Clinical Study of
Patient Service and Wait Times
(February-April 1996)

IOE 481 Hospital Systems
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0.0 Executive Summary

The purpose of this project is to decrease the amount a patient spends waiting in an exam room during his/her appointment in the Pediatric Community Clinic at the Taubman Center; a part of the University of Michigan Medical Center. Specifically, special attention was paid to reducing the amount of wait time a patient experiences when being examined by a doctor/medical student team. In order to achieve this, it was necessary to gain an understanding of the process which all relevant parties (i.e. the patient, doctor, medical student, nurse, and/or medical assistant) go through during a normal doctor visit, as well as the duration of these processes in order to isolate areas in the process which are most likely to result in long wait times.

To collect this data, each member of the project team performed time studies of the medical personnel during various shifts. For every appointment observed, each team member recorded the amount of time the patient spent in the exam room alone and the amount of time the patient was in the company of medical personnel. Once this data was collected, it was sorted according to four criteria: type of personnel the patient was examined by, time of day (mornings vs. afternoons), day of the week (Mondays vs. Wednesdays), and the type of visit (WCC, SC, etc.), and statistically analyzed.

From the data we collected and analyzed, we developed the following conclusions:

1) Exams conducted by doctor/student teams last longer than exams conducted by single doctors.
2) Exams conducted by doctor/student teams have a higher proportion of wait time than exams conducted by single doctors.
3) Morning exams last longer than afternoon exams.
4) Morning exams have longer wait times than afternoon exams
5) Exams conducted on busy days last as long as exams conducted on slow days
6) Well Child exams, Sick Child exams, and follow-up exams all last approximately the same amount of time and have the same amount of wait time.

In order to decrease the amount of wait time experienced by patients, we recommend that the Pediatric Community Center implement the following changes in their process when they move to their new location in the summer:

1) Have doctor/student teams conduct all of their discussions in the exam room instead of in the hall.
2) Eliminate the folder system of alerting nurses of new patients, and replace it with a beeper system.
3) Do not bring a patient into the exam room until the doctor is ready to see him/her.
4) Procure an IOE 481 group to conduct follow-up studies of the new processes.
1.0 Definitions

In this report, we will be using certain phrases to describe various situations and events. The following is a list of key phrases with our chosen definitions.

- **start time**: defined as the time that the medical assistant completes the preliminary exam of the patient (i.e. weight check, temperature check, eye check, etc...) and writes the patient's appointment on the appointment board.

- **end time**: the time that the patient leaves the exam room

- **exam, visit**: the patient's appointment as defined by the start time and end time

- **service time**: the duration of time that a staff physician, resident, medical student, nurse, and/or medical assistant is with the patient in the exam room.

- **wait time**: the duration of time that a patient is in the exam room with no medical personnel present.

- **external wait time**: the duration of time from the beginning of the patient exam to the time that the scheduled physician, resident, and/or medical student first enters the exam room.

- **internal wait time**: wait time procured during the patient exam after the physician, resident, and/or medical student has first entered the exam room.

- **total time**: the duration between start time and end time, also considered the sum of service time and wait time.

- **M3**: code name for medical student.

- **resident**: part time residents in the clinic

- **staff, staff physician**: faculty physicians in the clinic

- **doctor**: refers to both residents and physicians.
2.0 Introduction

The purpose of this project is to streamline the amount of wait time the average patient experiences in the exam room of the Pediatric Community Clinic, especially when being examined by a doctor/medical student team. Decreasing the amount of wait time will improve the quality of a patient’s visit. Not only will the reduction in wait time increase the proportion of service time in the visit, it will also decrease the overall duration of the patient’s visit; ensuring that fewer patients will experience excessive wait times as a result of late-starting appointments. Reducing wait time will also improve the efficiency of the medical personnel; again, by reducing the chance that an appointment will last longer than planned, causing a following appointment to begin late.

