Analysis of New Patient Lead Times for The Division of Cardiology

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Student Project Team

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Introduction and Background

The student Project Team consists of Jonathan Brinks, Brian Cross, and Robert Larsen. All three individuals are currently taking the class in Industrial and Operations Engineering 481 entitled “Special Projects in Hospital Systems.”

The student Project Team has accepted the opportunity to consult in the Division of Cardiology at the University of Michigan Hospitals in Ann Arbor, Michigan. Elizabeth Othman is the Project Coordinator. Patricia Barry, Administrator for the Division of Cardiology, is the Project Client.

The student Project Team is conducting analyses for the Division of Cardiology. The Division would like to implement new scheduling software. It is the student Project Team’s responsibility to determine new patient lead times, only. The student Project Team has decided that the lead time is the period in between when the appointment date was created and the actual appointment date. The determination of lead times are for the use of bench marking. The Division of Cardiology believes that if patients are served better (sooner appointments), the patients will be that much more satisfied and the amount of lost business will be reduced.

The Division of Cardiology at the University of Michigan Hospitals will be analyzed. The four locations that are relevant to this project are the main location at Taubman, the Faculty Diagnostic Unit (FDU), also located at Taubman, the Briarwood clinic, and Preventive Cardiology at MedSport.

Scheduling within the realm of the Division of Cardiology can be made several ways. First, patients can go through the centralized scheduling system because the Division of Cardiology is within the bounds of Internal Medicine. Second, individual doctors can make scheduling arrangements. Third, non-Taubman clinics like Briarwood and MedSport can schedule. Lastly, specialty units like heart transplant and the pacemaker unit can also make scheduling appointments. All schedules are made through computer scheduling software.

The student Project Team received a raw data disk. This disk contained patient visitation numbers, patient names, patient addresses and zip codes, appointment date, date the appointment was created, cancellation date (where applicable), patient type, appointment status, and Resource Code. The Resource code can represent the physician who worked on the patient, by visit specialty, a general clinic visit (staff), and a physician’s resident, fellow, or RN. For a complete list of Resource codes and their corresponding physician(s) and location, refer to the Appendix A. The raw data disk was in a MS Word file, but was translated to a MS Excel file by the student Project Team. The disk contains twenty months of raw data: from July 1994 through February 1996. The client, however, was interested only in the analysis of the final eight months of the data: from July 1995 through February 1996.

Lead time is the main variable that is being analyzed for this project. Lead times were analyzed against rates of cancellations, locations, physician, and seasonal/holiday patterns. The analysis was not only done by the four locations mentioned before, but five specialty units were also to be considered: General Cardiology, Heart Failure and Heart Transplant, Electrophysiology, Catherization and Valve. The data was analyzed for each physician at each of the four locations to determine availability of each. Also, average lead times for an appointment with each physician at different times during the year was analyzed. This was also done for each specialty unit, both as a whole, and by individual physicians as well.
Approach & Methodology

After receiving the raw data disk, it was necessary for us to find a way to calculate the Lead times for each of the many thousands of appointments given the appointment date and the date the appointment was created. The dates, however, were given in the form of eight consecutive numbers, the first four indicating the year (1994 through 1996), the next two indicating the month (01 through 12) and the last two indicating the day (01 through 31). These were converted, using MS Excel's features, to the form xx/xx/xx (e.g. 08/11/95 for August 11, 1995). In this form, a subtraction formula (appointment date minus appointment creation date) would give the lead time in days. The formula was copied down the spreadsheet column, and it was time to analyze.

First, the appointments were sorted by resource codes [location and physician(s)]. Four separate entities could now be analyzed: Taubman, the Faculty Diagnostic Unit (FDU), Briarwood, and MedSport. An overall average lead time and standard deviation was calculated for each entity. Before proceeding, any lead times beyond three standard deviations of the mean were removed from the data set.

Second, the files were then sorted by appointment date. Lead time averages were calculated for each month to determine any variations. Bar graphs were constructed for each location that showed monthly average lead times. The next step was to sort the appointments by resource code and then by appointment date within the resource code. This step was taken to calculate an overall lead time average for each resource over the entire period of time.

The appointment status was next to be considered. There were four classifications for appointment status: “A” for an appointment kept by a patient, “C” for a canceled appointment, “N” for a no-show, and “R” for a rescheduled appointment. A no-show was defined as the patient never contacted the Cardiology clinic before or after their appointment. Cancellations and Rescheduled appointments could occur after the patients scheduled appointment. So, if a patient called in the day after his scheduled appointment and wanted to reschedule his appointment, he would be classified as a rescheduled status and not a no-show status. The data was sorted by resource code, and then by appointment status to calculate the appointment status for each resource over the eight month period. A bar graph was then constructed showing the appointment status for each resource (A% + C% +N% +R% = 100%). These graphs are presented in a way to highlight appointments kept and rescheduled appointments. This can determine scheduling by predicting what patient percentage will follow-through on the appointment, and, conversely, what percentage will not show up.

After completing the analysis of each location, five specialty units were analyzed: General Cardiology, Heart Failure and Transplant, Electrophysiology, Catherization and the Valve unit. An average lead time was calculated for each unit over the eight month period. The appointments were then sorted by appointment date, starting with July 1995 and ending through February 1996. Monthly lead time averages were calculated over the five specialty units to see if there were any monthly or seasonal problems. A bar graph for each specialty unit was constructed showing each month’s average lead time.
Results & Conclusions

The results for the new patient lead time analysis for the Division of Cardiology are broken down into three sections. First, the results of the lead time analysis for the entire Cardiology clinic will be discussed. Second, the results of the lead time analysis by location will be discussed. Finally, we will discuss the results of the lead time analysis by specialty units. All of the Figures in this section of the report can be found in Appendix B in a larger size for better legibility.

