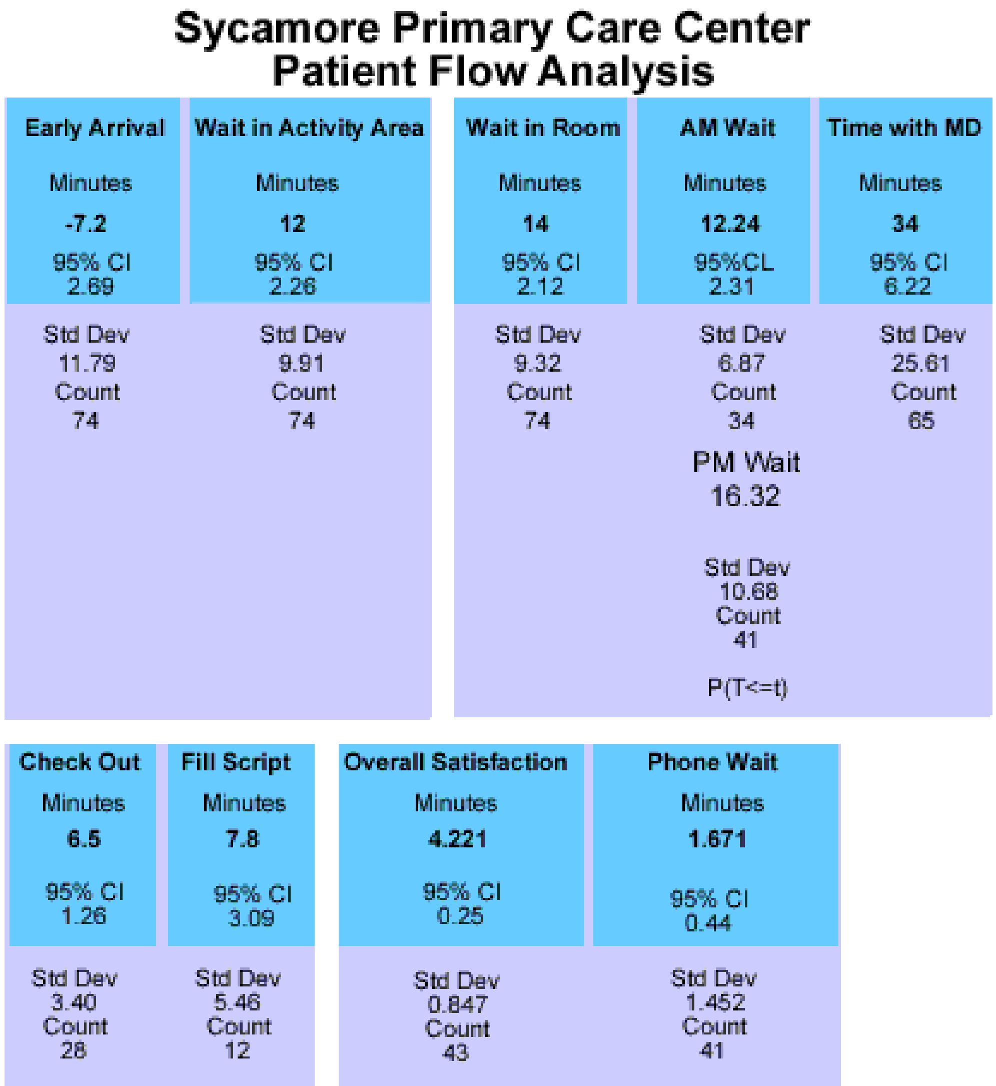

Figure 1: Patient Flow Analysis

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Sycamore Primary Care Center

Figure 2: Playroom to entertain and physically involve patients creates a unique, interesting waiting experience.

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Figure 3: Waiting room design uses quantitative methods to maximize customer satisfaction.

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