2.1 Background

The Pediatric Continuity Clinic is located on the first level of the Taubman Center as a part of the University of Michigan Medical Center. The clinic is scheduled to move to a new site across from Domino's Farms under the name of the East Ann Arbor Health Center. The new site will practice somewhat differently than the present. Currently, the pediatric clinic is staffed by:

- 3 full-time attending physicians
  Dr. Kenneth Pituch
  Dr. Adrienne Musci
  Dr. Dolores Mendelow

- 1 part-time attending physician
  Dr. Thomas Shope

- 17 residents (approximately 4 per day)
  Dr. Augenstein  Dr. Payne
  Dr. Piotrowski  Dr. Graziano
  Dr. Ping  Dr. Sartor
  Dr. Chapman  Dr. Gilligan
  Dr. Lindow  Dr. Baker
  Dr. Boyd  Dr. Chang
  Dr. Hoover  Dr. Tekkanat
  Dr. Riskalla  Dr. Park
  Dr. Allende

The staff is also assisted by nurses, medical assistants and clerical staff. In addition, medical students do rotations through the clinic.

One of the challenges facing academic centers is to maintain both a high quality education program and high patient satisfaction ratings. The relationship between service and wait times is considered a significant factor in both areas.
3.0 Current System

The procedure for a conducting a patient's exam depends largely on what type of medical personnel a patient is seeing: single physician or resident, single nurse, or doctor/student team. The process of a doctor/student team exam is what we are most concerned with examining and changing. In order to analyze the process in detail and isolate problem areas, we broke the procedure down into a sequence of individual activities and arranged them in a flowchart (flowcharts for the other types of exams are available in Appendix A). The current procedure for a patient exam conducted by a doctor/student team is depicted in Figure 1.

The main difference between this process and that of a single medical personnel is that a doctor/student team tends to accumulate more internal wait time. It is not that single physicians and residents never leave the exam room during an exam, but they do so much less often than the student doctor teams. Moreover, because the medical student must leave the exam room following his/her initial exam of the patient, it is guaranteed that every patient examined by a doctor/student team will experience at least one period of internal wait time; this occurrence is not as consistent with single personnel exams.
Does patient require a nurse's attention?

Yes

Nurse enters room and examines patient

Nurse leaves room

No

Patient leaves room
4.0 Approach and Methodology

4.1 Data Collection

In order to collect data regarding the service time and wait time of the average patient exam, our project team conducted time studies of clinic operations. Each team member was scheduled to observe clinic operations for six hours a week during different shifts and days for a total of 18 hours observation per week, a schedule is available in Appendix B. The time studies were conducted over a two month period, February through March; excluding the first week of March due to the University of Michigan’s Spring Break. The pediatric clinic has eleven exam rooms, numbered 0 - 11. Due to the layout of the clinic, team members only observed the patient exams conducted in rooms 0 - 7. Over 450 patient exams were observed during this time.

For each observation period, a team member sat in a chair in the hall of the clinic where she could easily observe rooms 0 - 7. For each patient exam, the team member recorded the room number of the patient exam, the start time of the exam, the times that a physician, resident, medical student, and/or nurse entered and left the exam room, and the time that the exam ended. Only the names of the doctors were recorded with each exam; medical students were recorded as M3. Team members also recorded the individual characteristics of each appointment such as the number of patients being treated, the reason for the exam, and circumstances causing an unusually long or short exam period (such as a patient arriving late for an appointment, or having to wait an excessively long time for any given reason). We also examined computer records of the appointment schedules to assist us in determining the reasons for the exams.

One factor which concerned us in performing the time studies was the potential affect our presence would have on the medical personnel. Having strangers sit in the hall watching their every move was likely to cause some awkwardness. There was the possibility that personnel would change their behavior because they were being watched. This is a typical concern with most studies. During the first few weeks of our observations, we did receive a few comments from medical personnel that they felt strange being watched all the time. After a while, though, the medical personnel did not pay as much attention to us; it seemed like they had gotten used to us as just part of the background.

4.2 Data Analysis

Once we completed our data collection, we entered our time records into a Microsoft Excel 5.0 spreadsheet using the same format as our hand written records (the raw data took up nearly 3000 rows of the spreadsheet). From the raw data, we compiled a summary sheet (sample data sheets in Appendix B). Each patient exam listed in the summary had its total service time, total wait time, external wait time, internal wait time, and total time recorded. Each entry also listed the type of visit, the medical personnel who examined each patient, the room number of the exam, and the date.