Entire Clinic Lead Time Analysis

This section of the results will concentrate on the overall Cardiology Clinic lead times. The first thing that we looked at was the average lead time for each month. Figure 1 below shows the average monthly lead time for July 1995 to February 1996. Above each bar there is the number of new patients seen that month and the standard deviation for lead time.

![Monthly Average Lead Times for the Entire Cardiology Clinic](image)

Figure 1. Average Lead Times by Month for the entire Cardiology clinic.

The next thing we looked at was the total number of appointments for each month. Figure 2 on the following page shows the total number of appointments for each month broken down by the number of appointments for each lead time group. Figure 2. shows that the total number of appointments fell in November and December and then rose in January and February. A possible reason for this is that the clinics decrease visits for a week in November for a National Cardiology Meeting. Also the clinic is closed for Thanksgiving and the following Friday in November. During December the number of appointments may have been low because of the Christmas Holidays.
Appointment Lead Time Totals by Month over all of Cardiology

Figure 2. Total Number of Appointments by Lead Time for all of Cardiology.

Next we decided that to compare each month on a similar basis we should give the percentage breakdown of appointments for each lead time group. Figure 3 below shows that December and January had the highest percentage of appointments with a lead time of less than one week. A possible reason for this is that because of the Christmas holidays, there is less demand for appointments in December. With the lower demand in December the lead times in December and January would have become smaller because of the increased number of appointments available.

Lead Time Percentages by Month for All of Cardiology Jul 95 - Feb 96

Figure 3. Monthly Lead Time Percentage Breakdown for the Entire Cardiology clinic.
The final thing we looked at for the entire Cardiology clinic was the rates of No-Shows, Cancellations, Rescheduling, and Appointments Kept. Figure 4 below shows that as the lead time goes up, the percentage of Appointments kept drops significantly. There is also a significant increase in the percentage of Rescheduling and Cancellations. No-Shows remained fairly constant at about 7% for the Cardiology clinic.

Figure 4. Appointment Status compared to Lead Time.
Location Lead Time Analysis

This section of the results looks at our analysis of new patient lead times by location. Location average lead time is important to determine resource allocation when lead times are relatively high. Figure 5 below summarizes the average lead times at all four locations within the Division of Cardiology. The overall average lead time for the Division of Cardiology is about 30.4 days. The Taubman location generally takes in approximately 65-70% of all new patients, and it is the one that drives the average lead time over the Division. The Faculty Diagnostic Unit (FDU) has the lowest lead time (23.9 days) based on our analysis and also has the least variation.

<table>
<thead>
<tr>
<th>Clinic</th>
<th>Average Lead Time (Days)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briarwood</td>
<td>LT=29.8</td>
<td>150</td>
</tr>
<tr>
<td>FDU</td>
<td>LT=23.9</td>
<td>218</td>
</tr>
<tr>
<td>Taubman</td>
<td>LT=30.3</td>
<td>1486</td>
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<tr>
<td>MedSport</td>
<td>LT=29.2</td>
<td>503</td>
</tr>
</tbody>
</table>

Figure 5. The Division of Cardiology’s four locations and corresponding lead times.

It is important to get more than a macro view of average lead times, and that thinking brought about an analysis of lead times within locations, namely the components of the location: the resource code. The resource code is a description of the location and physician. When attempting to get a beginning scheduling appointment, the resource is reviewed, and it is an indication of how many open slots there are over some set time period (for example, there are some Friday-only resources). All resources within the four locations were analyzed, and were sorted under their location. Figure 6 on the following page shows the four resources that are available at the MedSport Cardiology clinic. The average lead times at Briarwood, the Faculty Diagnostic Unit, and Taubman are located in Appendix D.
Patient appointment status is important when deciding on patient and staff scheduling. For the University Hospital scheduling system, patients are categorized into four groupings: Appointments kept (A), Cancellations (C), no-shows (N), and reschedules (R). For thoroughness, the Project Team determined that each location and each resource code should be analyzed. Figure 7 below shows the percentage of each appointment status by location. The overall graph is a weighted average of the four locations within the Division. Note that the overall is almost an exact copy of the Taubman bar graph. This is probably due to the high number of patients that Taubman accepts relative to the other locations.

Figure 7. Appointment status percentages for each of the four locations within the Division of Cardiology.
Next we did an analysis of the percentage of each status type across all resources within the Division of Cardiology. The MedSport Cardiology clinic is shown in Figure 8. Briarwood, the FDU, and Taubman's appointment status results are shown in the charts in Appendix C.

![MedSport Appointment Status Percentages for July 1995 through February 1996](image)

Figure 8. Appointment status percentages for resources within a location (MedSport). Note the data is in the form xx.x,y where xx.x is the average lead time for that resource and y is the number of appointments of that status type.
Specialty Unit Lead Time Analysis:

This section of the results will discuss the analysis of the lead times for the Specialty Units in Cardiology. The first thing we looked at was the average lead time for each specialty unit. Figure 9 below shows the average lead time for each specialty unit. It also shows the overall average line, and includes the number of appointments and the standard deviation for each specialty unit.

![Average Lead Times for each Specialty Unit](image)

Figure 9. Average lead time for each specialty unit in the Division of Cardiology.

![Lead Time Percentages for each Specialty Unit](image)

Figure 10. Lead time percentage breakdown for each specialty unit.
Figure 10 on the previous page shows the percentage of appointments for each specialty unit which had lead times of less than 1 week, 1 to 2 weeks, 2 to 3 weeks and greater than three weeks. Heart Failure and Transplant had the highest overall average lead time which could explain why it had the highest percentage of appointments with over a three week lead time. Electrophysiology had the second highest overall average lead time, however, as this chart indicates, it had the least percentage of appointments with over a three week lead time, and the most with less than a one week lead time.

Since Electrophysiology had the second highest average lead time and the fewest percentage of appointments over three weeks we decided to do further analysis which can be seen in Figure 11 below. As you can see, Electrophysiology had about 20% of its appointments with a lead time of over two months, higher than all four other specialty units. This would explain the high average lead time. In fact, Electrophysiology was the only specialty unit to have appointments with over a 90 day, or three month lead time. It had 24 of them. Also on the chart, you can see the Heart Failure / Transplant unit had the second highest percentage of appointments with over a two month lead time at about 18%. This specialty unit had the highest average lead time which can easily be seen by the data in the last two charts.

![Lead Time Percentage for each Specialty Unit](chart)

Figure 11. Lead time percentage for each specialty unit with the > 2 month lead time group added.

The specialty unit of General Cardiology had 1318 appointments over the eight month period between July 1995 and February 1996. They accounted for about 56% of the total number of appointments in all of Cardiology. Figure 12 on the following page is similar to the last two charts, but it shows the breakdown of only General Cardiology by month. Each month they had at least 45% of their appointments with a lead time of over 3 weeks, peaking at almost 70% in August 1995, which really has a large impact on driving the overall average lead time in all of Cardiology to be very high. An effort to reduce these lead times would help reduce the overall average significantly and most likely reduce the amount of lost business in the department.
Figure 12. Percentage breakdown of lead time by month for General Cardiology

Recommendations

The first recommendation from our analysis is to try and increase the number of appointment lead times of less than a week. Our data showed that the appointments with a lead time of less than one week had a higher rate of the patients keeping the appointments. Also, when lead time was less than one week the amount of lost business (Cancel + No Shows) was smaller than when lead time was greater than one week. Once the lead time was greater than three weeks the amount of lost business reached its highest percentage.

Next, we would recommend lowering your lead time by shrinking your patient waiting queue. Right now the current scheduling system is unable to lower the number of people waiting for appointments. If there is no change in the scheduling system then the patient lead times can be expected to increase. One way to shrink the number of patients waiting would be to open more new patient slots in the short term. Once you get your lead times down to a more reasonable level then you cut back on the new patient slots, though maybe not as low as the previous levels.

Finally, if you do lower your lead times then you should keep track of them in the future to insure that they don’t start climbing back up to the previous levels. This could be done with a monthly chart of lead times for each specialty unit or by location. It would also be helpful to keep track of the lead times for each individual resource code. The charts should probably include five to six months of previous lead time history and each month you could add a new month to the chart and remove the first month from the chart.
Appendix A

The following page shows each resource code, explaining which physician they correspond to and at which location he/she practiced at.
List of Resource Codes along with the physician and location it corresponds to.

<table>
<thead>
<tr>
<th>Briarwood:</th>
<th>Physician(s)</th>
<th>MedSport:</th>
<th>Physician(s)</th>
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<tr>
<td>BSCARMS</td>
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<td>MDSRUBE</td>
<td>Rubenfire</td>
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<td>Marcovitz</td>
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<td>Werns</td>
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<td>MDSEAGLE</td>
<td>Eagle</td>
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<td>Moscucci</td>
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<td>BSCPEAGLE</td>
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<td>MDSSHEA</td>
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**Faculty Diagnostic Unit (F DU):**

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**Taubman:**

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Appendix B

The following charts are all charts which appeared in the results section of the report. Here they are each enlarged to a full page size for the reader's convenience.
Average Lead Times for each Specialty Unit

<table>
<thead>
<tr>
<th>Specialty Unit</th>
<th>Average Lead Time (days)</th>
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<tr>
<td>Transplant</td>
<td>0 = 18.75, N = 1318</td>
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<tr>
<td>General Cardiology</td>
<td>0 = 18.01, N = 324</td>
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<td>Cardiology</td>
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<tr>
<td>Electrophysiology</td>
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<td>Catheterization</td>
<td>0 = 21.44, N = 227</td>
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<tr>
<td>General Heart Failure</td>
<td>0 = 35.00, N = 223</td>
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</tbody>
</table>

Overall Average: 30.4
Lead Time Percentages for each Specialty Unit

- General Cardiology
- Heart Failure / Transplant
- Electrophysiology
- Catheterization
- Valve

Lead Time Percentages for the Total Number of Appointments
Lead Time Percentage for Each Specialty Unit

<table>
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<th>Specialty Unit</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
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</table>

Lead Time Percentages:
- > 1 Week
- 1-2 Weeks
- 2-3 Weeks
- < 3 Weeks - 2 Mos
- < 2 Months
Lead Time Percentages by Month for General Cardiology

Month of Scheduled Appointment

Jan-95
Feb-95
Mar-95
Apr-95
May-95
Jun-95
Jul-95
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95

Percentages of Total Number of Appointments

< 1 Week
1-2 Weeks
2-3 Weeks
> 3 Weeks
Monthly Average Lead Times for the Entire Cardiology Clinic

Month of the Scheduled Appointment

- Feb-96
- Mar-96
- Apr-96
- May-96
- Jun-96
- Jul-96
- Aug-96
- Sep-96
- Oct-96
- Nov-96
- Dec-96

Overall Average (30.4)
Month of the Scheduled Appointment

Appointment Lead Time Totals by Month over all of Cardiology
Lead Time Percentages by Month for All of Cardiology

Month of the Scheduled Appointments

- July 95
- Aug 95
- Sep 95
- Oct 95
- Nov 95
- Dec 95
- Jan 96
- Feb 96

- > 1 Week
- 1-2 Weeks
- 2-3 Weeks
- < 3 Weeks

Percentage of each lead time

- 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

July 95 - Feb 96
Appointment Status Percentages by Lead Time in all of Cardiology

- No-shows
- HCancellations
- Rescheduled
- Appointments kept

Percentage of the Total Number of Appointments

<table>
<thead>
<tr>
<th>Lead Time Range</th>
<th>No-shows</th>
<th>Rescheduled</th>
<th>Cancellations</th>
<th>Appointments kept</th>
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<tbody>
<tr>
<td>&lt; 1 week</td>
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<td>&gt; 3 weeks</td>
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MedSport Appointment Status Percentages for July 1995 through February 1996

The format xx.x, y represents lead time for that status (xx.x), and number of occurrences (y).