We then sorted the entries in the summary table according to the type of provider who conducted the exam, the time of day (mornings vs. afternoons), the day of the week (Mondays vs. Wednesdays), and the type of exam. Type of visit categories were: WCC (well child), SC (sick/injured child), follow ups, other, unknown, and 2 patient (visits where more than one patient was examined during a single visit).
5.0 Results--Comparisons

Once the data was sorted, it was grouped into further categories for the purpose of comparing different situations. For this, it was necessary to calculate the averages for the lengths of the wait times, service times, and total times. Wait times were further analyzed by the contribution of external and internal waits. It should be noted that the length of a patient's exam varies greatly (this is discussed in further detail in Appendix C: Statistical Data). However, the average duration times of service times and wait times are still very useful for determining the general trends in exam lengths as they pertain to different situations. In each of the following graphs, average times are measured in minutes.

5.1 Service and Wait Times by Type of Provider

Overall, exams conducted by doctor/student teams take up the most amount of time, second highest are exams conducted by single residents, and exams conducted by single staff physicians take up the least amount of time (see Graph 1). This pattern is consistent for service times and wait times as well as the total exam time. For doctor/student exams and staff exams, the amount of service time a patient receives exceeds the amount of wait time s/he experiences by 2-4 minutes. Patients examined by single residents experience approximately equal service times and wait times (average wait time exceeds average service time by less than 1 minute).

Internal wait times associated with the type of provider followed the same pattern as overall exam times; the highest internal wait times were experienced with doctor/student teams and the lowest with single staff physicians (see graph 2). However, external wait times exhibited a different pattern. In this category, patients examined by single residents experienced the most external wait time, while patients examined by doctor/student teams experienced the second highest amount of wait time. Single staff physicians still procured the least amount of wait time. Additionally, it is noted that for single resident exams and single physician exams, the amount of external wait time greatly exceeds the amount of
internal wait time accumulated during the exam. In contrast, the internal wait time and external wait time associated with a doctor/student exam are nearly equal.

![Graph 2: Average Wait Times Based on Type of Provider](image)

5.2 Service and Wait Times by Time of Day (mornings vs. afternoons)

The total length of a patient exam was found to be the longest on Tuesday mornings and shortest on Wednesday mornings (see Graph 3). In almost all shifts observed, the amount of service time either exceeded or was equal to the amount of wait time; on Friday afternoon, the wait time exceeded the exam time. Overall, morning exams tended to last slightly longer than afternoon exams.

![Graph 3: Average Times by Time of Day](image)
Wait times followed a more consistent pattern than overall service and exam times (see Graph 4). For the morning shifts, total wait times were the greatest on Mondays, then decreased as the week progressed; external and internal wait times also followed this trend. In contrast for afternoon shifts, total wait times were lowest on Mondays, then increased as the week progressed; external wait times followed this trend, but internal wait times took a dip on the last day of the week. External wait times exceeded internal wait times for all shifts.

### Graph 4: Average Wait Times by Time of Day

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<th>Internal</th>
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<td>Tuesday Afternoon</td>
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</tr>
<tr>
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<td>0:09</td>
<td>0:02</td>
</tr>
<tr>
<td>Wednesday Afternoon</td>
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<td>0:06</td>
<td>0:02</td>
</tr>
<tr>
<td>Friday Morning</td>
<td>0:05</td>
<td>0:03</td>
<td>0:02</td>
</tr>
</tbody>
</table>

5.3 Service and Wait Times by Day of the Week (Monday vs. Wednesday)

Mondays and Wednesdays were the only days for which time studies were taken during both morning and afternoon shifts. They were also significant because Mondays are the clinic’s busiest days and Wednesdays the slowest. As seen in Graph 5, the average length of a Monday exam is nearly equal to that of a Wednesday exam. The proportion of service time and wait time for each day is also nearly identical.
The lengths of external and internal wait times were also very similar for Mondays and Wednesdays (see Graph 6). External wait times exceeded internal wait times for both days.