- Appointments kept
- Reschedules
- Cancellations
- No-shows

For July 1995 through February 1996 MedSport Appointment Status Percentages
Clinic Appointment Status Percentages for July 1995 through February 1996

- No-shows
- DCancellations
- Reschedules
- Appointments kept

<table>
<thead>
<tr>
<th>Resource Code</th>
<th>Overall</th>
<th>MedSport</th>
<th>FDU</th>
<th>Taubman</th>
<th>Briarwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentages</td>
<td>56.9%</td>
<td>7.3%</td>
<td>16%</td>
<td>15.3%</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>80%</td>
<td>23%</td>
<td>10%</td>
<td>13%</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>74%</td>
<td>16%</td>
<td>14%</td>
<td>12%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>72%</td>
<td>18%</td>
<td>12%</td>
<td>11%</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>70%</td>
<td>20%</td>
<td>11%</td>
<td>10%</td>
<td>0%</td>
</tr>
</tbody>
</table>

For July 1995 through February 1996
Average Lead Times at MedSport for July 1995 through February 1996

- MDSEAGLE: LT = 24.9, s = 13.5, n = 45
- MDSFLJCE: LT = 27.6, s = 16.3, n = 296
- MDSHEA: LT = 29.2, s = 23.8, n = 77
- MDSWRNS: LT = 19.6, s = 17.4, n = 74
Percentage of Appointment Status by Location

July 1995 through February 1996

Percentage of Appointments by Location:

- **Overall**: 6.5% No-Shows, 7.0% Cancellations, 50.4% Reschedules, 17.1% DNo-shows, 17.2% DReschedules
- **Briarwood**: 8.3% No-Shows, 7.8% Cancellations, 27.0% Reschedules, 14.9% DNo-shows, 57.4% DReschedules
- **FDU**: 8.0% No-Shows, 9.5% Cancellations, 26.0% Reschedules, 14.7% DNo-shows, 54.9% DReschedules
- **Taubman**: 8.8% No-Shows, 7.5% Cancellations, 18.6% Reschedules, 12.8% DNo-shows, 61.8% DReschedules
- **MedSport**: 1.8% No-Shows, 8.2% Cancellations, 30.0% Reschedules, 1.8% DNo-shows, 61.8% DReschedules

Total: N = 2346
MedSport Average Lead Times for Total Appointments for July 1995 through February 1996

Resource code

- MDSEAGLE: LT = 24.9, σ = 13.5, n=45
- MDSRUPE: LT = 27.6, σ = 16.3, n=296
- MDSSHEA: LT = 36.2, σ = 23.8, n=77
- MDSWERNS: LT = 19.6, σ = 17.4, n=75
Average Lead Time Over the Four Clinics in the Division of Cardiology from July 1995 through February 1996

- Briarwood: n=150, LT=29.8
- FDU: n=218, LT=23.9
- Taubman: n=1486, LT=30.3
- MedSport: n=503, LT=29.2
The following charts are bar graphs separated into four sections indicated by four different color schemes. Each bar represents data from each resource from the location at which they practice. The first section of the bar shows the percentage of that resource's appointments which were kept by the patient. The second section shows the percentage of appointments that were rescheduled. The third shows the percentage of appointments that were canceled, and the last represents the percentage of no-shows. Within each section of each bar are two numbers, the first indicating the average lead time for that section, and the second shows the number of appointments that the resource had for that section. The averages and totals shown are taken from data within the time period of July 1995 through February 1996.
Taubman Appointment Status Percentages for July 1995 through February 1996

The format xx.x, y represents lead time for that status (xx.x), and number of occurrences (y).
The format xx.x,y represents lead time for that status (xx.x), and number of occurrences (y).
Taubman Appointment Status Percentages for July 1995 through February 1996

<table>
<thead>
<tr>
<th>Resource Code</th>
<th>No-shows</th>
<th>Cancellations</th>
<th>Reschedules</th>
<th>Appointments kept</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSTMORFEL</td>
<td>14.0.1</td>
<td>54.3.4</td>
<td>11.0.15</td>
<td>13.0.1</td>
</tr>
<tr>
<td>HSTMORFAN</td>
<td>20.1</td>
<td>39.4.36</td>
<td>12.9.11</td>
<td>22.5.4</td>
</tr>
<tr>
<td>HSTMORADY</td>
<td>67.9.10</td>
<td>22.5.4</td>
<td>25.0.11</td>
<td>65.0.11</td>
</tr>
<tr>
<td>HSTMUDGE</td>
<td>22.5.13</td>
<td>27.3.14</td>
<td>25.2.20</td>
<td>20.6.33</td>
</tr>
</tbody>
</table>

The format xx.x.y represents lead time (x.x) and number of occurrences (y) for that status.

- 0%: 100%
- 10%: 90%
- 20%: 80%
- 30%: 70%
- 40%: 60%
- 50%: 50%
- 60%: 40%
- 70%: 30%
- 80%: 20%
- 90%: 10%
Taubman Appointment Status Percentages for July 1995 through February 1996

The format xx.x,y represents lead time for that status (xx.x), and number of occurrences (y).
Faculty Diagnostic Unit Appointment Status Percentages for July 1995 through February 1996

The format xx.x,y represents lead time for that status (xx.x), and number of occurrences (y).
Briarwood Appointment Status Percentages for July 1995 through February 1996

The format xx.x,y represents lead time for that status (xx.x), and number of occurrences (y).

No-shows
Cancellations
Reschedules
Appointments kept
Appendix D

The following charts show average lead times for each resource at the four locations, Taubman, the Faculty Diagnostic Unit (FDU), Briarwood, and Medsport. The results are taken from scheduling data within the time period of July 1995 through February 1996. Within each bar are three numbers, the first being the overall average lead time for an appointment with that physician(s). The second number indicates the standard deviation for those lead times, and the third shows the total number of appointments that were scheduled for that resource over the eight month period.
Abstract
Average Lead Times for General Cardiology within Taubman for July 1995 through February 1996

<table>
<thead>
<tr>
<th>Resource Code</th>
<th>Average Lead Time (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSTDAOSL</td>
<td>LT = 35.4  σ = 24.2  n=47</td>
</tr>
<tr>
<td>HSTDASHFEL1</td>
<td>LT = 28.5  σ = 14.2  n=69</td>
</tr>
<tr>
<td>HSTDASHFEL2</td>
<td>LT = 25.1  σ = 16.0  n=67</td>
</tr>
<tr>
<td>HSTSHFEL1LT</td>
<td>LT = 29.0  σ = 16.4  n=70</td>
</tr>
<tr>
<td>HSTSHFEL2LT</td>
<td>LT = 21.6  σ = 12.6  n=69</td>
</tr>
<tr>
<td>HSTPITTLT</td>
<td>LT = 46.5  σ = 35.2  n=28</td>
</tr>
<tr>
<td>HSTJUDGE</td>
<td>LT = 18.2  σ = 12.7  n=18</td>
</tr>
<tr>
<td>HSTEAGLELT</td>
<td>LT = 49.1  σ = 26.7  n=36</td>
</tr>
<tr>
<td>HSTEAFEL2LT</td>
<td>LT = 22.5  σ = 12.6  n=67</td>
</tr>
<tr>
<td>HSTEAFEL1LT</td>
<td>LT = 22.1  σ = 14.6  n=67</td>
</tr>
<tr>
<td>HSTDASFELLT</td>
<td>LT = 28.5  σ = 14.2  n=89</td>
</tr>
<tr>
<td>HSTDASLT</td>
<td>LT = 35.4  σ = 24.2  n=47</td>
</tr>
</tbody>
</table>

For July 1995 through February 1996.
Taubman for July 1995 through February 1996

Average Lead Time for Heart Failure/Transplant within

HSTCHF1: LT = 34.7, Q = 23.4, n = 58
HSTCHF2: LT = 35.9, Q = 18.4, n = 27
HSTHLT: LT = 37.3, Q = 21.7, n = 151
HSTNKLAS: LT = 46.0, Q = 4.9, n = 5
Average Lead Time for Electrophysiology within Taubman for July 1995 through February 1996

HSTSTAFEPILT = 16.3 ± 10.5 n = 49
HSTPMKMANLT = 26.0 ± 15.7 n = 16
HSTPACEFELT = 12.0 ± 7.1 n = 5
HSTMORFELLT = 42.9 ± 35.0 n = 56
HSTMORARLT = 9.9 ± 7.6 n = 16
HSTMORADYL T = 47.0 ± 46.0 n = 61
HSTAILCMA —LT = 8.5 ± 8.9 n = 5
HSTAILCDEFE —LT = 34.4 ± 30.0 n = 5
HSTAILCDEFE —LT = 18.3 ± 15.9 n = 5
HSTFED —LT = 47.0 ± 46.0 n = 61
HSTPMKMANLT = 9.9 ± 7.6 n = 16
HSTPMKMANLT = 16.3 ± 10.5 n = 49
HSTPMKMANLT = 26.0 ± 15.7 n = 16
Average Lead Times for Catheterization within Taubman for July 1995 through February 1996

Average Lead Time (Days)

For July 1995 through February 1996, the average lead times were as follows:

- HSTBATE1: LT = 27.8, σ = 11.7, n = 112
- HSTBATE2: LT = 22.0, σ = 11.3, n = 112
- HSTBATE3: LT = 31.0, σ = 30.1, n = 112
Average Lead Times for the Valve unit within Taubman for July 1995 through February 1996

HSTVALVE
LT = 27.3 Ω = 12.7 n = 70

HSTSTAR
LT = 27.7 Ω = 16.6 n = 26

HSTSTAFEL
LT = 29.8 Ω = 18.5 n = 47

HSTVALVE
LT = 24.4 Ω = 11.7 n = 61

for July 1995 through February 1996 Average Lead Times for the Valve unit within Taubman
Briarwood Average Lead Times from Total Appointments

From July 1995 through February 1996

<table>
<thead>
<tr>
<th>Resource Code</th>
<th>Average Lead Time (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSCARMS</td>
<td>LT = 34.7, σ = 20.8, n=40</td>
</tr>
<tr>
<td>BSCBACH</td>
<td>LT = 12.8, σ = 6.4, n=39</td>
</tr>
<tr>
<td>BSCNARMS</td>
<td>LT = 43.1, σ = 24.5, n=11</td>
</tr>
<tr>
<td>BSCFAVY</td>
<td>LT = 33.8, σ = 20.7, n=22</td>
</tr>
<tr>
<td>BSCMARCS</td>
<td>LT = 33.4, σ = 25.8, n=38</td>
</tr>
</tbody>
</table>