Our findings regarding service and wait times for Mondays and Wednesdays were unexpected. We expected that the exams conducted on the slow day would last longer and have a smaller proportion of wait time than those conducted on the busier day. However, it was noted that the number of medical personnel working on Mondays exceeded that of Wednesdays. Hence, while the number of patients treated on Mondays exceeds that of Wednesdays, the ratio of medical personnel to patient remains consistent for both days. We feel that this accounts for the consistency in exam lengths despite the inconsistency in the number of patients seen on a certain day.
5.4 Service and Wait Times by Type of Visit

The total lengths of follow-up exams, sick child exams, and well child exams all come within one minute of each other (see Graph 7). Service time for follow-up and well child visits slightly exceeded total wait time; for sick child visits, wait time was slightly greater than service time. For each of these categories, the average was taken of all visits where only one patient was examined. The service time and wait time for visits where two patients were examined was significantly greater than all categories averaging single patient exams. The average service time of a two patient exam was greater than the wait time. In Graph 7, the “Other” category refers to situations that do not fit into any of the three categories (e.g. a patient having his/her X-rays examined, patient having his/her blood pressure checked). Immunizations are not included in any of the categories; because our study was focused mainly on times associated with doctors and/or medical students, service and wait times associated with services performed by nurses and/or medical assistants were not included.

![Graph 7: Average Times by Type of Visit](image)

External and internal wait times for each of the three main categories again were nearly identical to one another (see Graph 8). For each category, external wait time exceeded internal wait time by 3-4 minutes. For two patient visits, the external wait time was equal to internal wait time.
Pediatric Continuity Clinic, (Feb-Mar 96), n=385

Graph 8: Average Wait Times by Type of Visit

- External wait
- Internal wait
- Total wait

Type of Visit: follow-up, sick child, well child, unknown, other, 2 children

Average Time:
- External wait: 0:28
- Internal wait: 0:20
- Total wait: 0:17
6.0 Conclusions

The following is a summary of our findings based on our comparison of the service and wait times associated with different types of exams. As a result of our data analysis, we have drawn the following conclusions.

6.1 Type of Provider

- Exams conducted by doctor/student teams take longer than exams conducted by single residents and single physicians. Both the service time and the total wait time for these exams exceeded that of single doctor exams.
- External wait times and internal wait times for doctor/student exams are greater than external and internal wait times for single doctor exams. Doctor/student exams are also the only type of exam where the amount of internal wait time exceeds the amount of external wait time.
- Single resident exams take longer than single physician exams. Again, both service and wait times for resident exams exceeded those of physician exams. Internal and external wait times for resident exams were also greater.
- For single doctor exams, external wait time exceeds internal wait.

6.2 Time of Day

- Exams conducted in the morning last slightly longer than those conducted in the afternoon.
- For the morning exams, wait time, both external and internal, is greatest at the beginning of the week, then decreases as the week progresses.
- For the afternoon exams, wait time, both external and internal, is the lowest at the beginning of the week, then increases as the week progresses.

6.3 Day of the Week

- The intensity of the clinic's schedule has no affect on the amount of service time and wait time (external and internal) that make up an exam. Exams last just as long on busy days as on slow days. There is more staff scheduled to work on the busy days; hence the ratio of medical personnel to patient remains consistent even though patient flow does not.

6.4 Type of Visit

- Overall, the type of exam a patient receives has very little affect on the length of that exam, with the exception of two-patient exams. Well child checks, sick child exams, and follow-up exams all have nearly the same external wait time, internal wait time, and service time.
- Two-patient exams have longer service times and wait times than single patient exams.
Overall, the biggest problem facing the clinic is external wait time. In almost all categories examined, external wait time exceeded internal wait time. At this point, we are not sure exactly why this large amount of external time occurs with most exams.
7.0 Recommendations--Process Change

The process we are most concerned with changing is that of the exams conducted by doctor/student teams. For these exams, we recommend that the doctor stay in the room with the medical student for the entire duration of the exam. In the revised process, the doctor be present while the medical student performed the initial exam of the patient. The doctor and student would conduct all of their discussions in the exam room in the presence of the patient. A flow chart of the proposed process is available in Figure 2.