BSCFAY: LT = 35.8, σ = 20.7, n=22
Faculty Diagnostic Unit Lead Times from Total Appointments

For July 1995 through February 1996

FDUSHEA: LT = 19.4, Q = 19.1, n = 33

FDUSANT: LT = 22.7, Q = 13.1, n = 103

FDURUBI: LT = 38.3, Q = 21.4, n = 35

FDUDAS: LT = 26.3, Q = 32.0, n = 15

FDUBACH: LT = 19.4, Q = 13.2, n = 33

Average Lead Time (Days)

0.0  5.0  10.0  15.0  20.0  25.0  30.0  35.0  40.0

Resource Code

FDUSHEA  FDUSANT  FDURUBI  FDUDAS  FDUBACH
The following graphs show the average lead times by month for each of the five specialty units. The number above each bar indicates the number of appointments that were scheduled for that month. To the right of each chart is a list of all the resource codes that practice within that specialty unit.
Average Lead Times for General Cardiology

Month of Appointment

- Jul-95: N = 172
- Aug-95: N = 200
- Sep-95: N = 151
- Oct-95: N = 158
- Nov-95: N = 118
- Dec-95: N = 118
- Jan-96: N = 204
- Feb-96: N = 198

Resource Codes Included
- BSCARMS
- BSCBACH
- BSCEAGL
- BSCFAY
- BSCMARC
- FDUBACH
- FDUDAS
- FDURUBI
- FDUSHEA
- HSTAOSH
- HSTDAS
- HSTDASFEL
- HSTEAFEL1
- HSTEAFEL2
- HSTEAGLE
- HSTJUDGE
- HSTPITT
- HSTSHEA
- HSTSHFEL1
- HSTSHFEL2
- MDSEAGLE
- MDSRUBE
- MDSSHEA
Average Lead Times for Heart Failure Transplant

<table>
<thead>
<tr>
<th>Month of the Appointment</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb-96</td>
<td>42</td>
</tr>
<tr>
<td>Jan-96</td>
<td>37</td>
</tr>
<tr>
<td>Dec-95</td>
<td>36</td>
</tr>
<tr>
<td>Nov-95</td>
<td>49</td>
</tr>
<tr>
<td>Oct-95</td>
<td>19</td>
</tr>
<tr>
<td>Sep-95</td>
<td>10</td>
</tr>
<tr>
<td>Aug-95</td>
<td>10</td>
</tr>
<tr>
<td>Jul-95</td>
<td>28</td>
</tr>
<tr>
<td>Jun-95</td>
<td>19</td>
</tr>
<tr>
<td>May-95</td>
<td>50</td>
</tr>
<tr>
<td>Apr-95</td>
<td>45</td>
</tr>
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<td>Mar-95</td>
<td>40</td>
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<td>Dec-95</td>
<td>25</td>
</tr>
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<td>Nov-95</td>
<td>20</td>
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<td>Oct-95</td>
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<td>10</td>
</tr>
<tr>
<td>Aug-95</td>
<td>5</td>
</tr>
<tr>
<td>Jul-95</td>
<td>0</td>
</tr>
</tbody>
</table>

Resource Codes Included: HSTCHF1, HSTCHF2, HSTNLTXPL, HSTNIKLAS
Average Lead Times for Electrophysiology

Month of the Appointment

Resource Codes Included
HSTAICD
HSTAICDFE
HSTAICDMA
HSTMORADY
HSTMORARN
HSTMORFEL
HSTPACEFE
HSTPMKMAN
HSTSTAFEP
Average Lead Times for Valve

Month of the Appointment

- July-95: N = 24
- Aug-95: N = 20
- Sep-95: N = 23
- Oct-95: N = 47
- Nov-95: N = 19
- Dec-95: N = 10
- Jan-96: N = 36
- Feb-96: N = 31

Average Lead Time (days)
The following charts show the average lead time for each resource within each specialty unit in descending order of the number of appointments that the resources had scheduled over the eight month period.
Average Lead Time for each Resource in General Cardiology in Descending Order of the Number of Appointments

N = 36

Resource Code | July '95 - Feb. '96
Average Lead Time for each Resource in Heart Failure / Transplant by Descending Order in the Number of Appointments

<table>
<thead>
<tr>
<th>Resource Code</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSTHTXPL</td>
<td>151</td>
</tr>
<tr>
<td>HSTCHF1</td>
<td>56</td>
</tr>
<tr>
<td>HSTCHF2</td>
<td>27</td>
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<tr>
<td>HSTNIKLAS</td>
<td>8</td>
</tr>
<tr>
<td>HSTNIKFEL</td>
<td>1</td>
</tr>
</tbody>
</table>

N = Number of Appointments
Average Lead Time for each Resource in Electrophysiology in Descending Order of the Number of Appointments

- HSTMORADY: N = 61, Average Lead Time = 50.0 days
- HSTMORFEL: N = 58, Average Lead Time = 45.0 days
- HSTFAEP: N = 52, Average Lead Time = 40.0 days
- HSTCRAP: N = 17, Average Lead Time = 35.0 days
- HSTPACEFE: N = 7, Average Lead Time = 30.0 days
- HSTICD: N = 5, Average Lead Time = 25.0 days
- HSTICDE: N = 5, Average Lead Time = 20.0 days
- HSTICDNA: N = 5, Average Lead Time = 15.0 days

Resource Code
Average Lead Time for each Resource in Catherization by Descending Order of the Number of Appointments

N = 76

N = 112

N = 75

N = 61

HSTBAFE2

HSTBAFE1

MDSWERN

HSTBATE

Resource Code

Average Lead Time (days)
Average Lead Time for each Resource in Valve by Descending Order of the Number of Appointments

HSTSTAFEL: N = 70
HSTVALVFE: N = 63
HSTVALV: N = 50
HSTSTAR: N = 26
FDUSANT: N = 14

Average Lead Time (days)
The following charts indicate appointment status percentages for four different lead time ranges. Each bar, for the indicated lead time range, shows the percentage of appointments in that range that were kept, rescheduled, canceled, or no-show.
Appointment Status Percentages by Lead Time in General Cardiology

- > 3 weeks
- 2-3 weeks
- 1-2 weeks
- < 1 week

Percentage of the Total Number of Appointments

- No-shows
- Cancellations
- Rescheduled
- Appointments kept
Appointment Status Percentages by Lead Time in Heart Failure / Transplant

- > 3 weeks
- 2-3 weeks
- 1-2 weeks
- < 1week

Legend:
- No-shows
- Cancellations
- Rescheduled
- Appointments kept

Percentage of the Total Number of Appointments
Appointment Status Percentages by Lead Time in Catherization

- > 3 weeks
- 2-3 weeks
- 1-2 weeks
- < 1 week

Legend:
- No-shows
- Cancellations
- Rescheduled
- Appointments kept

Percentage of the Total Number of Appointments
Appointment Status Percentages by Lead Time in Valve

Lead Time Range

- > 3 weeks
- 2-3 weeks
- 1-2 weeks
- < 1 week

Percentage of the Total Number of Appointments

- No-shows
- Cancellations
- Rescheduled
- Appointments kept
Appendix H

The following charts show appointment status percentages and totals by month for each specialty unit. The first five charts show the percentage of the total number of appointments for that month that were kept, rescheduled, canceled and no-shows. The next five charts show the same thing except not in percentages but instead by total numbers of appointments.
Appointment Status Percentages in General Cardiology

Month of the Scheduled Appointment

- Feb. '96
- Jan. '96
- Dec. '95
- Nov. '95
- Oct. '95
- Sep. '95
- Aug. '95
- July '95

% of the Total Number of Appointments

- No-Show
- Cancelled
- Re-scheduled
- Appointments Kept
Appointment Status Percentages by Month in Heart Failure / Transplant

Month of the Scheduled Appointment

Feb. '96
Jan. '96
Dec. '95
Nov. '95
Oct. '95
Sep. '95
Aug. '95
July '95

% of Total Number of Appointments

□ No-Show
■ Cancelled
□ Re-scheduled
■ Appointments Kept
Appointment Status Percentages by Month in Electrophysiology

- **Feb. '96**
- **Jan. '96**
- **Dec. '95**
- **Nov. '95**
- **Oct. '95**
- **Sep. '95**
- **Aug. '95**
- **July '95**

Legend:
- □ No-Show
- ■ Cancelled
- ▲ Re-scheduled
- ▻ Appointments Kept

% of the Total Number of Appointments
Appointment Status Percentages by Month in Valve

Month of the Scheduled Appointments

- 0.000
- 0.100
- 0.200
- 0.300
- 0.400
- 0.500
- 0.600
- 0.700
- 0.800
- 0.900
- 1.000

% of the Total Number of Appointments

Feb. '96
Jan. '96
Dec. '95
Nov. '95
Oct. '95
Sep. '95
Aug. '95
July '95

- No-Show
- Cancelled
- Rescheduled
- Appointments Kept
Appointment Status Totals for Heart Failure / Transplant

- No-shows
- Cancellations
- Rescheduled
- Appointments Kept

Month of the Scheduled Appointments:
- Jul '95
- Aug '95
- Sep '95
- Oct '95
- Nov '95
- Dec '95
- Jan '98
- Feb '98

Cumulative Number of Appointments
Appointment Status Totals for Electrophysiology

Cumulative Number of Appointments

Month of the Scheduled Appointments

- No-shows
- Cancellations
- Rescheduled
- Appointments Kept

Feb. '98
Jan. '98
Dec. '95
Nov. '95
Oct. '95
Sep. '95
Aug. '95
Jul. '95

Cumulative Number of Appointments
Appointment Status Totals By Month In Valve

<table>
<thead>
<tr>
<th>Month</th>
<th>Appointments Kept</th>
<th>Cancellations</th>
<th>Rescheduled</th>
<th>No-shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb '95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan '95</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec '95</td>
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<td></td>
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</tr>
<tr>
<td>Nov '95</td>
<td></td>
<td></td>
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<tr>
<td>Oct '95</td>
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<td></td>
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<tr>
<td>Sep '95</td>
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<td></td>
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</tr>
<tr>
<td>Aug '95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul '95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cumulative Number of Appointments
Appendix I

The following charts show monthly averages by resource code only for resources whose average lead time was greater than that of the entire specialty unit in which they practice. This was done to see if there were any monthly or seasonal problems within the resource that could be recognized and resolved in order to drive the specialty unit's average lead time down and increase their business kept.
Average Lead Time by Month for BSCARMS

- July '95: N = 3
- Aug. '95: N = 14
- Sept. '95: N = 2
- Oct. '95: N = 6
- Nov. '95: N = 4
- Dec. '95: N = 4
- Jan. '96: N = 8
- Feb. '96: N = 1

Month of the Scheduled Appointment

Average Lead Time (days)
Average Lead Times by Month for BSCEAGL

Month of the Scheduled Appointment

Average Lead Time (days)
Average Lead Times by Month for BSCFAY

Month of the Scheduled Appointment

- July '95: N = 2
- Aug. '95: N = 8
- Sept. '95: N = 3
- Oct. '95: N = 4
- Nov. '95: N = 2
- Dec. '95: N = 1
- Jan. '96: N = 2
- Feb. '96: N = 0
Average Lead Time by Month for BSCMARC