7.1 Advantages

There are many advantages to this process change. Recalling Graph 2, exams conducted by student doctor teams had about 12 minutes of internal wait time, compared to five minutes in internal wait time for exams conducted by single staff physicians. Not only could the new process reduce the internal wait time of doctor/student exams to that of single physicians, it is possible that doctor/student exams may actually end up having less internal wait time than single physician exams. If, during a doctor/student exam, the doctor requires any equipment or information outside the exam room, s/he could send the student out to retrieve it, or leave the student in the room while s/he retrieved it. The patient would still be in the company of medical personnel and not waiting alone in the exam room.

Additionally, holding discussions between the student and doctor in the presence of the patient may improve the quality of the discussion for both the medical personnel and the patient. The student and doctor will be able to include the patient and his/her parent(s) in the discussion, and hence, be able to ask the patient questions during the exam rather than running back and forth between the exam room and the hall. Additionally, the patient’s parents will be able to play a more active role in their child’s care by partaking in the discussion.

It should be noted that the new process will most likely not decrease the overall duration of the exam. Rather, the focus is on increasing customer satisfaction by increasing the proportion of service time in a doctor/student exam.

7.2 Disadvantages

The main problem with the new process deals with the potential personal reactions of the patient and medical students. It is possible that a patient’s parent feel uncomfortable listening to a doctor’s discussion with a medical student using the patient’s case as a teaching device. Similarly, a medical student may feel uncomfortable receiving instructions and criticisms from the instructing doctor in front of a patient. At this point, it is difficult to predict the reactions of the medical personnel and patients to the new process. The next section of the report will detail recommendations for gauging customer and personnel feelings towards the new process.
Figure 2: Proposed Process for Staff/Residents with M3

1. Med asst. writes appointment on board

2. Staff/Resident and M3 enter room

3. M3 examines patient

4. M3 and doctor conduct all discussions with each other and the patient in the room.

5. Doctor and M3 leave exam room

6. Does patient require a nurse's attention?

   a. Yes
      - Nurse enters room and examines patient
      - Nurse leaves room
      - Patient leaves room

   b. No
8.0 Recommendations--Miscellaneous

- One definite area for improvement is the external wait time for a nurse. These times varied from 0 to 30 minutes, with the average being 10 minutes (See Appendix B). We believe this may be caused by the folder system used to signal that a patient needs immunizations. Once a doctor finishes with a patient, s/he puts the patient's folder in a box for the nurses. However, the nurses do not sit idly waiting for these folders to accumulate. They have other work they need to do, in areas where they cannot see the folders. A large part of the nurse's job is to be on the phone tending to patients' problems. While medical assistants alert nurses of a folder, they are also often too busy to do so. An alternative to the folder system would be for nurses to have beepers to alert them of a waiting patient. Because beepers are used extensively in many other areas of the Taubman Center and hospital, implementing them in the Continuity Clinic would not be difficult.

- One possible way to reduce the amount of external wait time a patient experiences would be to refrain from bringing patients back to the examining room until a doctor is ready to see them. It is unclear exactly how many minutes this would cut from the average external wait time associated with an exam, but as will be discussed in Section 9, this will be one of the process changes that may be studied by in a subsequent IOE 481 project.
9.0 Recommendations--Implementation and Follow-Up

9.1 Implementation

It is recommended that the clinic begin implementation of the new doctor/student exam process by June 1. Beginning the process change in June will allow all relevant medical personnel to become familiar with the new process over the summer. By the beginning of the University of Michigan’s Fall Term 1996, the process should be running smoothly. If there are no medical students scheduled to work over the summer, the process should be implemented at the start of Fall Term 1996.

The nurses should be fitted with beepers by the July 1, 1990. This is to allow two months of ordering and receiving the beepers.

The process of bringing patients into the waiting room only when the doctor is ready to see them should be implemented by June 1.

9.2 Follow-Up: Time Studies

It is recommended that a second series of time studies be taken of the new process using the same methods for data collection and analysis that were used with this study. The object is to compare data from the old processes with data from the new processes and determine if there are any changes in the average service and wait times associated with different exams. Again, special attention should be paid to exams conducted by doctor/student teams to see if the proportion of service time increased in these exams, and if so, by how much.

9.3 Follow-Up: Patient and Medical Personnel Surveys

The follow-up study should include a customer survey of patients and/or their parents who are examined by doctor/student teams; as well as a survey of medical students and doctors who perform doctor/student exams. The object of the customer survey is to determine how comfortable or uncomfortable the patients are with having the doctors and students conduct their discussions in the exam room, and to gage their overall satisfaction with their exam. Medical students will be asked how comfortable or uncomfortable they are with receiving instructions and criticisms in front of their patients, and doctors will be asked for their feelings towards giving instructions and criticisms in front of the patients.

9.4 Follow-Up: New IOE 481 Project

It is highly recommended that the clinic continue its relationship with Dr. Coffey’s IOE 481 class in the Fall Term '96. A new group should be procured to perform the follow up study of the new process for it’s Senior Design Project in order to gage the effects of the new process. If the new process was implemented in June, the group should begin it’s study of the clinic at the beginning of September. If the process was implemented at start of the Fall term, the study should begin at the beginning of October.
APPENDIX A:
Flowcharts
Single Staff Physicians or Residents

Med asst. writes appointment on board

Doctor enters room and examines patient

Doctor enters room and examines patient

Does the doctor have to leave the room before the exam is completed?

Yes

Doctor leaves room and completes required task(s)

No

Doctor leaves room upon completing exam

Does patient require a nurse's attention?

Yes

Nurse enters room and examines patient

Nurse leaves room

Patient leaves room

No
Nurses Administering Immunizations

Med asst. writes appointment on board

Nurse enters room, takes patient's info.

Is the shot prepared?

Yes

Nurse leaves room
Nurse prepares shot
Nurse re-enters room.

No

Nurse administers shot to patient

Nurse leaves room

Patient leaves room
APPENDIX B:
Observation Schedule
Clinic Schedules
Sample Data Sheets
APPENDIX 1:
Observation Schedule
Clinical Schedule
Sample Data Sheets
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Observation Schedule
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Sample Summary Sheet
APPENDIX C:
Statistical Data
Statistical Data

Averages alone cannot always be properly interpreted. For example, a distribution of times with some exceptionally high outlying points will bring the average time up, while the majority of cases may actually take a shorter average time. Hence, we plotted the histograms for many of the graphs which were examined above, to see how the data was distributed, and if the averages correctly portray the data.

These graphs have some features in common. Service times tend to be relatively bell shaped, while wait times tend to be rather skewed. In addition, most of the histograms have long tails, meaning that there is a large variability in this direction, and not in the other direction (no negative times are possible). All of the following graphs show the average as a patterned bar. It should be noted that due to difficulties in plotting histograms of times, the scales are not correct. In other words, every number on the x axis is not included, only those where times fell are labeled. The effect this has is to make the curves look more normal, when they actually have long tails. It does not usually affect the beginning data, because there are usually times for every minute up to a certain point. At this point, where times become variable, the graphs are distorted.

Please note: Graphs that are labeled “Medical Student” refer to data associated with doctor/student exams, not time data associated with single medical students.
I. Histograms of Times by Type of Provider

Below is the histogram of resident service times. This graph shows that the service times approximate a normal distribution with an elongated tail. The average is also an excellent approximation of the actual time that is most likely to occur when a resident provides service (i.e. it is not skewed towards one end or the other, but lies in the middle, where most of the service times lie).
The graph of resident total wait times is more skewed than the service time graph, with an average of a 20 minute total wait time. The maximum total wait times was 1 hour and 19 minutes, while the most common wait time was 11 minutes.

**Histogram of Resident Total Wait Times**

![Histogram of Resident Total Wait Times](image)
The histogram of resident total visit times is again, bell shaped with an elongated tail. The variability is huge, with a maximum total visit time of 2 hours and 2 minutes, and a considerable number of appointments lasting longer than 1 hour. Again, these times only include time associated with a doctor. The average total visit time is 41 minutes.

Histogram of Resident Total Visit Times
The resident external wait time graph shows that the average time is 12 minutes. Some external wait times reached over an hour. So, a patient waited for over an hour before a resident ever stepped foot into the examining room.