Month of the Scheduled Appointment

July '95 Aug. '95 Sept. '95 Oct. '95 Nov. '95 Dec. '95 Jan. '96 Feb. '96

N = 10 N = 5 N = 4 N = 5 N = 4 N = 5

Average Lead Time (days)
Average Lead Time by Month for HSTBAFE1

<table>
<thead>
<tr>
<th>Month of the Scheduled Appointment</th>
<th>Average Lead Time (days)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>July '95</td>
<td>15.0</td>
<td>8</td>
</tr>
<tr>
<td>Aug. '95</td>
<td>30.0</td>
<td>13</td>
</tr>
<tr>
<td>Sept. '95</td>
<td>35.0</td>
<td>13</td>
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Average Lead Times by Month for HSTBATE

Average Lead Time (Days)

Month of the Scheduled Appointment

July 95 Aug. 95 Sept. '95 Oct. 95 Nov. '95 Dec. 95 Jan. '96 Feb. '96

N = 10
N = 8
N = 6
N = 5
N = 8
N = 9
N = 3
N = 12
Average Lead Time by Month for HSTCHF1

Month of the Scheduled Appointment

- July '95: N = 5
- Aug. '95: N = 12
- Sept. '95: N = 9
- Oct. '95: N = 10
- Nov. '95: N = 5
- Dec. '95: N = 1
- Jan. '96: N = 0
- Feb. '96: N = 14
Average Lead Time by Month for HSTCHF2

Month of the Scheduled Appointment

- July '95: N = 5
- Aug. '95: N = 3
- Sept. '95: N = 7
- Oct. '95: N = 0
- Nov. '95: N = 1
- Dec. '95: N = 0
- Jan. '96: N = 0
- Feb. '96: N = 11
Average Lead Times by Month for HSTDAS

Month of the Scheduled Appointment

- July '95: N = 10
- Aug. '95: N = 6
- Sept. '95: N = 3
- Oct. '95: N = 6
- Nov. '95: N = 5
- Dec. '95: N = 2
- Jan. '96: N = 9
- Feb. '96: N = 8
Average Lead Time by Month for HSTDAFEL

Month of the Scheduled Appointment

- Jan. '96: N = 7
- Feb. '96: N = 10
- March '96: N = 8
- April '96: N = 11
- May '96: N = 17
- June '96: N = 19
- July '96: N = 10
- August '96: N = 12
- September '96: N = 18
- October '96: N = 20
- November '96: N = 19
- December '96: N = 18

Average Lead Time (days)
Average Lead Times by Month for HSTEAGLE

Month of the Scheduled Appointment

- July '95: N = 5
- Aug. '95: N = 5
- Sept. '95: N = 8
- Oct. '95: N = 4
- Nov. '95: N = 0
- Dec. '95: N = 7
- Jan. '96: N = 5
- Feb. '96: N = 2
Average Lead Time by Month for HSTHLTXPL

Month of the Scheduled Appointment

- July '95: N = 18
- Aug. '95: N = 4
- Sept. '95: N = 33
- Oct. '95: N = 0
- Nov. '95: N = 30
- Dec. '95: N = 17
- Jan. '96: N = 36
- Feb. '96: N = 13
Average Lead Time by Month for HSTMORADY

Month of the Scheduled Appointment

July '95: N = 16
Aug. '95: N = 3
Sept. '95: N = 9
Oct. '95: N = 7
Nov. '95: N = 4
Dec. '95: N = 7
Jan. '96: N = 5
Feb. '96: N = 10
Average Lead Times by Month for HSTMORFEL

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Average Lead Times by Month for HSTP1TT

Month of the Scheduled Appointment

July '95 Aug. '95 Sept. '95 Oct. '95 Nov. '95 Dec. '95 Jan. '96 Feb. '96

Average Lead Time (days)

N = 2
N = 3
N = 4
N = 8
N = 0
N = 0
Average Lead Time by Month for HSTHFE1

- July '95: N=11
- Aug. '95: N=7
- Sept. '95: N=8
- Oct. '95: N=8
- Nov. '95: N=7
- Dec. '95: N=10
- Jan. '96: N=10
- Feb. '96: N=11

Month of the Scheduled Appointment
Average Lead Times by Month for HSTSTAFEL

Average Lead Time (days)

Month of the Scheduled Appointment

July '95 | Aug. '95 | Sept. '95 | Oct. '95 | Nov. '95 | Dec. '95 | Jan. '96 | Feb. '96

N = 10 | N = 9 | N = 3 | N = 16 | N = 7 | N = 6 | N = 6 | N = 13
Average Lead Time by Month for HSTSTAR

Month of the Scheduled Appointment

N = 3
N = 2
N = 6
N = 1
N = 4
N = 4
N = 3
N = 3
N = 2
N = 1
N = 4

Average Lead Time (days)
Average Lead Time by Month for HSTVALV

Month of the Scheduled Appointment

- July '95: N = 5
- Aug. '95: N = 4
- Sept. '95: N = 5
- Oct. '95: N = 7
- Nov. '95: N = 6
- Dec. '95: N = 6
- Jan. '96: N = 13
- Feb. '96: N = 4

Average Lead Time (days)
Average Lead Times by Month for MDSSHEA

Month of the Scheduled Appointment

July '95  Aug. '95  Sept. '95  Oct. '95  Nov. '95  Dec. '95  Jan. '96  Feb. '96

Average Lead Time (Days)

N = 14  N = 2  N = 0  N = 9  N = 12  N = 12  N = 12  N = 14