Histogram of Resident External Wait Times
The following graph shows the distribution of internal wait times while a resident is the provider. The distribution is nowhere near normal, with the greatest number of internal wait times being 0 minutes. The average internal wait time however, is 8 minutes. This average is not a very good approximation of what usually happens because most of the points lie to the left of the average. So, the distribution, once again, shows that there is enormous variability in the data, as the maximum internal wait time was 48 minutes, and the minimum was 0.

**Histogram of Resident Internal Wait Times**

![Histogram of Resident Internal Wait Times](image)
The staff service time distribution looks approximately normal, however, it again has a long tail. The average staff service time is 16 minutes, and this agrees with the picture of the data.
The average total wait time for a staff is 14 minutes. The distribution, not surprisingly resembles the previous wait time distributions.

Histogram of Staff Total Wait Times

[Histogram showing distribution of staff total wait times]
The staff total visit times are bell shaped as well. The variability to the right side is once again large, due to the combined variability of the service and wait times. The average staff total visit time is 30 minutes, the exact number of minutes allotted for a staff physician appointment. However, please remember that this total visit time only includes the service or wait times attributed to a doctor, and does not include any nurse times, MA times, or times attributed to other personnel. So, the actual appointment times might be a great deal longer in some cases.

Histogram of Staff Total Visit Times
The staff external wait times are shown below. The average external wait time was 9 minutes, however, 19 out of 125 people waited longer than 20 minutes, with the longest time being 49 minutes before a staff physician entered the room.

Histogram of Staff External Wait Times
The staff internal wait times were considerably less than the external wait times. 52 out of 125 people (42%) had no internal wait time while the average internal wait time was 5 minutes. Again there is large variability. This could be due to the way the staff practice, but also the nature of the appointments. For example, some sick patients need to get medical attention while they are waiting for a hospital room to become available. All of this time would be counted as internal wait time.

**Histogram of Staff Internal Wait Times**

![Histogram of Staff InternalWait Times](image)
The medical student distribution of service times has a similar shape to the staff and resident service time distributions. However, the average service time is higher, at 26 minutes, indicating that it generally takes medical students longer to examine patients than residents or staff.

Histogram of Medical Student Service Times
The histogram of medical student total wait times is shown below. The average total wait time is 23 minutes, and this accurately portrays the situation, seeing that 39 people waited for a shorter time, and 37 people waited for a longer time. This indicates that the average is also near the median wait time.
The medical student total visit time distribution is shown below. The average total visit time was 50 minutes, 20 minutes longer than the average staff visit time, and 9 minutes longer than the average resident total visit time. Again, none of this data include times to see nurses or other personnel.

Histogram of Medical Student Total Visit Times
The distribution of the medical student external wait times looks similar to the previous external wait time distribution of the staff. However, the medical student average is slightly higher, with a value of 11 minutes rather than 9 minutes. Additionally, a slightly higher percentage of patients had to wait longer than 20 minutes than did patients who saw staff. In this case, 18 out of 84 patients, or 21% of the people waited longer than 20 minutes.

Histogram of Med. Student External Wait Times
The medical student internal wait times have a similar variability to the distribution of the staff. The y axis scales, which record the number of each appointment which lasted for a certain time, are different for these two graphs, so they must be analyzed carefully. The staff’s graph looks distorted, however, it is only due to the different scales. The medical student average internal wait time, with a value of 12 minutes, was higher than the staff’s value of 5 minutes. Additionally, only 7 patients had an internal wait time of 0 minutes.

Histogram of Med Student Internal Wait Times
II. Histograms by Type of Visit

The following graphs are histograms by type of visit. Only well-child checks, sick child checks, and follow ups were considered. Some appointments had immunizations, however these times were eliminated to make the data comparable. Additionally, only visits which examined 1 child were included in these graphs.

The sick child service times are distributed normally with the exception of an elongated tail to the right. The average sick child service time is 18 minutes. All of these visits are for only 1 child.

Histogram of Sick Child Service Times
The sick child wait times are shown below. The average total wait time is 20 minutes, combining external and internal. The graph again assumes the distribution typical of wait time distributions.

**Histogram of Sick Child Wait Times**
The total visit time distribution for sick children is shown below. The average time is 38 minutes, while the range was from 8 minutes to 1 hour and 49 minutes. This graph is one of the most variable seen out of all of the graphs. The total visit times are spread over an extremely wide range.

Histogram of Sick Child Total Visit Times

[Histogram image]
The sick child external wait time distribution has an average of 11 minutes. The data is clustered from 0 to 11 minutes, however, a long tail extends all the way out to 1 hour and 4 minutes.

**Histogram of Sick Child External Wait Times**
The sick child internal wait times have an average of 8 minutes. The greatest number of patients had an internal wait time of 0 minutes. This would be an ideal distribution for wait time, if only the tail did not extend out so far. One patient was in a room for a total of 48 minutes with no medical personnel present.
The well child service time average is 21 minutes. This is only 1 minute longer than the sick child service time, however, well children often receive immunizations, and this time is not included in this graph. Additionally, only well child checks with 1 child were included here.

**Histogram of Well Child Service Times**

![Histogram of Well Child Service Times](image-url)
The well child wait time graph is shown below. It has an average of 18 minutes. The tail extends all the way out to 1 hour and 14 minutes, and the distribution is similar to other wait time distributions.
The average well child total visit time takes 39 minutes. Again, remember that this includes only the doctor's time, and not time for nurses. The variability is huge, with a maximum of 2 hours and 2 minutes for one visit for one child.

**Histogram of Well Child Total Visit Times**
The average well child external wait time is 10 minutes. However, note that one patient waited 1 hour and 6 minutes before a doctor ever entered the room.

**Histogram of Well Child External Wait Times**

![Histogram graph showing distribution of external wait times with a peak at 10-11 minutes and a notable outlier at 1 hour and 6 minutes.](image-url)
The average well child internal wait time is 7 minutes. This distribution overall seems to have lower values than the distributions for external wait times. It is very similar, however, to the previous distribution for sick child internal wait times.

Histogram of Well Child Internal Wait Times
The follow up service time average is 20 minutes, nearly identical to the service times for well and sick children. The maximum service time is 1 hour and 4 minutes, less than the maximum times for sick and well children. Additionally, the average seems to approximate the median point well.

**Histogram of Follow-Up Service Times**

![Histogram of Follow-Up Service Times](image-url)
A follow-up average total wait time is 19 minutes. This distribution seems to have no identifiable high point. The times are rather spread almost evenly between 7 and 34 minutes.
Similarly, the follow-up total visit time distribution is rather spread out. The most people who shared a common time was 3. The average time was 40 minutes, right in the center of the graph.

**Histogram of Follow-Up Total Visit Times**
The average follow-up external wait time is 11 minutes. The maximum is 44 minutes, and the distribution is extremely variable.
The follow-up internal wait time is 8 minutes. This is similar to the well-child check and sick child internal wait times, and the distribution has much variability.

**Histogram of Follow-Up Internal Wait Times**
III. Histograms of Nurse Times

The following histograms examine the total wait time, external wait time, and internal wait times for nurses to treat patients. The majority of these visits were immunizations for well-child checks. The rest were for sick child checks, follow-ups, or solely immunization appointments. If a doctor went into a room, came out, and then a nurse went in, came out, and a doctor returned, we would attribute the times as follows. The only wait time for the nurse would be the time between when the doctor exited and the nurse entered (as well as any internal wait time). Service times are not included here because they do not seem to be a problem. The wait times, however, are unnecessary, and need to be reduced.

The average total wait time for a nurse is 10 minutes. The distribution is again typical of wait times, with a long tail extending to 30 minutes.

**Histogram of Nurse Total Wait Times**
The average external nurse wait time is also 10 minutes. This means that practically all of the time spent waiting for a nurse is before she enters. Once the nurse enters a room, she is unlikely to leave before finishing her work.

**Histogram of Nurse External Wait Times**

![Histogram of Nurse External Wait Times](image)
This graph of nurse internal wait times confirms the previous statements. Over 45 of the patients examined had internal wait times of 0 minutes.

Histogram of Nurse Internal Wait Times